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Barriers to efficient water distribution

A case study of the water distribution system of Distrito 8, Cochabamba, Bolivia

Master of Science Thesis in the Master's Programme Industrial Ecology

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Hinder för effektiv vattendistribution

En fallstudie om vattendistributionssystemet i Distrito 8, Cochabamba, Bolivia

Examensarbete i Masterprogrammet Industrial Ecology

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CHALMERS TEKNISKA HÖGSKOLA
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Cover: Water distribution trucks (*aguateros*) waiting to fill up their cisterns in front of a private seller's home (photo: Carl-Johan Södersten 2014)

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Abstract

Bolivia is a country where large parts of the population are affected by the lack of access to clean water. In 2005, only 72% of the population had access to potable water. In the country's third biggest city, Cochabamba, the figure is below 50%.

The aim of this study is to provide a systems analysis of the water distribution system in Cochabamba, listing and describing the different actors present, analysing the interaction between them and identifying problems in the current system. The purpose is to provide a comprehensive understanding of the current water situation, which can be used as a basis for further research on improvement possibilities. The assessment was performed focusing on the following research questions:

- Who are the main actors in the water distribution system and what are their characteristics?
- How do different actors interact with each other?
- What are the problems in the current water distribution system?

In order to answer these questions, a field study was performed in Cochabamba's Distrito 8. This specific district was chosen upon recommendation from people with considerable knowledge of the city and of its water situation, as the water distribution situation in Distrito 8 is particularly challenging. The data was obtained through semi-structured expert and user interviews.

The main actors were identified to be the municipal water company SEMAPA, local organisations responsible for water distribution and administration (communal water systems), Empresa Misicuni (the company in charge of a major long-term water supply project), *aguateros* (water distribution trucks) and the municipality of Cochabamba (through the Plan Maestro Metropolitano). Identified problems include administration difficulties within SEMAPA as well as within the communal water systems, distrust between different actors, property rights on water, water availability and general lack of funding.

These results can be of use when assessing the broader Cochabamba and possibly also other metropolitan areas, provided that the urban waterscape in question is similar.

Keywords: water distribution systems, water management, barriers, Cochabamba, Bolivia

Sammanfattning

Bolivia är ett land där stora delar av befolkningen påverkas av bristen på rent vatten. Enbart 72% av befolkningen hade tillgång till drickbart vatten i 2005. I Cochabamba, landets tredje största stad, var siffran lägre än 50%.

Målet med denna studie är att göra en systemanalys av vattendistributionssystemet i Cochabamba genom att beskriva de olika aktörerna, analysera interaktionerna mellan dem samt identifiera problemen i det befintliga systemet. Syftet är att skapa en omfattande beskrivning av vattensituationen som skall kunna användas som bas för vidare forsking på förbättringsmöjligheter. Utvärderingen gjordes genom dessa forskningsfrågor:

- Vilka är huvudaktörerna i vattendistributionssystemet och vad har de för egenskaper?
- Hur interagerar de olika aktörerna med varandra?
- Vad är problemen i det nuvarande vattendistributionssystemet?

För att besvara dessa frågor utfördes en fältstudie i Distrito 8 i Cochabamba. Denna stadsdel valdes baserat på rekommendationer från personer med god kunskap om staden och dess vattensituation, då vattendistributionen är särskilt komplicerad i det området. Informationen erhölls genom semistrukturerade intervjuer med experter och användare.

De identifierade huvudaktörerna är vattenverket SEMAPA, diverse lokala organisationer ansvariga för vattendistribution och administration, Empresa Misicuni (företaget som är ansvarigt för ett stort långsiktigt vattenförsörjningsprojekt), aguateros (lastbilar som levererar vatten) och kommunen i sig (genom Plan Maestro Metropolitano). De huvudsakliga problemen identifierades som administreringssvårigheter inom SEMAPA och inom de lokala organisationerna, misstro emellan de olika aktörerna, äganderätt till vatten, tillgången på vatten samt finansieringssvårigheter.

Resultaten kan tänkas vara till nytta för att studera andra delar av Cochabamba och eventuellt andra storstadsområden, förutsatt att vattensituationen är likartad.

Nyckelord: vattendistribution, vattenförvaltning, hinder, Cochabamba, Bolivia

Resumen y reconocimiento

Bolivia es un país en dónde gran parte de la población se encuentra afectada por la falta de acceso a agua limpia. En 2005, tan sólo el 71.7% de la población tuvo acceso al agua potable. En Cochabamba, la tercera ciudad más grande del país, el porcentaje es menor al 50%. El objetivo de el presente estudio es proporcionar un análisis sobre el sistema de distribución del agua en Cochabamba, haciendo mención y describiendo a los diferentes actores presentes, así como analizar la interacción entre ellos e identificar los problemas del sistema actual. El propósito es proporcionar un entendimiento comprehensivo de la situación actual del agua, lo cuál puede ser utilizado como base para mayor estudio sobre posibilidades para su mejora. La investigación fue realizada a través de las siguientes preguntas:

- ¿Quiénes son los actores principales en el sistema de distribución del agua y cuáles son sus características?
- ¿Cómo interactúan los diferentes actores?
- ¿Cuáles son los problemas en el sistema de distribución del agua actual?

Para poder responder estas preguntas, un estudio de campo se llevó a cabo en el Distrito 8 en Cochabamba. Este distrito fue elegido en específico por recomendación de personas con conocimiento considerable de la ciudad y de la situación del agua, ya que su distribución en el Distrito 8 es particularmente desafiante.

Los datos fueron obtenidos a través de entrevistas semi-estructuradas a expertos y usuarios. Los actores principales identificados fueron la compañía municipal de agua SEMAPA, organizaciones locales responsables de la distribución y administración del agua (sistemas de agua comunal), la Empresa Misicuni (la compañía a cargo del proyecto más grande a largo plazo para el abastecimiento del agua), los aguateros (camiones de distribución del agua) y el municipio de Cochabamba (a través del Plan Maestro Metropolitano).

Los problemas identificados incluyen la falta de fondos en general para una nueva infraestructura, la disponibilidad del agua, dificultades en la administración de SEMAPA así como al interior de los sistemas de agua comunales, y la desconfianza entre los diversos actores. Estos resultados pueden ser útiles al asesorar a Cochabamba más ampliamente así como otras áreas metropolitanas, en caso de que el panorama urbano del agua en cuestión sea similar.

Palabras claves: sistema de distribución de agua, obstáculo, gestión de agua, Cochabamba, Bolivia

Contents

List of acronyms

ASICASUR	Asociación de Sistemas Comunitarios de Agua del Sur (association of the communal water systems of the south)
CASA	Centro de Aguas Y Saneamiento Ambiental (the water and environmental sanitation centre of the University of San Simón)
CBNRM	Community-based natural resource management
CWS	Communal Water Systems
EPSAS	Entidad Prestadora de Servicio de Agua Potable y Saneamiento (water and sewerage service entity)
FECOAPAC	Federación Departamental de Cooperativas de Agua Potable y Alcantarillado de Cochabamba (departmental federation of water and sanitation cooperatives)
GWP	Global Water Partnership
IMF	International Monetary Fund
IWRM	Integrated Water Resource Management
LPP	Ley de Participación Popular (Decentralisation and Popular Participation law)
OLPE	Operador Local de Pequeña Escala (small-scale local water operator)
OTB	Organización Territorial de Base (grass roots organisation)
NGO	Non-Governmental Organisation
PMM	Plan Maestro Metropolitan (metropolitan master plan)
POA	Planes de Operaciones Anuales (an OTB's annual proposition regarding infrastructure and service expansion for the following year)
SEDES	Servicio Departamental de Salud (departmental regional health services)
SEMAPA	Servicio Municipal de Agua Potable y Alcantarillado (municipal water and sewerage service company of Cochabamba)
UMSS	Universidad Mayor de San Simón (the university of Cochabamba)
UN	United Nations

1 Introduction

1.1 The water situation in the world

1.1.1 The human impact on the hydrological cycle

Ever since humans settled the Earth, water has been taken for granted. The Earth's hydrologic cycle has ensured that rivers, lakes and underground aquifers have kept refilling themselves regularly, and water has been considered an inexhaustible resource. However, in the last two centuries, human population growth took whole new levels. In 1800, the world was populated by barely one billion humans. That figure doubled in 120 years, and by 2012 it had increased sevenfold (USCB, 2014). What enabled this incredible and sudden growth was a combination of technological advances in fields such as industry, agriculture and biochemistry, along with the discovery of a new unprecedentedly powerful source of energy, oil (Ponting, 1993).

This massive growth in population and human activity on Earth evidently put a lot of stress on the Earth's ecosystems, and in the twentieth century, freshwater supplies all over the world became threatened of depletion. Examples abound; the Aral Sea, formerly the world's fourth largest lake, shrank to a tenth of its size in just a few decades due to extensive damming and diversion (Micklin and Aladin, 2008). The water table in large parts of Central Asia, the Middle East and North America are steadily shrinking; Beijing's water table has shrunk by 30 meters in the past forty years (National Geographic, 2014b, Finnegan, 2002). Several of the largest rivers in the world no longer, or only rarely, reach their deltas; this is the case for the Colorado River in the USA, the Indus River in India/Pakistan and the Yellow River in China (National Geographic, 2014a).

Along with the depletion of water reserves, human activity has had other negative impact on the hydrological cycle. Industrial activity, mining and agriculture have severely contaminated the world's waters. 70% of industrial wastes in developing countries end up in waters without being treated; mean nitrate levels in global waterways have risen 36% since 1990 (Pacific Institute, 2010). Moreover, inadequate sanitation leads to pathogens from faeces polluting drinking water in many developing countries, causing diarrhoea and other diseases (WHO, 2011).

