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# A Paradigm Confronting Reality: The River Basin Approach and Local Water Management Spaces in the Pucara Basin, Bolivia

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ABSTRACT: The current Bolivian water policy incorporates the IWRM paradigm adopting the river basin as the space for water management in the country. The linkage of water management with communal territories in the Andes challenges the application of the river basin approach, bringing water spaces into the discussion. Considering the example of the Pucara River Basin, the article uses space theory to identify characteristics of local spaces for water management and to contrast them with the river basin concept. The river basin concept is applied by water professionals, mostly taking the perceived dimension of this space into consideration and sometimes in abstract terms. In contrast, the lived dimension of space is more important in local water management spaces and it is not represented in abstract terms. Local water spaces are flexible and strongly related to local organisations, which allows them to respond appropriately to the needs and demands of peasant society in the area, characteristics that cannot be found in the river basin space.

KEYWORDS: Space, water management, river basin, IWRM, Cochabamba, Bolivia

## INTRODUCTION

The Bolivian state is committed to the implementation of Integrated Water Resources Management (IWRM) and has recently been encouraging the adoption of this paradigm throughout the country. One of the consequences of this decision is the consideration of river basins as units for water management and governance. The *Plan Nacional de Cuencas* (National River Basin Plan), the official document that frames the application of IWRM policy in Bolivia, defines the river basin as "the basic unit of water planning and management", which links IWRM with Integrated River Basin Management (IRBM) (Gobierno de Bolivia, 2006). In this way, the plan faithfully follows a global trend in which "[i]ntegrated Water Resources Management and its Integrated River Basin Management (IRBM) derivative have now become a rallying call of mainstream thinking on water management" (Molle, 2009: 491).

Although the implementation of IWRM is relatively new in Bolivia, experiences with river basin management date back to the 1980s. This decade witnessed the emergence of river basin management projects aimed to protect urban infrastructure in the three main cities of the country, all funded by international donors. These first actions opened the way for larger programmes that gradually adopted an integrated river basin management approach (Salm, 2010). These accumulated experiences grounded the formulation of the *Plan Nacional de Cuencas* (PNC) during the early 2000s, and influenced the formal establishment of river basins as units for water management in the country.

The consideration of river basins as 'natural units' for water management has been widely questioned for a number of reasons, including the ambiguity of river basin delimitation, the complexity of hydrological processes, the neglect of social processes and politics in their definition, and the fact that river basins rarely correspond to political-administrative jurisdictions (Budds and Hinojosa, 2012). With regard to the disconnection of river basin units from social, political and economic characteristics (i.e. Cohen and Davidson, 2011; Warner et al., 2008), the link between communal territories and local water management, which is typical of the Andean region, may further question the appropriateness of the implementation of river basin approaches. Its implications are explored here considering a case from the Bolivian Andes.

The 1953 National Agrarian Reform of Bolivia resulted in the (re)constitution of peasant communities in the Andean zone, assigning them the land and water pertaining to former haciendas (landed estates) (Larson, 1998). Consequently, all existing water systems went to peasant communities and their management started to "depend on agreements between communities and community members that compose them" (Gerbrandy and Hoogendam, 1998: 31; my translation), based in customary practices locally known as *usos y costumbre*s. These are defined as "the mutually agreed-on norms of water rights and management practices" (Perreault, 2008: 839), normally related to irrigation but also important in drinking water systems, especially in rural areas. As a consequence of this process water resources management in the Andean region of Bolivia is traditionally governed through customary norms and institutions (Bustamante, 2006; Gobierno de Bolivia, 2006) encompassed in *usos y costumbres*.

*Usos y costumbres* are "based on consensus, collaboration, and mutual vigilance" thus they "can only exist within a context of communal resource control and social organization" (Perreault, 2008: 840). In the Andes, the relationship between the management of water and the governing of local territories has been widely recognized. "In several Andean river basins and sub-basins inter-zonal socio-productive systems in which hydraulic management is combined with the management of other natural and human resources still exist or have been renewed" (Boelens, 2006: 24; my translation). Thus, understanding water management involves the consideration of communal territories. In the Andean region it can be said that "water belongs to the territory and the territory belongs to the community" (Hendricks, 2006: 94; my translation).

This particular context highlights two important aspects in relation to the adoption of river basins as water management and governance units. Firstly, there is an existing relationship between local water management and communal territories. Therefore, river basin spaces overlap locally with existing water management spaces and with communal territories. Secondly, as *usos y costumbres* are locally defined, one must be acquainted with how local communities currently understand water spaces and how this may differ from river basins. To explore both of these aspects, the article makes use of different dimensions of space to identify and analyse the characteristics of water spaces held by local water systems in the Pucara River Basin and compares these with characteristics of river basin spaces. In this way, it seeks to highlight possible differences in the perceptions about water spaces in order to inform science-based policies and potentially minimise and avoid the reductionism induced by the mainstream orthodox application of the river basin approach in the Andean region.