Gleick and Palaniappan (2010) speak of the phenomenon of "peak water". The analogy to the nowadays mostly established concept of "peak oil" refers to the idea that freshwater also has a peak and then decline in production. They distinguish three types of peak water concepts: peak renewable water, peak non-renewable water and peak ecological water. Peak renewable water occurs when the water availability over time is limited by flow constraints, e.g. such as in the case of the Colorado, Indus and Yellow rivers. Peak non-renewable water applies in underground aquifers where production rates substantially exceed natural recharge rates and where overpumping or contamination leads to a peak of production followed by a decline in the total volume. This is the phenomenon that leads to the shrinking water tables mentioned above. Finally, peak ecological water is a situation where the costs of disruptions and pollutions surpass the value of the water for human use, i.e. the point beyond which the sum of the ecological and human benefits of water starts decreasing. To understand and recognise

these three concepts is, according to Gleick and Palaniappan, an imperative step towards a responsible water management and sustainable water future.

1.1.2 Water on the agenda

At the turn of the last century, leaders from all United Nations (UN) member states (189 at the time) gathered for a summit regarding the future of the world's poorest countries. The gathering was the largest summit of world leaders in history, and it led to the ratification of the United Nations Millennium Declaration, and along with it the implementation of the Millennium Development Goals (MDGs). The MDGs were grouped in eight distinct categories, covering areas typically affecting poor countries, such as hunger, poverty, infectious diseases, child mortality, etc, and the goals were to be achieved by 2015 (UN, 2014a).

As 2015 is approaching, the targets set in 2000 will likely not be reached in many countries, and a new post-2015 agenda is currently being implemented. In this new agenda, water is set as a central priority for the realisation of all goals; in a debate in February 2014 regarding the new agenda, UN General Assembly President John Ashe stated: "Lack of access to water, sanitation and sustainable energy is a compound magnifier of poverty, ill-health and mortality, and gender inequality" (UN, 2014b, p. 1 of 1). Access to clean water is indeed a prerequisite for many of the MDGs: sustainable agriculture, the eradication of extreme hunger and infectious diseases, the reduction of child mortality, the improvement of maternal health, environmental sustainability, etc. Studies have shown that unsafe or inadequate water is responsible for 80% of illnesses and 30% of deaths in developing countries (Elhance, 1999). According to some projections, between 34 and 76 million people will die from preventable water-related diseases by 2020 (Gleick, 2004). Still, according to UN estimates, 783 million people still live without access to clean water (2014b).

Water is hence a crucial issue in today's environmental and social debate, and as it becomes scarcer as a result of growing populations, climate change and unsustainable use, it is likely to remain a central theme for decades to come (World Water Council, 2014).

1.2 Aim and objectives

The purpose of this study is to provide a comprehensive understanding of the current water situation in Cochabamba, which could be used as a basis for further research focusing on improvement possibilities.

In order to achieve this, the study aims at providing a systems analysis of the water distribution system in Cochabamba, listing and describing the different actors present, analysing the interaction between them and identifying problems in the current system.

1.3 Research questions

A set of research questions has been formulated in order to reach the objectives mentioned above:

- Who are the main actors in the water distribution system and what are their characteristics?
- How do different actors interact with each other?
- What are the problems in the current water distribution system?

1.4 Limitations

One of the recurrent limitations with field studies concerns the availability of information and the challenges of obtaining it. Since the study is limited in time, the researcher is often having difficulties with finding accurate and updated contact information of the intended interviewees as well as managing to organise meeting with them. In this particular study, information about the different OTBs[1] and their presidents was found to be either outdated or unavailable, which led to difficulties to make contact with all of them. This is discussed further in section 5.1.2.1.

Another typical consequence of the lack of time is the need to narrow down the area; in this particular study, focus was put on Distrito 8; reasons for this are listed in section 2.2.1.

1.5 Methodology

The project entails a field study in Cochabamba, Bolivia, and thus can be broken down into three main stages: a pre-trip literature study, a field study in order to collect data and a post-trip analysis of the acquired data. The methodology is further elaborated in section 2.

[1] See section 5.1.2.1

2 Methodology

This Master's Thesis involves transdisciplinary research and the applied methodology will therefore be described in detail. This chapter is divided into three subsections, corresponding to the three stages of the project mentioned in the introduction.

2.1 Literature study

The first phase of this Master's Thesis involved a thorough literature study, done in order to gain knowledge of the different subjects touched upon throughout the study, as well as to investigate if any similar research had been done before. The literature study also contributed to the development and formulation of the research questions.

2.2 Field study

In order to gather data for analysis, an eight-week field study was performed in Cochabamba, Bolivia.

2.2.1 Area of study

The purpose of this study is to obtain a comprehensive understanding of the current water situation in Cochabamba and of how the different actors in Cochabamba's water distribution system interact. Since the field study was limited to eight weeks, it was deemed unfeasible to map and study the entire city of Cochabamba. Hence, a smaller area of study was chosen, Cochabamba's Distrito 8 (District 8). This specific district was chosen upon recommendation from people with considerable knowledge of the city and of its water situation, notably PhD student Ida Helgegren, as the water distribution situation in Distrito 8 is particularly challenging.

2.2.2 Choice of research method

This study combines elements from the fields of engineering as well as social science. It does not aim at measuring exact data, but rather to provide an understanding of some aspects of social life. Besides, since the goal is to describe a situation that has not been thoroughly described prior to this study, a qualitative approach was more appropriate for the gathering of empirical data (Neuman, 2005). Moreover, the field study consists in several interviews with the involved stakeholders, and their perception of the situation constitutes part of the results. This also made a qualitative approach more suitable (Punch, 2005).

However, the qualitative approach is often criticised, especially in some scientific communities, and for various reasons (Neuman, 2005). Firstly, the researcher's objectivity is a recurrent theme in the criticism. There is always room for personal interpretation and biased formulation of interview results, even in the case of structured interviews. This can be partially surmounted by precise interview guides and meticulous and diligent analysis of the interviews (this is further discussed in section 2.2.3.1). Secondly, critics often argue that the findings are not rigorous enough. Data acquired from the methods of a qualitative approach usually generate words rather than numbers, and as a result they are more difficult to assess and compare. Still, if the research question is a qualitative one, then the most rigorous way to answer it is by using qualitative methods (Neuman, 2005).

2.2.3 Data collection

2.2.3.1 Interviews

The main source of information during the field study consisted in interviews with relevant stakeholders. The use of interviews brings about several aspects that ought to be discussed upon doing such a qualitative study.

A central aspect that needs to be considered at all times while performing interviews is that of ethics. The researcher doing a field study has many responsibilities towards the people he/she interviews, both during the interview and when the final study report is disseminated. Those responsibilities are consistently summarised and categorised in the four principles established by Beauchamp and Childress (2001):

- Autonomy – respect the rights of the individual
- Beneficience – doing good
- Non-maleficience – not doing harm
- Justice and equity – be fair

Particularly important are the two issues of *consent* and *confidentiality*. Consent implies that the participants in the study have consented to it freely and without being coerced, and that they are fully aware of what the participation implies. Confidentiality implies that the participant's identity is protected at all times.

The conducted interviews were mostly of the semi-structured type, using a so-called topic guide, i.e. a questionnaire containing the key questions to be asked followed by a series of useful prompts, which may incite the interviewee to reveal further relevant information. The reason for using such an interview format was that the research questions were specific enough to allow for it and that is was considered more efficient and time-optimising. An example of such a topic guide can be found in appendix B.

In order to ensure reliability and validity and convey trustworthiness, a few guidelines were followed when developing and performing the interviews. The techniques used in the interviews were aimed to be:

- **Reproducible**, i.e. that another interviewer could obtain the same data using the actual interview guides
- **Systematic**, i.e. that the interviews were performed thoroughly and objectively, and that neither interviewees nor data were being favoured at any point
- **Credible**, i.e. that the questions were asked in a way that incited credibility and objectivity
- **Transparent**, i.e. the questions and methods are made available so that the reader can verify where the data was collected from

However, the samples in this research are purposive: the interviewees were chosen because they were considered relevant for the study and because they were thought to be potential sources of useful data. Also, the technique of snowball or chain sampling was applied, i.e. that once a few key participants had been found, those individuals were asked to name other

potential informants (Ellsberg and Heise, 2005). This was deemed to be an efficient way to come across relevant stakeholders for the interviews.

In order to facilitate the subsequent data processing and analysis, most of the performed interviews have been recorded (80% of them) and transcribed (70%). However, only a small part of the contents has been translated (when quoted directly in the text). The interviews were performed in Spanish, a language that the author is proficient in, and it was decided against a full translation.

2.3 Data processing, analysis and dissemination

As mentioned above, one of the most crucial aspects of qualitative research through interviews is the strife for objectivity in the data analysis, in order to obtain trustworthiness. Green and Thorogood (2013) suggest the following criteria for rigorous qualitative analysis:

- **Transparency:** the data collecting and analysing procedures used by the researcher should be clearly accounted for and justified so that the reader can follow the researcher's trail. The evidence should be available for independent inspection, including fieldwork notes and interview transcripts.
- **Validity:** the interpretations made by the researcher should be accompanied with evidence from the empirical data. Rigorous and systematic application of this minimises the risk of anecdotalism, i.e. that the conclusions drawn from the study are based not on ample empirical evidence but merely on a few anecdotes obtained during the field study.
- **Reliability:** the data set should be analysed comprehensively. The empirical data should elicit similar analysis results regardless of the analyst.
- **Comparison:** data should be compared between and within cases in the data set, and the findings should be compared to other studies.
- **Reflexivity:** the researcher should account for his/her own role in the research. How did the researcher affect the interviewees?

Qualitative data analysis is typically an iterative process, where the analysis emerges incrementally as more data is gathered and analysed (Patel and Davidson, 2003, Green and Thorogood, 2013). This is an underlying principle of the Grounded Theory methodology, developed by Glaser and Strauss (1967), and it consists in the discovery of theory through the analysis of empirical data.

There are several different methods for analysing data obtained from qualitative research, but it is often argued that the descriptive thematic approach is the most suitable (Green and Thorogood, 2013); the broad and diverse character of this field study did indeed make that approach appropriate to process the performed interviews.

The basic principle of thematic analysis is that the researcher goes through all the collected data in order to identify the main topics, i.e. the themes that recur throughout the study. The process can be divided into four key phases:

- **Reading and annotating the transcripts:** this is the primitive stage where the researcher makes some first preliminary notes; this is often done in the early phase of the data analysis

- **Identifying themes:** in this subsequent stage, the researcher reads the transcripts in more detail and labels paragraphs with a few key words, in order to be able to produce a short summary of each interview
- **Developing a coding scheme:** once the interviews have been summarised, the researcher develops a *coding scheme*, i.e. assign "code" to each of the identified themes in order to prepare for the fourth phase of the thematic analysis
- **Coding the data:** in this final phase the codes developed in the third phase are applied to all the data, e.g. by marking certain paragraphs or pages of the transcript. Ideally, all the data ought to be coded to ensure that the analysis is comprehensive

Once the data had been transcribed and coded, the cutting-and-pasting technique was applied. This consists in taking data extracts from their original context to merge them with other similar data, or simply to pick out the data that is relevant for the study. This method is sometimes criticised but it is a necessary analytic procedure notwithstanding (Bong, 2002).

Along with the cutting-and-pasting of the data, the interviews were categorised according to the role of the interviewees and their position relative to the themes discussed. Examples of these categories include experts interviews, interviews with actors directly involved in the water distribution, independent interviews, etc.

The relevant data was then analysed, both from the author's perspective and by referring to existing theory. The performed analysis led to a discussion about the obtained results, their validity and other issues deemed important.

Finally, the outcome of the study was organised into a comprehensive report in order to be disseminated to the target audience. This includes the informants and interviewees that did, during the course of the field study, express their wish to be kept informed on the thesis, particularly the water and sanitation centre of the San Simón University in Cochabamba (CASA). It also includes other stakeholders that may be interested in the thesis, such as NGOs involved in water issues, other researchers working on similar topics and the scientific community in general.

3 Background

This section provides a short but concise background about Bolivia, Cochabamba and the so-called Water War, an event that put the city in the international spotlights.

3.1 Bolivia

Bolivia is a country located in the heart of South America (Figure 3-1). Its high average elevation and extreme geography make it one of South America's least densely populated countries, surpassed only by the Guianas (CIA, 2013). However, the Andean mountains are home to large mineral reserves, and Bolivia ranks high in the worldwide production of valuable minerals: 4th biggest producer of tin, 6th largest producer of silver, 8th largest producer of zinc (Index Mundi, 2009); in addition, the protected salt lake Salar de Uyuni contains 50 to 70 percent of the world's lithium reserves, although it is currently not exploited (Lithium Investing News, 2014). Furthermore, Bolivia is Latin America's second biggest producer of natural gas after Mexico (CIA, 2013).

Figure 3-1 - Map of South America with Bolivia highlighted (World Atlas, 2014)

Despite these favourable prerequisites, Bolivia emerges as South America's poorest country. According to the CIA World Factbook, half of the population live below the poverty line (i.e. under US$2 a day) (2013). Social indicators tell the same story: life expectancy is 67 years and the under-5 mortality rate is 41 per 1000 births (World Bank, 2012). These numbers are the worst in the Americas and Caribbean after Haiti.

The country's water coverage is another relevant indicator of the poverty: in 2009, only 63.3% of the population had access to tap water (which includes indoor, outdoor and communal taps). That average number does not, however, reflect the huge gap between urban and rural coverage: the figures were, in 2009, 87.9% and 17% respectively (WHO, 2014).

To better understand the current situation of Bolivia and to determine what events contributed to it, a brief overview of the country's last two centuries is needed, as it retells the

story of a nation that has seen its natural resources fall into the hands of neighbouring countries, and where military coups, unstable governments, uprisings and wars have been the norm.

3.1.1 History

Upon proclaiming independence in 1825, Bolivia was, like most countries that have recently broke free from colonisation, in a state of social, political and economic instability. The first government, led by the duo that had played the major role in the country's fighting for independence, Simón Bolívar and General Antonio José de Sucre, only stayed in power for three years. Since then, Bolivia has endured nearly 200 changes of governments (Library of Congress, 2006). Along with this political instability, the country has been involved in a series of wars with neighbouring countries, mainly because of its ample supplies of valuable natural resources. Between the years 1867 and 1938, Bolivia lost large parts of the rubber-rich region in the north to Peru and Brazil, 225,000 sq km of the oil-rich Chaco region to Paraguay, and Chile annexed 350 km of valuable coastline in order to gain access to the guano and nitrate deposits scattered over the Atacama Desert (McGurn Centellas, 2008). Bolivia was thereby left landlocked and stripped of many of its natural resources. Figure 3-2 shows a map of the country's major territorial losses between 1867 and 1938.

Figure 3-2 - Bolivia's major territorial losses between 1867 and 1938 (Jacobs, 2012)

Since then, Bolivia has struggled to keep its economy together. The lack of coastline hampers exports and imports, and because of the country's geographical characteristics and extreme terrain, only 3.49% of the surface is categorised as arable land (CIA, 2013). Between 1950 and 1980, a series of structural adjustments were implemented by the many governments that went through office and eventually by the World Bank and the International Monetary Fund (IMF), but they did not succeed in bringing the country out of the recession it was experiencing. In the end of the 1980s, a new stabilisation program was established by the government, upon increasing pressure from the World Bank and the IMF, involving a neoliberal economic policy, promoting price liberalisation and privatisation of state enterprises, as well as opening up markets to foreign firms. The program would, according to

the World Bank, help Bolivia out of its economic crisis (Finnegan, 2002). Privatisation was seen as an efficient way to break free from corruption. The Bolivian government hence sold many public companies and industries, such as the train service, the electric utilities and the national airline (Public Citizen, 2001). Many of the mines were taken over by foreign firms (Walnycki, 2013). In an attempt to ameliorate the water coverage and sanitation of the country, privatisation was, once again, seen as the weapon of choice. Only private companies (which in practice very often implies multinational corporations), it was argued, could bring about enough capital to efficiently and thoroughly manage to expand the water and sanitation networks on a national scale (Finnegan, 2002). Hence, with the help of foreign donors and the World Bank, the cities of La Paz, El Alto and Cochabamba were privatised in the end of the 1990s. The concession for water and sewerage provision in La Paz and El Alto was taken over by the World's biggest water consortium, Lyonnaise des Eaux, via the company Aguas del Illimani S.A. (AISA), whereas in Cochabamba it was granted the only bidder, the company Aguas del Tunari, a subsidiary of the multinational US-based Biwater and Bechtel (Hailu et al., 2012).

3.2 Cochabamba

Cochabamba, located at 2500m amsl, is Bolivia's third-largest metropolitan area, and is one of the cities that have been notably affected by the privatisation trend. The city was particularly prone to end up in the centre of the water issue; its location in a valley makes it vulnerable to destructive hydrological effects (see Figure 3-3).

Figure 3-3 - Topographical map of the Cochabamba valley, with the Tunari mountain range in the north (Google, 2014)

The city grew dramatically in size during the second half of the twentieth century: from a modest 75,000 in 1950, it reached 200,000 inhabitants in 1976, and then doubled again in fifteen years; at the turn of the century, the population had leaped to more than half a million (Shultz and Draper, 2008). This rapid increase was partly due to the collapse of the silver and tin mining industries, in particular the closing of tin mines located in the region in 1985, and to rapidly degrading agricultural lands as well as a series of drought in the 1980s. These events led to huge migrant flows towards the Cochabamba valley, resulting in unplanned urbanisation. The urban services could not keep up with the growth, and in 1999, the city's

water and sewerage coverage were, respectively, 57% and 48% (Assies, 2003). The former figure had been 70% just ten years earlier (Pitman and Ringskog, 2002).

While the population of Cochabamba increased, the water availability did the opposite. Intense deforestation along with the aforementioned draughts led to rapidly declining supplies of surface water. The municipal water and sewerage service company, SEMAPA (Servicio Municipal de Agua Potable y Alcantarillado), favoured short-term fixes rather than long-term solutions. Since the 1960s, a project for long-term water supply called Misicuni had been planned and started (see chapter 5.2.3). The project involved the collecting of water from three rivers stemming from the nearby mountain range in Tunari, through a series of tunnels and aqueducts. The promises of the implementation kept the people hopeful: not only would it supply the city with freshwater, but it would also provide ample of irrigation for the agricultural areas, as well as produce hydroelectric energy while doing so. However, lack of funding kept postponing the project further, and the project is still far from finished (Laurie, 2005, Walnycki, 2013).

Instead, wells were drilled deeper and further away, leading to conflicts between the districts of Cochabamba and nearby Quillacollo. Quillacollo, the country's most important food-producing region, argued that the new wells would cause draughts in the region, leading to dramatic consequences for the country's food supply. Nonetheless, SEMAPA proceeded with several well-drilling projects around the Cochabamba district. The protests, that came to be known as the War of the Wells, were countered with the help of the military, and the tension grew further (Crespo Flores, 1999, Shultz and Draper, 2008).

3.2.1 The privatisation of water and Ley 2029

In 1999, the situation climaxed, and the government decided to put the Misicuni project out to bid, along with SEMAPA. It was thought, once again, that privatisation would lead to a fast development of the project. Along with the privatisation, the government instated *Ley 2029* (law 2029), a legal framework for public-private partnerships for potable water and sewerage. The concession signed between the government and Aguas del Tunari entailed a 40-year program, in which the consortium guaranteed that it would provide the entire city of Cochabamba with access to clean water and sanitation, as well as the fulfilling of the Misicuni project. In return, Aguas del Tunari would have exclusive rights over the concession area. This implied, among other things, that it would gain power of all private wells that had been built and were operated by autonomous water committees, small cooperatives, farmers, etc. The privatisation of water thus implied that the consortium could now start charging the residents for using their own wells (Finnegan, 2002). Additionally, the consortium was contractually guaranteed to gain a 15% return on equity (Assies, 2003).