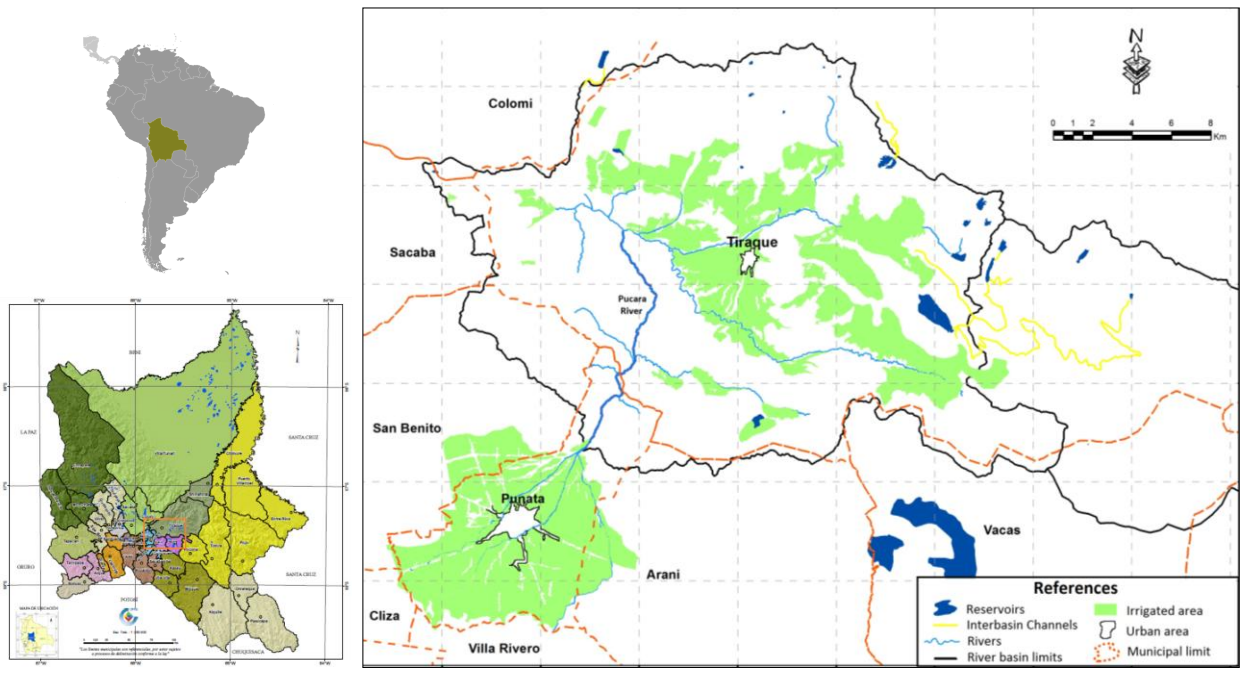
The empirical information for the study area was mainly obtained from research reports, publications and databases produced by research projects carried out by *Centro Andino para la Gestión y Uso del Agua* (Centro AGUA, The Andean Centre for Water Management and Water Use) during the period 2007-2014, in partnership with the Danish Institute for International Studies (DIIS), Denmark, and the *Grup de Recerca en Ciències de l'Enginyeria i Desenvolupament Global* –UPC (Research Group on Engineering Sciences and Global Development, Barcelona Tech). The projects focused on conflict and cooperation in local water governance, the local implementation of IWRM, and the development of technical tools to support the implementation of IWRM.

The next section describes the characteristics of the study area in relation to the objective of the article. We then discuss and clarify the theory of space dimensions utilized for the analysis and the discussion of water spaces. The ensuing section clarifies the river basin concept and its relation with different rationalities in a historical perspective. We then move on to using the theory of space to analyse the empirical data on water management in the Pucara River Basin. Finally, we discuss the main characteristics of local water spaces, contrasting them with the characteristics of the river basin space, and present the conclusions that emerge from the analysis and discussion.

## STUDY AREA

The study area is the Pucara River Basin, located in the Tiraque municipality, Cochabamba province, Bolivia (See Figure 1). The area is situated at the head end of the '*Valle Alto*' (high valley), a valley close to the city of Cochabamba, a city globally known as a symbol of water anti-privatization strikes (see i.e. Shiva, 2003; Olivera and Lewis, 2004). The *Valle Alto* is well known in Bolivia for its long agricultural tradition linked to cereals and potato production, and for the presence of strong peasant organisations. Due to its altitude and close vicinity with the tropical area of Cochabamba, the Pucara river basin provides water for most of the largest irrigation systems in *the Valle Alto* region. Water development projects have been continually implemented in the basin since the 1970s by diverse government programmes and NGOs mainly funded by international donors. For all of these characteristics, the Pucara River Basin was selected as one of the six river basins in the *Programa Intercultural Cuencas Pedagógicas* (PCP, Pedagogic River Basin Programme) by the Bolivian government, a programme that supports the implementation of PNC through the "management of knowledge and development of community skills on IWRM" (Gobierno de Bolivia, 2012).

Figure 1. Geographic location of the area of study (Pucara river basin).




Source: Own elaboration based on information from Geodatamap, Gobierno departamental de Cochabamba and information database of Centro AGUA – UMSS.

The Pucara river basin is comprised of high valleys and mountainous areas, located between 2800 and 4200 m. a. s. l. The inhabitants are organised in peasant communities formed after the National Agrarian Reform of 1953. At that time, communal limits were not well defined, especially in higher and steeper areas where springs, lagoons and other water sources are found. However, in 1994 a state law formally recognized peasant communities as part of municipalities, and consequently territorial limits of municipalities and communities became more important and began to influence the use of water and other natural resources.

Agriculture and livestock are the main livelihood activities in the basin. The most important cultivated crops are, in order of importance: potatoes, legumes (broad beans, peas, tarwi) and cereals (barley, oat, maize and wheat) (Cossío et al., 2009). Most households also have livestock, primarily sheep for meat and wool but also poultry, pigs and cattle. Oxen are reared for agricultural work and their use prevails over the use of tractors. Consequently, manual labour is predominant in farming, which generates strong dependence on extended family and communal relationships.

Given the predominance of farming, water in the area is mainly used for crop cultivation, livestock rearing and household use. The area has had a rich and complex history of water infrastructure development that resulted in the establishment of a diversity of irrigation as well as drinking water systems (Delgadillo and Durán, 2012). These systems depend on small mountain lakes, springs and rivers as water sources. They are managed by autonomous and self-managed water and community based organizations (Gerbrandy and Hoogendam, 1998). Peasant unions are responsible for water management in small water systems, while larger systems are managed mostly by water organisations created specifically for that purpose. The latter are autonomous as regards the decision making and operational activities, but they maintain a close relationship with the peasant organisational structure (Cossío et al., 2009). Besides the use of water through water systems, many inhabitants take water directly from springs and boreholes (Fons et al., 2011) according to nuclear or extended family arrangements, and/or accessing public water sources, mostly rivers and creeks, especially for livestock and human consumption (Cossío and Soto, 2011).

## CONCEPTUAL CONSIDERATIONS OF SPACE

The understanding of space has changed over time under the influence of various processes, of which state formation and capitalist development have perhaps been the most important (Lefebvre, 1991; Smith, 2008). This change can be interpreted as a process of abstraction by which the concept has been gradually detached from its original social and material characteristics. As Neil Smith argues "the history of the concept is marked by a progressive abstraction of space from matter. The distinction that we make today did not apply in earlier societies" (2008: 95-96). In earlier conceptions "people, as part of nature, are intimately linked to land" (Sack, 1980, cited by Smith, 2008: 96). Thus, "[t]o belong to a territory (…) is a social concept which requires first and foremost belonging to a societal unit" (ibid). Conversely, "space is today commonly represented as a universal receptacle in which objects exist and events occur" (Smith, 2008: 95), considering its materiality solely, or even considering it in more abstract terms as "a 'thing in itself' with an existence independent of matter" (Harvey, 2006: 121), as in mathematical representations.

However, this process of abstraction of space has never been fully accomplished (Lefebvre, 1991), a fact more evident in rural areas where farming-based livelihoods still predominate, especially in non-industrialized countries. "As long as productive human activity remains tied to the land as agricultural production, the social production of space separate from natural space is limited in extent" (Smith, 2008: 108). Consequently, it should be expected that rural inhabitants' understandings of space are more closely related to both society and nature, as compared with space concepts in urban areas. This suggests the existence of social characteristics and forms of relation with nature that remain hidden under conceptions of space. With this in mind, to properly understand space, Lefebvre (1991)

recommends to focus on analysing the experience of a subject in relation to its space. In his words, there is a "subject in whom lived, perceived and conceived (known) come together within a spatial practice" (Lefebvre, 1991: 230). With this statement, he suggests three analytic categories to distinguish different aspects that the conceptualisation of space may entail. However, as all three can be found in the same subject, they cannot be fully separated. Hence, his formulation also suggests that these aspects are constantly interacting and influencing one another.

Lived space is a representational space. It is the space of "sensations, the imagination, emotions, and meanings incorporated into (…) everyday lives and practices" (Harvey, 2006). The sense of familiarity with a territory, knowledge and fears of natural processes, sensations of freedom or restriction of access to some spaces are some examples of this aspect. As such, "they are part and parcel of the way … [people] live in the world" (ibid).