3.2.2 The Water War

The privatisation of the water supply in Cochabamba had repercussions on many level. The first effects were dramatic and instantaneous increases of the water prices. Within days of the takeover by Aguas del Tunari, tariffs rose by 35% on average, but for some households the increase was much higher, in some cases up to 150% (Assies, 2003). The increases were meant to cover for parts of the huge expenses involved in the concession, notably repairs of the current network and payment of SEMAPA's debts (ESC Pau, 2012). Moreover, the tariffs were fixed to the US dollar, which made prices rise even further (Assies, 2003). Most people of

Cochabamba could not afford such an increase, and protests erupted in February 2000. Roadblocks and strikes kept the city completely shut down for four days. The protests lasted for three months and culminated in April, when a 17-year old student was shot dead by a police sharpshooter. The military was brought in to retain the escalating protests, but as the situation kept deteriorating, the executives from the Aguas del Tunari consortium eventually abandoned their offices and fled the city, and the government finally decided to revoke the concession, the water privatisation and *Ley 2029* (ibid).

3.2.3 Aftermath of the Water War

For the people of Cochabamba, the outcome of the Water War was seen as a huge success. The victory over the Aguas del Tunari consortium has been coined the first great Latin American popular victory over transnational capitalism (Fundación Abril, 2013). Luis Sánchez-Gómez, former director of SEMAPA, calls it "the defeat of the neoliberal principles which the international financial organisations support and advocate" (Olivera, 2004, p91). Oscar Olivera, the leader of the city unions during the protests, uses the analogy of "David versus Goliath" in his published accounts of the Water War, alluding to the poor versus the multinational corporation (2004).

The protests that led to the Water War were not an isolated scenario. Three years later, a new series of anti-governmental protests and riots erupted during what was going to be known as the Gas War. What lay behind those protests were disagreements over the construction of a new gas pipeline and the increased privatisation of the industry (Kaup, 2010). With the Water War still fresh in the Bolivian's minds, the people refused to see yet another natural resource fall into the hands of foreign corporations. The first wave of protests was met with force. In February 2003, 30 people died during conflicts between protesters and Bolivian armed forces in La Paz. More clashes in October the same year left twice as many dead, but led to the resignation of president Gonzalo Sánchez de Lozanda (Barr, 2005). As a result of the nationwide uprisings, Congress proposed a bill suggesting a rise of the taxes paid by foreign energy companies from 18% to 32%, but many of the protesters thought it was inadequate, and asked for nationalisation of the hydrocarbon sector in a referendum proposed by the new president Carlos Mesa (Hodges, 2007, Kaup, 2010). However, Mesa was reluctant to sign the bill, fearing that such an increase would discourage foreign investors. This fuelled the discontent further and a new wave of protests led to his resignation as well. In the beginning of 2006, Evo Morales and his Movement for Socialism (MAS) came to power, and within months of his appointment decided to nationalise the hydrocarbon sector (Kaup, 2010).

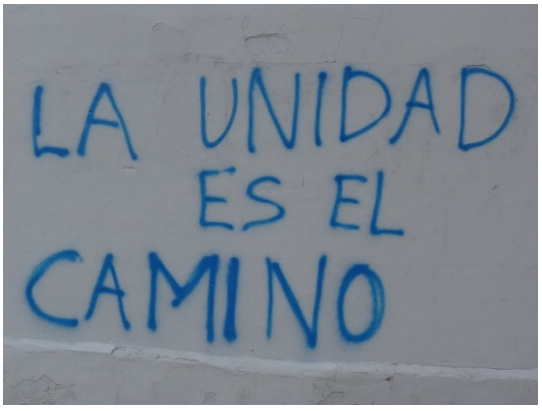

Figure 3-4 - "Unity is the way" - graffiti seen in Cochabamba (photo: Carl-Johan Södersten, 2014)

The reasons behind the civil unrest in Bolivia are essentially related to economic issues and to the living situation in the country. Bolivia was, and still is, in desperate need for money. Most stakeholders agree that ultimately, foreign investment is unavoidable if the water situation is to ever be improved (Finnegan, 2002). However, the outcomes of the Water War and the Gas

War have had a severe impact on the foreign-investment level, and along with systematic instances of corruption within SEMAPA, it has made it difficult to attract new foreign capital (Finnegan, 2002, Tran, 2006).

3.2.4 The situation today

The Water War may not have had the impact that people had hoped for. After Aguas del Tunari lost the concession, SEMAPA regained control over the water network and assured the population of Cochabamba that it would increase the participation of the community in the water system management and work hard to ameliorate the existing network as well as to extend it (Olivera, 2004). But ten years later, the city's water situation has not improved (Walnycki, 2013, Fundación Abril, 2010). Meanwhile, the population keeps increasing and the metropolitan area of Cochabamba now comprises seven cities, as can be seen in Figure 3-5.

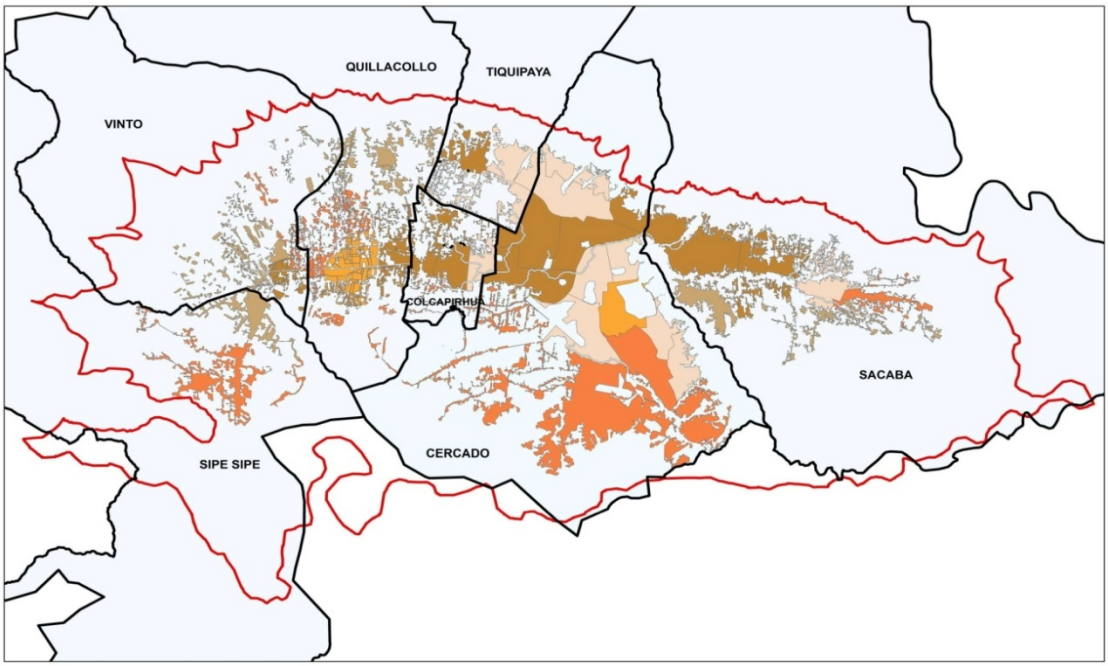

Figure 3-5 - The metropolitan area of Cochabamba (Gobernación de Bolivia, 2014)

3.3 The *zona sur* and Distrito 8

The city of Cochabamba, referred to as El Cercado, is divided into 14 districts, or *distritos*, as can be seen in Figure 3-6. Districts 5, 6, 7, 8, 9 and 14 are collectively referred to as the *zona sur* (the south). The *zona sur* accounts for 250000 inhabitants, which corresponds to roughly half of the city's population (Fundación Abril, 2013). Most of these arrived during the huge migrant inflow of the end of the century, which resulted in an uncontrolled expansion of the southern parts of the city; as a result, many neighbourhoods lack basic necessities such as water and sanitation services. In the most marginalised districts (7,8,9 and 14), only 24% of the houses have access to piped water (CEDIB, 2007).

Distrito 8 is located in the south-eastern part of the city and has a population of 39000 (2007 estimate) (CEDIB, 2007). It is one of the poorest and least developed districts of the city, as various indicators suggest; only 12% of the roads are asphalted (city average: 30%) (Gobernación de Bolivia, 2014), under 5 mortality is 21% higher than the city average (CEDIB, 2007), etc. Reliable recent statistics regarding water coverage are scarce; CEDIB estimated that

17% had access to piped water in 2004, while less than 1% of the district was connected to SEMAPA. This issue is further discussed in section 7.1.1.

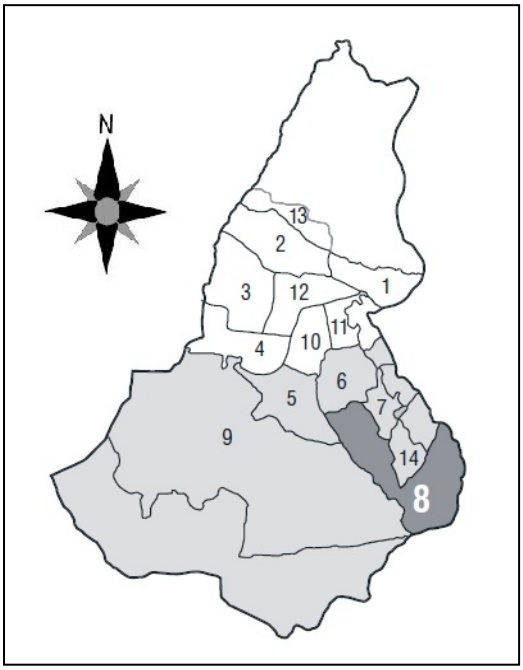

Figure 3-6 - The different districts of El Cercado, with *Distrito 8* highlighted in dark grey and the *zona sur* in light grey (CEDIB, 2007)

4 Theoretical framework

As this thesis discusses different ways of managing and administrating water distribution, an insight into water management theory is necessary. This section provides a concise theoretical background of two major, contrasting theories that are relevant for the situation in Cochabamba.