Perceived space is "the space of experience and of perception open to physical touch and sensation" (Harvey, 2006: 130). It refers to the material or physical space that is "expressed in daily routines, in the practice of everyday life" (Swyngedouw, 1992). This material space can also be understood in different ways (see for example Harvey, 2006; Smith, 2008). According to Harvey (2006) space can change in relation to time leading to different interpretations of the same material space at distinct moments. Furthermore, the use of various geometries by distinct persons may emphasise different characteristics, certainly increasing the variability in the interpretation of material space. Consequently, "[i]t is impossible to understand space independent of time under this formulation and this mandates an important shift of language from space and time to space-time or spatio-temporality" (Harvey, 2006: 122). This conception of perceived space can be especially useful for analysing rivers and water infrastructure, spaces in which water circulates and which are thus constantly changing.

Conceived space refers to the "reflection of the material realities that surround us through abstract representations" (Harvey, 2006: 131). It is a space produced in the mind of a subject in relation to their perceived and/or lived space; a mental representation of its space. Subjects are aware of this space and most of the time can describe it verbally. However, in another sense, conceived space refers to a 'discursively constructed' space, the "space used and produced by, among others, planners, architects, geographers, and social engineers which codify, textualise, and hence represent space" (Swyngedouw, 1992). In this last sense, conceived spaces are produced with the mediation of science or specialized knowledge related to different fields, which commonly use maps, graphs and diagrams to represent them. It leads to the existence of what Lefebvre (1991) calls 'abstract spaces', which can be considered as the uttermost expression of the process of abstraction of space from nature and society.

In the field of water management, representations of water use systems and delimitation of river basins related to hydraulics, hydrology, water engineering and planning, are examples of conceived spaces that are often represented in abstract terms. They are frequently utilized as such in plans, policies and water development programmes. It is through these actions that abstract conceptions of space may be able to influence the perceptions of people in relation to space, fuelling the persistence of the abstraction process.

## RIVER BASIN SPACE RATIONALE

IWRM advocates argue that it can integrate different water uses and users and achieve a management that also encompasses environmental preservation. Addressing these concerns entails a shift of the main space unit considered for water management and planning, from the traditional space of water use systems to wider spaces that embrace several uses and users. Most definitions and mainstream recommendations for the implementation of IWRM do not suggest the consideration of a specific space unit. However, river basins have been mainstreamed as the 'adequate' space for the application of this approach. In the case of Bolivia, the river basin is considered as "the basic unit for planning and

management of water and environmental resources" (Gobierno de Bolivia, 2006: 6), around which IWRM and IRBM will be established (ibid).

Several factors that have influenced the river basin concept and its utilisation since the term was first theorized depict various rationalities associated to it. The first set of factors is related to the quest for engineering solutions to water related problems. These consider the river basin "a legitimate unit for the application of a technical rationality aimed at solving problems of storage, water allocation, flood control or risk management" (Molle, 2009: 492). This technical and engineering rationality and the related economic interests around the development of infrastructure have historically dominated the use of the concept. This is exemplified by interventions to improve river navigation, flood control, dam construction and later the formulation of IRBM plans in many parts of the world.

A second set of factors is related to environmental concerns that have been increasingly recognized around the globe since the 1970s. These factors have influenced water management issues, especially in response to a growing concern about water pollution, water withdrawals and scarcity, and the decline of fish populations. The river basin was "seen as an ecosystems continuum and water as an integral part of ecosystems" (Warner et al., 2008: 122). Consequently, it was considered important to solve water pollution and depletion problems, and address their detrimental consequences for living species.

The former concepts and applications of river basin approaches are related to the widely advocated natural boundaries established by river basins. These interpret 'natural' as "related to physical and biological processes that influence water flow, aquatic, riparian and floodplain ecologies, and river and watershed form and evolution" (Vogel, 2012: 165). In addition, the application of this rationale has been supported by arguments of control of nature and the use of scientific knowledge as the best way to solve societal problems. The latter is expressed in the belief that "scientific knowledge and systematic rational planning could radically change society if they could emancipate themselves from vested interests and politics" (Molle, 2009: 487). Thus, the dominant concept of river basin space, i.e. conceived space is grounded in natural processes, mediated by science, and detached from society and politics.

This dominant concept of river basins has also prevailed in Bolivia. It can be observed, for example, in the application of the river basin management approach for flood control and civil infrastructure protection that began in the 1980s. Influenced by the IWRM paradigm, the PNC has additionally incorporated concerns for society and environment by promoting the "social management of water and environment in river basins" (Gobierno de Bolivia, 2006). However, until now the implementation of PNC guidelines has been dominated by traditional river basin management measures, such as afforestation and building of infrastructure for protection of soils, although giving higher importance to measures for preservation of water sources and improvement of water use efficiency (see for example Saavedra and del Castillo, 2014; Montaño, 2010). Many projects implemented under the umbrella of the PNC are traditional irrigation and drinking water projects that include certain measures of IWRM (Salm, 2010), which in general allowed to incorporate environmental concerns (see e.g. Montaño et al., 2010; Saavedra and del Castillo, 2014). Over the last years it was further encouraged by demands to consider climate change adaptation and mitigation actions. To address social concerns the formation of RBOs has been added to the traditional activities of capacity building included in water projects. The Ministry of Environment and Water reports the creation of 33 RBOs for the management of micro-basins across the entire country (Ministerio de Medio Ambiente y Agua, 2014), a small fraction of what would be relevant for the country. Thus although the need to consider societal issues is recognized, the progress in practice is limited.

Contrary to arguments of disassociation from politics, the history of utilisation of the river basin concept actually shows its use as part of various political objectives and agendas. For example, the concept was used as a political weapon against centralisation in France and Spain (Molle, 2009), and to

fight against dominant groups in Perú (Warner et al., 2008). The latter can be interpreted as challenges to traditional political spaces and delimitations, where power resides, by using the river basin concept.

On the other hand, Molle (2009) highlighted that upstream-downstream relations have probably always been recognized but that the initial focus of hydrology was not on the basin but on the river itself. The recognition of upstream-downstream relations shows social characteristics originally attached to river spaces that can still be found at present. As will be discussed in the next section, water users may be aware of river courses and the upstream and downstream relationships they entail, but these social relations are not directly linked to the river basin space.

As stated previously the definition of the river basin concept is based on the natural characteristics of water flow through rivers. On this basis, river basins have been imposed as 'holistic spaces' encompassing social and political features (Vogel, 2012). However, it is precisely in relation to this point that the application of the river basin concept has been strongly criticized. As Molle states "[p]olitical or administrative boundaries seldom correspond to watershed lines, and the socio-economic forces and processes as well as the webs of power that influence the management of water resources … do not dovetail with natural limits" (2009: 492). For the case of Bolivia, Delgadillo and Durán (2012: 110) argue that "there is no coincidence between the natural limits of river basins and the current political and administrative units of the country … water generated in a river basin is not used just within its limits but also outside them… [and] that water transfers from adjacent basins … imply agreements with people that live in those river basins". In the same way, as will be discussed in the next section, existing local water spaces and their related communal territories may not fit in river basin spaces.

## THE SPACES FOR WATER MANAGEMENT IN THE PUCARA RIVER BASIN

Considering the three dimensions for the analysis of space described before, this section reflects on the characteristics of spaces of water use and management in the Pucara River Basin according to local people's practices, experiences and perceptions. In the study area water is predominantly provided through collective water suply systems. Bearing this in mind, the analysis in this section is organized according to the three main physical elements of this kind of systems: water sources, water infrastructure and areas of water use. In a conventional view, water systems depend on a source to supply water to a certain area that consists of several points of use. Water infrastructure is the means by which water is taken from the source, conveyed to the area of use, and then utilized by end users. Taking a socio-technical perspective, the functioning of water systems depends on the interaction between people and these three physical elements. Additionally, as previously stated, in the Andean region water management is linked to communities. Therefore, these physical elements of water supply systems are constantly interacting with the communal territories, a fact that is also considered in the analysis. Of special note in this case are river spaces that interact with the mentioned perceived spaces, but also have their own special characteristics.

### The space of water use

The delineation of the perceived space of water use is strongly related to existing water access mechanisms in the area. In this region, people can have access to water because they are entitled with water rights defined according to existing rules and processes or, for people without such rights, through other 'informal' access mechanisms (Ribot and Peluso, 2003) existing at community and family levels.

Another notable characteristic of water access mechanisms in the study area is that they are attached to persons. With regard to irrigation this means that water rights are assigned to farmers – persons who own land and practice agriculture – leaving it up to them to choose the plot they will irrigate, within the limits of one irrigation system. Considering that most farmers in this region cultivate several plots, spread over one or several communities (Cossio and Delgadillo, 2012), the extent and

spatial distribution of the irrigated area will change for every irrigation event because users may decide to irrigate different plots every time. Further changes can occur due to the use of other mechanisms for accessing water, such as water selling and exchange, during one or several irrigation events.

Consequently, although the area of influence of each irrigation system is delimited by infrastructure, there is a flexible delineation of the perceived space where water is actually used in every irrigation event. When asked to represent the irrigated area of one system, peasants describe it in terms of the communities that make use of the water provided by this system. The concept of community includes people linked to a territory and thus refers not only to a physical (perceived) space but also to people, in the same way as irrigation water is assigned to a person who owns a cultivated plot; the physical space is attached to people. Local farmers are aware of the shifting characteristic of irrigation space, since it varies for each event depending on their decisions.