The first section describes the concept of community-based natural resource management (CBNRM), and the related idea of communal water management, which is currently prevalent in Cochabamba, particularly in Distrito 8. The second section discusses the concept of Integrated Water Resource Management (IWRM), which is relevant as it could constitute an attractive alternative for the future of the Cochabamba waterscape.

4.1 Community-based natural resources management

Community-based natural resource management is an approach where local communities are responsible for the management of natural resources within a specific area. Upon its emergence in the 1990s, it promised a more sustainable and equitable distribution and use of natural resources (World Bank, 2011). CBNRM is built upon the concept of collective and voluntary participation, and it also implies that the members of the community participate in the decision-making processes regarding the management and administration of the natural resources. An extensive body of literature exists covering the subject, and much of it tends to focus on the difficulties associated with CBNRM rather than the benefits of it. Reed (2008) offers a comprehensive overview of it.

Some studies question the capacity of the community to efficiently manage resources (Agrawal and Gibson, 1999, Blaikie, 2006); a case study by Nelson et al. (2008) demonstrates that CBNRM may in fact lead to unsustainable use of resources. Others stress the fact that the image of communities as consensual and ecologically harmonious entities may in fact be romanticised and exaggerated (Walnycki, 2013) and even invented by local social actors as political means to gain access to scarce resources (Leach et al., 1999).

Other studies emphasise the difficulty of generalising methods for the sustainable management of natural resources; Agrawal (2001) argues that the multitude of relevant variables and the non-comparability of results from different studies hamper the creation of a systematic theory regarding common property.

Another recurrent observation concerns the problems associated with the institutionalisation of stakeholder involvement. For instance, Kapoor (2001) discusses the difficulty of incorporating the many aspects of participation and social ecology into community-based environmental management, while Leach et al. (1999) highlight the challenges of institutionally embodying the intra-communal dynamism and ecological heterogeneity characteristic to indigenous communities in the strife for increased community involvement.

Nevertheless, Reed (2008) offers evidence that stakeholder participation can indeed improve the quality of the decisions made thanks to more extensive and varied inputs, but that it depends on the processes leading to them, and concludes that more research on stakeholder participation in environmental management is needed.

4.2 Communal water management

The issue of water management and administration remains one of the most sensitive and complex ones to be solved in Cochabamba's waterscape. As was explained earlier, the rapid growth of the city combined with the government's failure to meet the needs for basic services led to citizens organising themselves to obtain water. Along with the outcome of the Water War, this has helped community-based management attain legitimacy, and the concept of community-based water management still lies warm in the heart of many Cochabambinos. As the Misicuni project is dawning, the question of how to manage the additional inflow of water to the city remains one of the main problems in the future of the Cochabamba waterscape[2]. Figure 4-1 displays an example of communal water management: a team of neighbours from Villa Pagador is in charge of the management and operation of a small water treatment facility.

Figure 4-1 – Communal water management in practise in Villa Pagador, Cochabamba (photo: Carl-Johan Södersten, 2014)

Communal water irrigation systems have been thoroughly investigated through various case studies, and conclusions are often consistent with those from the CBNRM studies mentioned in section 4.1. Cremers et al. (2005) confirm the difficulty of translating traditional community-based irrigation practices into institutional legislation; Cleaver (2001) reaches the same conclusion in his case study from irrigation systems in Ecuador. Similarly, Mosse (2003) suggests a more historically grounded understanding of aspects concerning the use of resources, based on observations of communal irrigation systems in South India.

The conclusions reached by Abdullaev et al. (2010) from their research in the Ferghana Valley in Central Asia also concur with the CBNRM studies. They emphasise the problems associated with the lack of managerial skills as an obstacle to efficient water management.

Some research does highlight the beneficial aspects of communal water management. For instance, Bastakoti and Shivakoti's (2012) study of irrigation systems in Nepal concludes that

[2] Interviews with e.g. R. Ríos, S. Gareca, M.E. Flores, R. Bustamante 2014

locally written rules for operation and maintenance of irrigation systems are more suitable than rules prescribed by the state.

However, while studies on communal water systems in agriculture abound, some of which performed specifically on Andean communities (e.g. Cremers et al., 2005, Beccar et al., 2002, Perreault, 2008), little research has been done on the use of communal water systems (see section 5.1.2) in peri-urban areas. Walnycki (2013) discusses the issue extensively in her PhD thesis, and raises several interesting points concerning the implications of communal water management. Similarly to other studies, she focuses on the negative aspects rather than the benefits. She stresses the issue that water management is often used as a political tool; also, she refers to studies concluding that governments sometimes advocate for community-based management as a way to avoid taking on the water distribution problems in marginalised areas, which are often very complex. Furthermore, she mentions examples of case studies where the introduction of communal water management in fact led to adverse effects, including increased regional inequalities and intra-communal conflicts, and asserts that "there are extensive examples that reveal how community water provision does not necessary lead to equal access to water" (ibid, p.40).

4.3 Integrated Water Resource Management

Integrated Water Resource Management (IWRM) is a water management concept that emerged in the end of the 1990s. It seeks to address the problems related to present and future water resources and to implement efficient, equitable and sustainable solutions. The Global Water Partnership (GWP) defines it as

> "a process which promotes the coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (Global Water Partnership, 2000, p.22).

The GWP lists growing populations, increased economic activity, improved standards of living and lack of pollution control measures as reasons for the increasing pressure put on freshwater resources. The fragmented and uncoordinated management in traditional, sectoral, top-down approaches are, according to the GWP, amplifying these problems (ibid).

IWRM is essentially based on the interdependency of the different uses of water resources and the interconnectedness of natural and human systems. It advocates a long-term, macroscopic approach to water management, stressing that water is an integral component of the ecosystem, and thereby aims at integrating the entire hydrological cycle with other natural systems and the socio-economic system. IWRM suggests cross-sectoral, bottom-up management and policy approaches as well as interdisciplinary perspectives, through the integration of institutional, economic, technical, managerial and social aspects into the development of water management strategies (Scoullos et al., Grigg, 2003).

As water scarcity is becoming a more urgent problem worldwide, the comprehensive underlying principles of IWRM have helped the concept gain worldwide popularity, both in politics (Rahaman and Varis, 2005, Global Water Partnership, 2010) and in academia (Tas, 2013, Stålnacke and Gooch, 2010, Hlavinek et al., 2006, Scoullos et al.). Although IWRM is increasingly seen as a sustainable and efficient alternative to traditional water management,

literature suggests that the process of effectively implementing the theory into practise is problematic.

It is frequently argued that the heterogeneity of the different water situations in the world make it difficult to establish a general implementable framework and design of IWRM. Recurrent issues include e.g. differences in institutional arrangements and policies, management capacities, physical attributes and availability of resources (Scoullos et al., Biswas, 2008, Lahtela, 2001, Hlavinek et al., 2006). Rahaman and Varis (2005) argue that another challenge stems from the fact that the importance of water varies widely between different societies; likewise, Biswas (2008) mentions the topics of heterogeneous cultures and social norms as additional obstacles against the creation of a single paradigm of integrated water resources management.

Overall, the concept of IWRM is considered as a propitious strategy, but more work is needed on how the implementation could be practically carried out. Meanwhile, current focus lies on conceptualising it rather than making it a usable tool (Biswas, 2008, Rahaman and Varis, 2005, van der Zaag, 2005).

4.4 Relevance for the case study

The theory behind the two concepts of CBNRM and IWRM will be used in the discussion part of this report to analyse the situation and to support claims and conclusions. The two approaches are distinct; CBNRM focuses on neighbour participation and local solutions, while IWRM considers the entire hydrological cycle in order to create a macroscopic solution. Notwithstanding, both approaches are relevant for the study, for different reasons. CBNRM is currently being used in many of the interviewed neighbourhoods and can hence be analysed with empirical data, whereas IWRM can constitute a future alternative for the management of the entire Cochabamba valley, through the Plan Maestro Metropolitano (see section 5.3).

5 The Cochabamba waterscape

The Cochabamba waterscape is constituted of a complex array of different organisations and entities, comprising large public enterprises and a variety of small-scale community water systems. It is by far the most complex in Bolivia, and most likely in the world. The Cochabamba valley counts four major public water companies, between 60 and 80 water cooperatives and between 600 and 700 communal water systems, comprising committees, directives, secretaries, associations, agrarian unions, etc (PAPC, 2013). In the *zona sur* alone, 240 water organisations were present in 2007 (CEDIB, 2007). Figure 5-1 illustrates the situation in the Cochabamba valley.

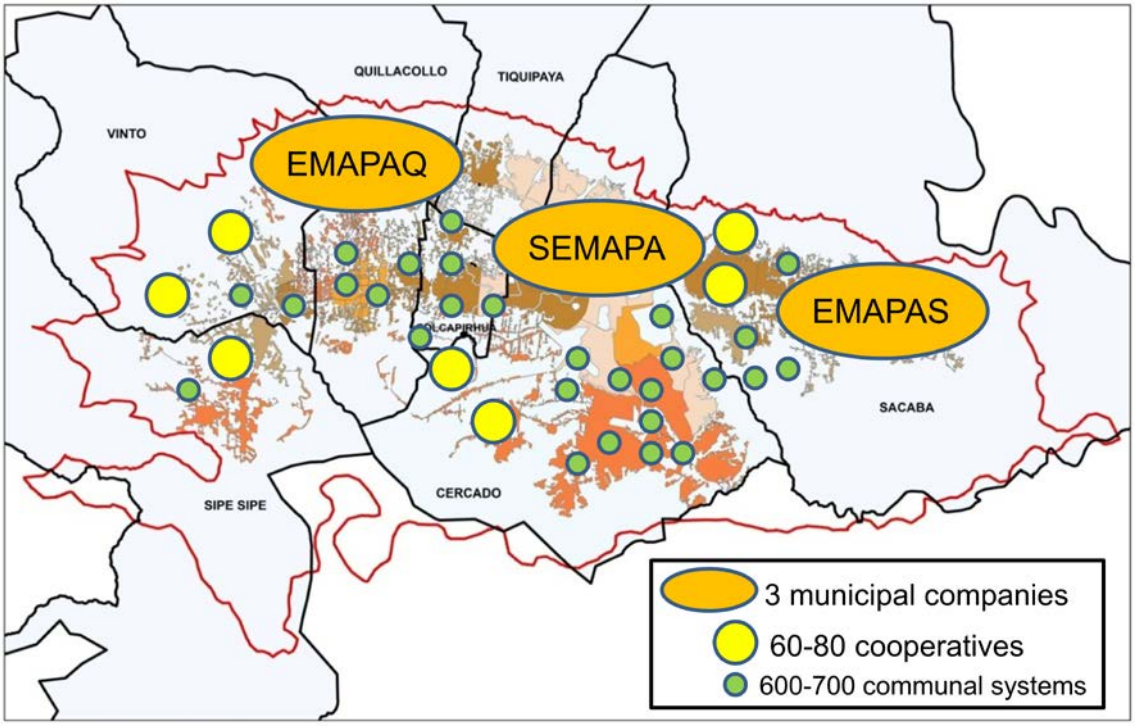

Figure 5-1 - An illustration of the current waterscape in Cochabamba

The means by which these different entities obtain water are also diverse: some have access to piped water, some rely on wells, some collect it from nearby watersheds, and some buy water from independent, private-run water delivery trucks, known as *aguateros* or *cisternas*; on their own, through a neighbourhood committee or via the municipal water company SEMAPA.

Therefore, this section aims at listing the main actors in the water distribution system of Cochabamba, as well as describing the differences and similarities between them. Focus lies on the actors operating in or in some way relevant to Distrito 8. The information is based both on existing literature and on data obtained during the field study.

5.1 Different models of water governance

Entities providing water and sewerage services are referred to as EPSAS (Entidad Prestadora de Servicio de Agua Potable y Saneamiento). The Bolivian state recognises four different models of water governance: public entities, mixed entities, communal water systems and cooperatives (Asamblea Constituyente de Bolivia, 2008). The latter two are sometimes jointly called *Operadores Locales de Pequeña Escala* (OLPE, or small-scale local operators). A study performed by the World Bank (2007) concluded that 47% of OLPEs are either *Organizaciones*

Territoriales de Base (OTBs, grass roots organisations) or *juntas vecinales* (neighbourhood assemblies), 30% are water committees, 16% cooperatives and 7% civil associations. As of 2013, no examples of mixed entities existed in Bolivia and these will therefore not be treated (PAPC, 2013).

5.1.1 Public entities

Public companies in charge of water and sanitation include SEMAPA in El Cercado and its equivalents in the nearby cities of Quillacollo and Sacaba, EMAPAQ and EMAPAS, respectively.

5.1.1.1 SEMAPA

SEMAPA was created in 1967, as the former citywide water provider was institutionalised as a public body responsible for water and sanitation services in the city. Five years later it was given administrative, financial and managerial autonomy.

As explained in section 3.2.4, since SEMAPA was reinstated as a public company in 2000 in the aftermath of the Water War, water access in the city has not improved. The municipal company primarily attends to the needs of the central and north-eastern part of the city, and covers only 47% of El Cercado's households (Gobernación de Bolivia, 2014). That being said, the quality of the service varies greatly between different parts of the cities; some of the neighbourhoods that lie within SEMAPA's covered area enjoy continuous water availability (neighbourhoods in e.g. districts 1, 11 and 12), while others struggle to fulfil their needs with just a few hours per week (neighbourhoods in e.g. districts 6,7 and 8). This is discussed further in chapters 6 and 7. Therefore, citizens of Distrito 8 (and admittedly to many other areas of Cochabamba[3]) have adopted a habit of systematically storing large quantities of water in private tanks as soon as they receive it, be it from SEMAPA or other sources. This "*cultura del tanque*", as Ledo García (2008) has coined it, has had repercussions on the water distribution system of the city, as is further explained in section 7.3.2.

5.1.2 Communal water systems

Communal water systems (CWSs) were born towards the end of the twentieth century along with the fast growth of the city, and are based on the concept of communal governance. Communal governance can be described as

> "a form of living together based on ancestral and cultural laws and uses and customs, where collective work and active participation in the deliberation and taking of decisions regarding property and matters that concern the community prevails, based on the principles of reciprocity, solidarity, justice, equity and transparency" (PAPC, 2013, p. 6)

The first CMSs emerged due to the lack of municipal water provision in the new suburbs that had surfaced in the outskirts of El Cercado (predominantly in the south), as a mergence between the trade unionism of the migrating miners and the local area knowledge of the rural population. Neighbours from small communities joined forces to drill wells, dig ditches and lay basic pipelines that would provide the inhabitants with water, using their own funding. Today, between 600 and 700 communal water systems exist in the metropolitan area of Cochabamba (PAPC, 2013), which corresponds to 90% of the country's CWSs (World Bank, 2007).

[3] Interviews with R. Bustamante, S. Gareca, A.M. Romero, 2014

5.1.2.1 OTBs

OTBs are formally recognised indigenous or neighbourhood organisations that act as decentralised legal entities in charge of community services. Since the *Ley de Participación Popular* of 1993 (LPP - Decentralisation and Popular Participation laws), they serve as official representation between the people and the municipality. Through the *Plan de Operaciones Anual* (POA), they have the legal right to suggest the implementation of public services in their area of operation, such as sanitation and water supply, but also regarding health, education, urban planning, etc. The state provides them with much of their income as well as with a certain amount of technical assistance, as one of the outcomes of the LPP[4]. OTBs may or may not administer the water services in their area of operation, depending on several factors. In districts where SEMAPA has a high coverage, for instance, the company itself is in charge of the water management. Conversely, in districts where SEMAPA's coverage is low, the OTB may be involved in the water administration; sometimes as a sole actor, sometimes jointly with a water committee or cooperative, sometimes not at all.

A variety of scenarios was encountered while interviewing the OTBs of Distrito 8. Of the 41 current OTBs, 26 were interviewed. Figure 5-2 illustrates the water situation in the district; an analysis is provided in section 7.1.2. The information was obtained through interviews with the OTBs as well as water committees.

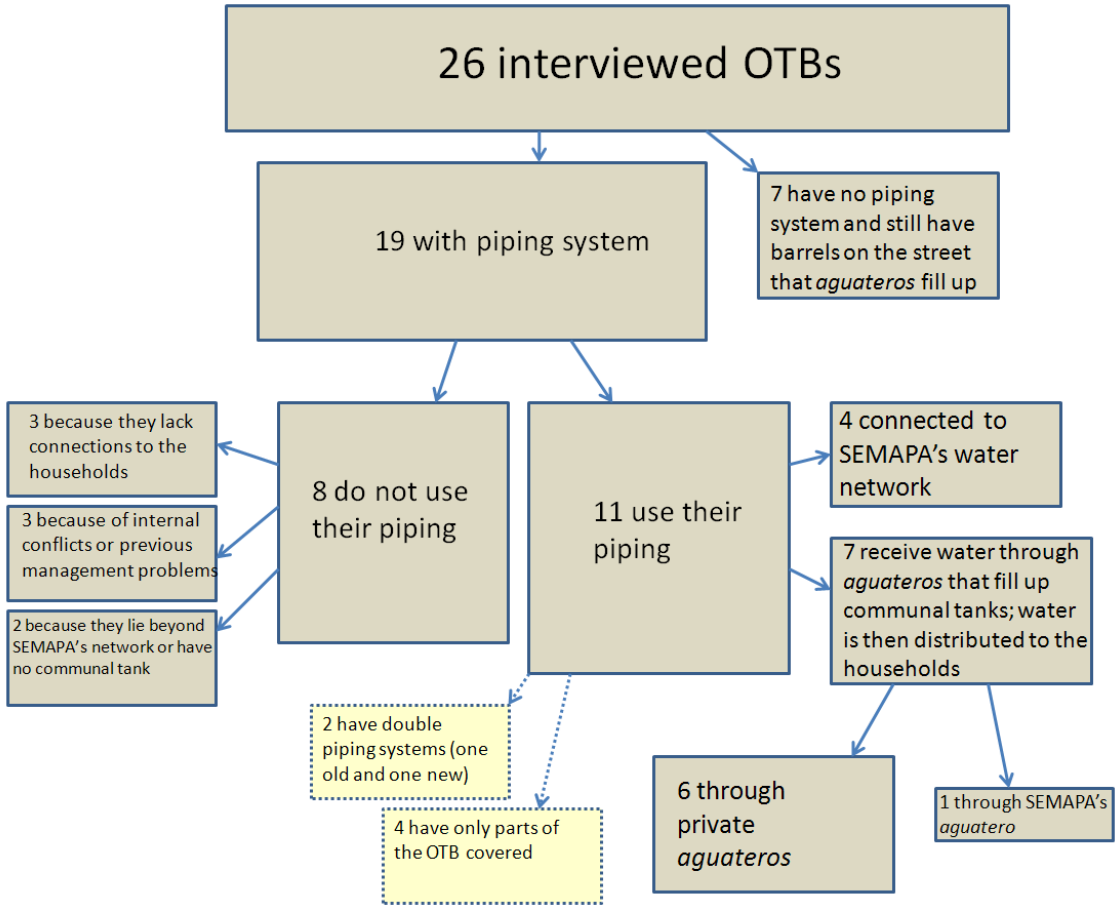

Figure 5-2 - The water situation in the 26 interviewed OTBs in Distrito 8 (source: own investigation)

[4] Interview with C. Oropeza, 2014

5.1.2.2 *Juntas vecinales*

Juntas vecinales are neighbourhood organisations that have not yet been granted the state of OTB. They are similar to OTBs when it comes to operation and purpose, as they are also in charge of public services. The major difference is that, despite being recognised by the state as legal entities, they are not covered by the LPP because they are not categorised as OTBs, and hence are not funded by the state. Instead, *juntas vecinales* sometimes rely on external help from NGOs or the church, and otherwise by contributions from the inhabitants. Many of today's OTBs were *juntas vecinales* before the LPP was instated, and most of today's *juntas vecinales* strive to obtain the status of OTB[5].