This flexible, changing, and human-defined space of water contrasts markedly with the conceived space of conventional irrigation development practitioners, which commonly represent irrigated areas as the space delimited by the infrastructure of one irrigation system. Compared with the dynamic local perception of the space of irrigation water use described above, these are rather crude and static representations.

In relation to drinking water systems, the link between people and place of use is less dynamic. Water is supplied to persons with houses in the communities and in most cases there are taps in every house. However, not all the persons in the communities are part of the systems, some families make use of the available boreholes or small springs owned by some families, or public sources such as springs and rivers for washing clothes, livestock watering and human consumption (Cossío and Soto, 2011).

### The space of water infrastructure

Two aspects of property relations are important to consider in relation to water infrastructure spaces in the study area. On the one hand, community members have a strong sense of ownership over their communal territories. Thus all infrastructure built is considered part of the community. On the other hand, property over water infrastructure is also related to the origin of water systems. Many irrigation systems were built by landlords before the national agrarian reform of 1953, in many cases making use of water sources far from the land being irrigated. During the agrarian reform, peasants took over these systems together with the land, acquiring at the same time the rights to use infrastructure placed outside their communities. In other cases, people obtained rights of use through the investment in infrastructure located outside their communities. In all cases, the acquired rights have been consolidated through the use of infrastructure during long periods of time (*usos y costumbres*).

In practice, the use of water infrastructure is possible if there are agreements between the beneficiaries of water systems, which have rights of use, and people in the communities in which the infrastructure is located. There are important differences between cases where infrastructure is built within the communities that benefit from a system and cases where it is built outside their territories. In the first case, there is no need for agreements with other communities. However, as stated before, infrastructure is property of the community, so it is not of exclusive use of any system. As in Pucara 69% of the irrigated land is served by two or more irrigation systems (Caceres, 2009), most of the infrastructure is used to deliver water of at least two sources. Thus, agreements are made to coordinate this use between irrigation systems and most users are part of several irrigation organisations.

Most large water systems in the area have infrastructure located in communities that are not part of the beneficiaries. These systems have the consent of those communities to use the water infrastructure. In the case of conveyance infrastructure for drinking water systems, because their infrastructure consists mostly of underground pipe schemes, the beneficiaries of the system have exclusive use. However, the situation in case of irrigation systems is different. Open channels that pass

through a number of communities are not exclusively used by the system beneficiaries but also by these communities. In some cases, this situation has resulted in formal agreements. In other cases, the uncoordinated use of infrastructure that passes through and/or water theft by neighbouring inhabitants are sources of constant conflicts (Cossío et al., 2010). Under any of the conditions described above, water infrastructure spaces are conceived to be part of communal territories.

Considering the spatio-temporality of perceived spaces, the examples given above illustrate that irrigation infrastructure can be part of a system in one moment, and part of a distinct system in another. This may also give infrastructure different meanings to the people that use it. Therefore, a proper analysis of infrastructure in this context demands an account of the moment in which it is described or analysed, and the identification of the systems to which the infrastructure is linked. Water professionals normally represent infrastructure in relation to one water system only, thereby making abstractions that do not fully recognize the complexity of the situation.

### The space of water sources

In the study area "all water resources are strongly linked to one territory, in other words, to a social group that occupies a physical space for a long time" (Gandarillas et al., 1994: 208, my translation), as is common in the Andean region. The rights of use of these sources are rarely contested. An inventory of conflict and cooperation in the area showed that they normally correspond to attempts to renegotiate the terms of existing shared agreements, rather than to a takeover of the resource (Cossío et al., 2010).

In close relation with infrastructure built, many water sources of large water systems are placed in communities outside the area of use. This creates a relation between the communities in which the sources lie and the communities that use the water. The acts of negotiation between these communities and the granting of water concessions to communities where the sources are placed (Cossío et al., 2010) can be considered an explicit recognition of this interdependence.

The sources of water and the area of use of one system can be placed either within the same river basin or in adjacent river basins. In the area, several large irrigation systems depend on river basin transfers made through dams and large canals (Caceres, 2009). These water transfers create upstream-downstream interdependences between places that are not part of the same river basin. Peasants in the area are familiar with such river basin transfers and often consider them as one of the options when planning to improve their water availability (Quiroz et al., 2012). Rivers are spaces that connect different groups of people through the passage of water. In Pucara Basin, most people recognize this connection though it is more emphasized by people downstream (Quiroz et al., 2012). An important characteristic of rivers is that they are considered public spaces. However, the public nature of rivers deserves careful explanation in relation to water use when temporality is considered. During the rainy season, all the water that rivers convey can be used freely for any purpose. In the same way, during the dry season, the flow of water is used as a public source for washing clothes, livestock watering (Cossío and Soto, 2011), and human consumption but not for irrigation. Most rivers have well-defined irrigation user groups during the dry season, as in the case of the two main rivers in the area. Furthermore, several river courses are used as conveyance channels for large irrigation systems that depend on dams (Caceres, 2009). The latter normally operate during certain periods in the dry season. Consequently, for some irrigation systems upstream-downstream relations may be important in the dry season but can be considered irrelevant during the rainy season, while these relations remain almost constant during the year for livestock and human use. This example shows the importance of temporality in local inhabitants' conception of space.