Distrito 8 counts 32 *juntas vecinales,* all located in marginalised, high-altitude areas beyond the reach of SEMAPA's network, and hence rely on *aguateros* to attend to their water needs. Due to lack of time, these were excluded from the study, and will therefore not be discussed further in this report.

5.1.2.3 *Water committees*

Water committees are organisations that deal exclusively with water issues. As opposed to OTBs and *juntas vecinales*, water committees are not recognised as legal entities and therefore receive neither governmental funding nor technical assistance. Instead, they often rely on help from the church, from NGOs and to a certain extent from its members (sometimes referred to as *auto-ayuda*, or auto-help) to cover for the costs of operation. The role of a water committee is to provide and administer potable water to the inhabitants, in neighbourhoods where SEMAPA's coverage is low or deficient. Figure 5-3 shows the headquarters of a water committee in Distrito 8.

Figure 5-3 - The headquarters of the water committee Villa San Miguel Km4, shared with the OTB of the same name (photo: Carl-Johan Södersten, 2014)

Often the committees have built huge water tanks in which they gather water, e.g. from rain collection during the rainy season or by purchasing it by bulk from water delivery trucks. Some committees also rely on privately dug wells or on nearby watersheds. In neighbourhoods that

[5] Interview with C. Oropeza, 2014

have a piping system, the water is often distributed directly to each home. In others, committee members need to collect water from a communal tank and bring it back home manually.

Water committees are predominantly present in the *zona sur*, and they proliferated there in the years following the Water War. Since the coverage of the municipal water provider SEMAPA is very low in certain districts of the *zona sur* (notably in Distrito 8, where less than one percent of the inhabitants are connected to SEMAPA; CEDIB, 2007), the water committees have a strong influence, both socially and politically. In most of the cases, the committees work independently and their concession areas sometimes stretch over areas larger than those of OTBs[6].

As is illustrated in Figure 5-2, 11 of the 26 interviewed OTBs of Distrito 8 were found to be using a piping system to distribute water. In eight of these the water was administered and distributed by a committee, while in the remaining three it was done by the OTB itself. In the OTBs where a piping system was inexistent or not in use, people bought water individually from *aguateros* and a water committee was therefore not needed.

5.1.2.4 Other organisations

ASICASUR (Asociación de Sistemas Comunitarios de Agua del Sur, the association of the communal water systems of the south) is a transcendental non-profit organisation comprising 46 OLPEs of the *zona sur* (Gobernación de Bolivia, 2014). It was created in 2004 as an attempt to promote and encourage communal water management in the *zona sur*, and its objectives include giving technical support to its members as well as assisting them with legal issues. After the Water War, people had temporarily regained trust in the newly restructured SEMAPA, but as the water situation did not seem to be improving, a group of committees formed ASICASUD in the hope of gaining more response from the government. Today, ASICASUD is the main water actor in the southern part of the city and it has taken on the role as spokesperson for the many water committees. It is a recognised legal entity and therefore is formally in charge of the communication between the inhabitants and the authorities[7].

FECOAPAC (Federación Departamental de Cooperativas de Agua Potable y Alcantarillado de Cochabamba, the departmental federation of water and sanitation cooperatives), is another autonomous non-profit institution that acts as a spokesperson for smaller OLPEs, but as it only encloses water cooperatives from the northern parts of the city and neighbouring cities, it will not studied in detail.

Other types of water organisations exist, such as *sindicatos agrarios* (agrarian unions) and civil associations, but those will not be discussed here as they are either marginal or not of substantial importance for this specific study. Moreover, organisations that serve the same purpose of water committees may be referred to by other names in different OTBs, such as *directorio* (directive) or *secretario* (secretary), but as these operate similarly to committees they will not be treated separately here.

[6] Interview with C. Oropeza, 2014
[7] Interview with C. Oropeza, 2014

5.1.3 Water cooperatives

Cooperatives are an alternative model of water governance. They are similar to committees in their tasks and objectives, but they differ in their organisational structure. While committees are administered and managed by members of the local community itself, cooperatives have an external governing management. Also, a cooperative has the status of a company, where members are beneficiaries and own a certain amount of shares. Cooperatives are, however, more common in the outskirts of the city, and will therefore not be analysed further.

5.2 Other actors and stakeholders

Besides from the associations in charge of water governance, there are several other important stakeholders present in Cochabamba's waterscape. Below is a description of some of them.

5.2.1 Aguateros

Aguateros ("watermen") is the name given to the people that deliver water by cistern trucks (or *cisternas*). They typically buy the water from private sellers that have access to nearby wells (mostly in the northern parts of the city), and sell it elsewhere, e.g. to people whose piped water supply is insufficient or to neighbourhoods that are not covered by SEMAPA's network. Most *aguateros* work independently: the driver usually owns and drives the cistern truck (although some water sellers possess their own delivery trucks). The *aguateros* deliver the water to predetermined areas, admittedly[8] defined in conformity amongst them. Figure 5-4 shows an *aguatero* filling up his cistern.

Figure 5-4 - *Aguatero* filling up his cistern (photo: Carl-Johan Södersten, 2014)

Because of the long distances *aguateros* usually have to cover to distribute the water to the marginalised areas, the price for a cubic metre of water is heavily inflated compared to what people pay in the city centre. When purchased in bulk, one delivery of 12000 litres costs

[8] Interviews, 2014

between 160 and 190 Bolivianos (US$23-27), i.e. US$1.9-2.25 per cubic metre, which is then sold at US$2.5-2.6. However, in the neighbourhoods where no communal tank exists, people often have no other option but to purchase water directly from the *aguateros,* and prices are therefore much higher, and increase the further the household is. Some possess larger tanks but many still store the water in 200-litre barrels (such as the one displayed in Figure 5-5), and the price of a cubic metre of water can rise up to US$4.3[9].

Figure 5-5 - A barrel used for storing drinking water delivered by *aguateros* (photo: Carl-Johan Södersten, 2014)

Another important concern with the *aguateros* is the quality of the water delivered. The water is seldom analysed and the people have no way of knowing whether or not the water is clean enough to be consumed. Moreover, the aforementioned barrels are often stationed along the street, without proper concealment, and are therefore prone to contamination.

As the city keeps expanding while the water supply does not, the need for *aguateros* is on the rise, and the volumes of water transported everyday are tremendous. In an attempt to assess those volumes as well as ameliorate the quality of the water delivered, the departmental institution for health services (SEDES) performed a campaign for controlling and analysing the state of the delivery trucks in 2011. The trucks' cisterns were checked, and if they were deemed clean enough to be used for potable water, the trucks were marked with a quality seal. Although the campaign was voluntary, some 175 trucks were granted the seal[10]. However, the total number of water delivery trucks operating in Cochabamba is estimated to be much higher (twice as high according to Ana Maria Romero, the current director of the water and environmental sanitation centre (CASA) of the University of San Simón in Cochabamba[11]). Moreover, the campaign turned out to be a one-time initiative and there have been no official follow-up controls on the delivery trucks since then[12].

[9] Interviews with various OTBs in *distrito 8*, 2014
[10] Interview with L. Vargas, 2014
[11] Interview with A.M. Romero, 2014
[12] Interview with R. Bustamante, 2014

No official numbers exist regarding the volumes of water transported every day, but a back-of-the-envelope calculation performed by the author estimates the amount of water delivered on a Sunday during the dry season to more than 8 million cubic metres (see appendix C1).

Although *aguateros* typically work individually and independently, there are forms of cooperation between them. A trade union called Sindicato de Aguateros Tunari has been active for almost two decades, comprising some 40 *aguateros*, and according to the union president, René Severiche, the trucks are regulated and their statuses controlled on a trimestrial basis[13]. These controls, however, are done by the union itself, and although it is recognised as an official organisation by the government, the extent and reliability of them remain unclear.

5.2.2 Private water sellers

As is explained above, *aguateros* purchase water in bulk from private sellers in the northern parts of the city. The water is pumped from privately owned wells dug directly in the gardens, at depths ranging from 50m to 100m[14], and transferred to the cisterns via aerial pipes (see picture Figure 5-6). Around 40 sellers [15] operate in El Cercado, almost exclusively in the northern parts of the city. Many wells exist in the south but the water collected from them is deemed unsuitable for human consumption and is solely used for cleaning and washing purposes (and to some extent for irrigation). The groundwater in that area contains excessive levels of salt and other minerals, and nearby industrial activity such as large factories, oil refineries and garbage dumps have contributed to contaminating the water further.