## LOCAL CHARACTERISTICS OF WATER SPACES AND THE RIVER BASIN

The description of spaces in the former section has shown some key characteristics of the spaces considered by local inhabitants for water use and management in the Pucara River Basin. In this

section, they are contrasted with the river basin space. The analysed spaces show the relevance of the consideration of the three dimensions of space utilized in this article: lived, perceived and conceived spaces. Furthermore, as can be seen in what follows, the characteristics identified underscore the importance of considering space in relation to nature and society.

An overall characteristic of local water spaces is their linkage with current practices of peasant families. Their use respond foremost to needs of the families making it clear that the mere existence of water systems, and thus of water spaces, is explained by their belonging to production strategies and daily practices of the families. This underlines the importance of the lived dimension in the understanding of water spaces, and the characteristic of flexibility of the spaces identified. Perceived space is flexible, which means that its characteristics can change over time, making its representation, i.e. conceived space, more complex.

The studied case elucidates that water spaces can be flexible in the short and in the long term. In the short term, the flexibility of perceived water spaces is influenced by societal and natural factors. For example, changes in the layout and extent of irrigated areas may be caused by discharge variations in water sources – river and spring discharge varies between rainy and dry season -, but also by constant changes in the number of people that use irrigation at any time, and the freedom that peasants have to choose the plots they want to irrigate at different moments. In the long term, the flexibility is mostly influenced by societal factors. Infrastructure development may change the dimensions of water spaces, normally increasing the areas of use and consequently the number of users, but also creating 'new' upstream-downstream interdependencies with other communities, which may even lie beyond river basin boundaries. Long term flexibility is associated with the implementation of various water development projects in the area. They have influenced the views of people in the communities of the Pucara Basin in such a way that currently water and community organizations are continuously planning the implementation of water infrastructure development projects (Cossío and Delgadillo, 2012). Thus, for a peasant in the basin, to be a member of one community may signify the possibility of obtaining access to water under the current conditions of the systems, or in the future, if water availability is increased through new water projects.

This flexibility of local water spaces is clearly conflicting with the 'fixed' delimitations of water systems and river basins, which conceive these spaces only according to water flow and place of use, thereby considering the materiality of spaces but ignoring lived dimensions that are so fundamental to local users. As the case illustrates, the flexibility of water spaces highlights the relationship of perceived space with water users, local organisations, infrastructure development and natural cycles, all aspects that make spaces flexible as illustrated above. By considering the community in representations of water spaces, material space, society and natural resources are all encompassed and in that way incorporate the lived space dimension of local water spaces.

The basic definition of river basins as "an area of land draining into a common body of water such as a lake, river, or ocean" (Cohen and Davidson, 2011: 1) indicates clearly how they are only determined by natural characteristics; the demarcation of their limits is based on the natural flow of water. As such, the concept allows one to be aware of temporal variations in natural flow i.e. during dry and rainy seasons. This delimitation also helps to envisage upstream-downstream relations between people, especially when referring to causal relationships with regard to water pollution and depletion. These characteristics are similar to those of water spaces identified in the Pucara basin as both have a relationship with nature and society. However, in the case of river basins these links do not affect the way in which they are conceived, e.g. by revising their delimitation to include upstream-downstream effects that may go beyond the watershed. On the other hand, although river basins are delimited by natural characteristics, their representation do not necessarily entail the perception of their materiality by water practitioners and thus they are many times used in abstract terms, i.e. awarding them common characteristics. On the contrary, water spaces found at local level depart from perception

(materiality) and always entail a lived dimension constructed through daily interaction with those spaces.

However, in the same way as abstract conceptions of water systems have been utilized, water professionals' abstract conceptions of river basins are currently the basis of water development projects. In turn, through the implementation of projects that utilize such conceptions of water systems and river basins they have gradually become familiar to local people. As an example, in addition to verbal representations of irrigation systems linked to communal territories, some irrigation farmers in the Pucara basin begun to make use of abstract sketches of irrigation infrastructure to represent their irrigation systems, in the same way as irrigation practitioners do (Quiroz et al., 2012). In this way, local peasants have learned to use the language of water development, especially when looking for technical assistance and funds for new projects. However, an examination of their daily water management practices show that local conceptions of water spaces still prevail.

The linkage of perceived spaces to people is another characteristic of local spaces identified here. In fact, it is through the occupation and/or utilisation of perceived (physical) spaces that community members are linked to communal territories, and water users to water spaces. Consequently, organisations have been formed in relation to these spaces, precisely in order to preserve their relationship with people, which is fundamental for daily activities. However, these types of organisations cannot be found at the scale of the Pucara River Basin. There are no people linked to the entire space of the river basin for their daily activities, and no one refers to it more than to upstream-downstream relationships along river courses. This non-recognition or identification complicates the application of the river basin approach. Even when organisations are created at the river basin level, as recommended by the PNC in Bolivia, they represent a space that is abstract for people and consequenly may need external support to remain. This goes against the self-governed and self-managed characteristics of local organisations that are strongly related to the lived dimension of local spaces. It is unclear whether and to what degree the basin residents will one day identify with the river basin space, although they have begun to become aware of it through the strong and persistent efforts of water practitioners in numerous water development projects.

For peasants in the area, it is clear that water spaces entail upstream and downstream relationships although in no way related to the river basin space. The term is even facing resistance from local peasants. In meetings carried out in the area to discuss the possible establishment of a river basin organization, several groups manifested their disagreement with the delimitation of the river basin and the groups included within it. Even its name – 'Pucara' – was questioned, as the main river receives different local names along its course. The examination of research results of projects carried out in the area shows that peasant inhabitants make no mention of the river basin space when discussing water management. The scale above or outside water systems is taken into consideration only in cases where the systems have physical elements located both inside and outside beneficiary communities, normally linked through infrastructure and/or the use of a water source. These can lie within a river basin but also span different basins, as was described before. However, in small systems where all physical elements are circumscribed to one community, as in most drinking water systems, the scale above the system is not considered at all in water management. Water spaces in the Pucara River Basin are perceived in their materiality, and related to daily practices of peasant communities (their lived dimension). Though local populations may be aware of the 'river basin' it is not linked to daily practices, to a lived space, which explains the lack of identification with that space.

## CONCLUSIONS

The use of the concept of space has proven useful for exposing and unravelling the complexity of water management spaces in the communities of the Pucara Basin, showing how they diverge from the dominant conception of river basin space that tends to be defined solely in relation to its materiality.

The application of space theory in this rural context has also shown that understandings of space strongly linked to both society and nature can still be found in peasant societies. However, the discussion of space in relation to its relationship with society and nature would not suffice in this case to explain differences between the river basin and local water spaces, as both can be related to society and nature. It is rather the distinction between the perceived, lived and conceived dimensions of spaces that helped highlight differences and explain why peasants in the area do not acknowledge the river basin space in water management.

The abstract conceptions of space such as found in definitions of river basins or water systems are mediated by science while conceptions of space by local populations are based on empirical knowledge. Although the river basin concept is not completely abstract as it is based on natural water flow, its lack of a lived dimension for those who use it and the way in which it has evolved, has triggered its use in abstract terms. The peasants' concept of space in relation to water management is on the contrary strongly linked to perceived and lived dimensions. However, abstract conceptions of water systems and river basins are currently used during discussions for the development of new water projects. Thus, abstract conceptions have also started to be used by local population though specifically circumscribed to planning and implementation of water development projects where they interact with water practitioners.

The flexibility of water spaces can be considered a product of their lived dimension, in other words a product of the inseparability of materiality from people's practices. This study showed that flexibility is of utmost importance for peasant organisations and farmers in their understanding and usage of water, which is currently neglected in water management and use under the river basin approach. This flexibility further challenges the application of the 'technical rationality' and the related 'avoidance of interests and politics' that has dominated the use of the river basin approach. On the one hand, short-term flexibility underscores that it is the ubiquitous decisions of peasants working in their communities and through inter-community relationships that defines when water will flow and where it will flow on a seasonal, weekly or even daily basis. This highly unpredictable nature of water flow will be difficult to estimate and plan for based solely on knowledge about natural forces, successive river branches and installed infrastructure as in the river basin approach. On the other hand, long-term flexibility challenges the assumption that a basin delineates where water flows. The article exemplifies how flows often leave basins and travel between them through inter-basin transfers. This, however, is not based on infrastructure development only, but many times also includes the negotiation of agreements about the use of the territory of other communities. This has been internalized by local peasants in the area through their experience in water projects.

The analysis and discussion of local water management spaces supports the criticism of the application of IWRM, which in the case of Bolivia encourages water management at wider scale considering exclusively the river basin space. The imposition of an abstract space on societies that do not conceive of space as abstract, but rather as dynamic and highly related with their perceptions and ways of using and sharing water, is one of the main reasons why the implementation of water management at river basin level may face resistance.

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