Figure 5-6 - Two examples of aerial pipes used to transfer water from private wells to *aguateros* (photo: Carl-Johan Södersten, 2014)

[13] Interview, 2014
[14] Interview with J. Herbas, 2014
[15] Interview with J. Herbas, 2014

The water-selling business remains an unofficial commercial activity in Cochabamba; one of the aftermaths of the Water War was the creation of a law that prohibits turning water distribution into a profit-generating activity. Hence many water sellers were found to be reluctant to participate in an interview; the ones that did asserted, on numerous occasions, that they were involved in the business solely with the purpose of fulfilling a social and altruistic function, and that the price charged was only to cover for the operation and maintenance costs. However, another simple back-of-the-envelope calculation (see appendix C2) based on information obtained during an interview with one of the sellers concluded that the income generated from selling water to *aguateros* ought to average, for that particular seller, around US$90 per day during the dry season. To put that into context, the average annual income per capita in Cochabamba in 2009 was US$1438, i.e. less than US$4 per day (Bolivia Weekly, 2009).

No legislation exists regarding the treatment of the water sold privately, but a few sellers have installed small-scale water treatment facilities (see Figure 5-7).

Figure 5-7 - Water treatment facility installed by a private water seller (photo: Carl-Johan Södersten, 2014)

5.2.3 Empresa Misicuni

The Misicuni Multiple Project was first proposed in 1952, and was initiated in the end of the 1960s (Assies, 2003). The basic idea was to collect water from the three rivers Misicuni, Viscachas and Putucuni, located behind the Tunari mountain range (see Figure 3-3). The objectives of the project were to provide potable water to the urban populations of the central valley of Cochabamba, to bring irrigation water to the surrounding agricultural lands and to construct a hydroelectric power plant. Ever since the project was proposed and started, the Misicuni project has been regarded as the ultimate solution to the region's water problems, and it has, over time, become a sort of "neoliberal dream" (Walnycki, 2013, p. 138). Assies (2003, p. 19) says it has "acquired magical aura in the minds of many Cochabambinos", while Romero states in an interview that "Misicuni is like a god of water"[16] (own translation). Indeed,

[16] 2014

the figures given by Empresa Misicuni, the company in charge of the project since it became institutionalised as a state enterprise in 1987, are promising: a total water flow of 6100 l/s, out of which 3900 would be used as drinking water while the rest would provide 5900 ha of agricultural lands with irrigation; current flows from superficial waters are just under 500 l/s (Gobernación de Bolivia, 2014). Furthermore, the 120 MW hydroelectric power plant would generate around 500GWh of electricity per year (Empresa Misicuni, 2007).

The project has, however, been hindered by many obstacles since its start, and its completion has been postponed multiple times. Lack of public funding and foreign investment make its progress slow, and although the first phase of the project, the drilling of a tunnel through the mountain range, was completed almost a decade ago, the ultimate goal is still far from reach. Moreover, the success of the project is directly dependent on a substantial amount of additional infrastructure expansion as well as renovation of current systems, which are beyond the control of Empresa Misicuni and are to be undertaken by SEMAPA. This is developed further in section 6.1.2. As of April 2014, the construction was on hold due to financial problems.

5.2.4 NGOs, CASA, SEDES

Various other actors are present in the Cochabamba waterscape: different NGOs (e.g. Fundación Abril, Agua Tuya, etc), the university's water and sanitation centre CASA, the departmental institution for health services SEDES, etc, but these will not be discussed in detail in this study, as the focus lies on the actors directly involved with the water distribution and management. Nevertheless, interviews have been performed with some of the NGOs whose work covers Distrito 8, as they were considered to be valuable sources of information.

5.3 Plan Maestro Metropolitano

The Plan Maestro Metropolitano (PMM, metropolitan master plan) is an extensive plan initiated by the government and elaborated with the help of several international engineering consulting firms, some of which specialised in water distribution systems, to propose a strategy to solve the problems associated with water supply in the entire Cochabamba valley. It covers the seven cities located within the metropolitan area of Cochabamba and encompasses all the available water sources in the entire valley, both superficial and underground. The plan has a time frame of 30 years, and it is divided into three stages: short-term, mid-term and long-term. The overall aim of the PMM is to propose an efficient, equitable and sustainable way to manage and distribute the water in and around El Cercado at the dawn of the completion of the Misicuni project, through a certain amount of objectives listed in appendix D (Gobernación de Bolivia, 2014). As such, the plan basically constitutes an implementation of IWRM, and the implications of this will be discussed further in subsequent sessions.

The PMM contains an extensive hydrological and climatologic study of all the water sources in the Cochabamba valley. It provides quantitative data of superficial water flows and groundwater statuses, lists existing wells, abductions, treatment plants, water tanks, etc, and takes into account future additional water resources, e.g. from the Misicuni project. It also contains a systematic summary of each of the cities comprised in the metropolitan area, describing and diagnosing the existing infrastructure as well as the financial, social and institutional situation.

6 Interactions

This section describes the interactions between the five actors considered to be the most relevant for the scope of the study: the local actors present in Distrito 8, SEMAPA, *aguateros*, PMM and Misicuni.

The main local actors of Distrito 8, OTBs and water committees, are central actors in the water distribution system. Although it has been argued that OTBs and water committees from overlapping areas are often in dispute among themselves[17], the results from the performed interviews indicate otherwise. Hence the interaction between these two actors will not be discussed here.

6.1 OTBs

Two main topics will be discussed: the interaction with SEMAPA and the future interactions with the PMM and the Misicuni project. The relationship between OTBs and *aguateros*, albeit crucial for the water distribution, will not be brought up, as interviews with the OTBs indicated that it was perceived as a mere buyer-seller interaction. Moreover, the *aguateros* constitute a temporary solution rather than a permanent solution.

6.1.1 SEMAPA

As was illustrated in Figure 5-2, the water situation varies considerably, and so does the nature of the interactions between OTBs and SEMAPA. Upon asked about their willingness to be collaborate with the municipal company, the OTBs tended to have distinct opinions. These are summarised below, followed by a few observations that have been made concerning SEMAPA's perception of the OTBs.

6.1.1.1 Negative towards a collaboration with SEMAPA

Out of the four OTBs that are connected to SEMAPA's network, none is fully satisfied with the service, for various reasons. Due to water scarcity, SEMAPA only delivers water once or twice a week to these neighbourhoods, for three to four hours each time. Therefore most of the consumers need to resort to *aguateros* as well to attend to their needs. Further, bills seldom reflect the actual consumption. Many houses lack mediators and are therefore charged according to the size of the house or the number of installed taps. Those houses that do have mediators are reportedly charged for more than they consume[18]; since the piping system is not pressurised, pipes fill up with air during idle periods – air that is subsequently charged for as it affects the mediators. Furthermore, many mediators are malfunctioning or unreadable, which admittedly often leads to estimates being reported rather than actual readings[19]. According to SEMAPA engineer Samuel Gareca, SEMAPA needs to install or change around 70000 mediators in the city. The rate of installation, however, is slow: in 2013, only 2000 mediators were installed[20].

Another problem stems from the fact that many communal water systems have been funded and built by the community itself, and they are therefore reluctant to pass on the administration of their infrastructure to SEMAPA; they fear that they will lose infrastructure

[17] Interview with M.E. Flores, R. Bustamante, 2014
[18] Interview with S. Gareca, J. Baldillón Garcia, M. Tupa, J.L. Ballesteros, A. Villca, 2014
[19] Interview with S. Gareca, 2014
[20] Interview with S. Gareca, 2014

that belongs to them (such as they did when Aguas del Tunari took over the water administration prior to the Water War) and that the time and effort that they have invested in their systems will go to waste[21].

Overall, most of the interviewed OTBs appeared reluctant to putting SEMAPA in charge of the water administration and management.

6.1.1.2 Positive towards a collaboration with SEMAPA

Six of the interviewed OTBs declared that they would rather have their water administered and managed by SEMAPA. The reason for this was not, however, that they were positive towards SEMAPA per se, but rather that they were negative towards the alternative choice, i.e. having the water distribution administered by a local entity. Three of the OTBs used to have a piping system in place, but due to problems of internal conflicts, poor management and corruption, they are no longer using it and have been forced to go back to filling barrels with water from *aguateros*, thereby leaving a fully functional piping system to dilapidate.

The other three OTBs that asserted being positive towards SEMAPA grounded their opinions on similar reasons. Hence, the SEMAPA option seems to be a "best worst option" rather than a fully vindicated choice.

6.1.1.3 SEMAPA's perception of the OTBs

Interviews with SEMAPA engineer Samuel Gareca indicated that SEMAPA doubts the capability of the local OTBs and water committees to efficiently administer the Misicuni water. Lack of managerial experience and technical proficiency is seen as a barrier to a well-functioning water management and distribution. Instead, SEMAPA strives to obtain control of the water distribution in the entire *zona sur*. In order to gain the citizens' trust, the company frequently distributes flyers listing promising water rates and excellent service; promises that they are seldom able to hold[22].

6.1.2 PMM and Misicuni

The interviewed OTBs were found to have little faith in the PMM. The reasons for this include that previous attempts at creating metropolitan master plans have failed, that they doubted that the opinions of small local actors will be heard. Regarding Misicuni, many OTBs asserted still having hope for the Misicuni water to arrive, despite decades of postponement.

Upon asked about their visions for the eventual arrival of the Misicuni water, which, according to the PMM, would be administered by SEMAPA until it reaches the city, many of the OTBs suggested a scenario where they would buy water in bulk from the municipal company and then distribute and manage it themselves within the OTB. This is an alternative that has been widely advocated by NGOs (e.g. CeVi), ASICASUR and CASA.

6.2 SEMAPA

During the course of the field study, rare were the occasions where positive views were uttered about SEMAPA. Indeed, there is an overall feeling of discontent and distrust towards SEMAPA, from local actors such as OTBs, from NGOs, from institutions such as CASA and SEDES, etc. In the evaluation of SEMAPA provided in the PMM documents, the judgment is

[21] Interviews with various OTBs, 2014
[22] Interviews with S. Archidiacono, A.M. Romero, C. Oropeza, 2014

similar; a multitude of problems with their current performance is described and it is concluded that SEMAPA is ”among the least efficient companies in the country in terms of management of water resources” (Gobernación de Bolivia, 2014, p. 358). This is further described in section 7.1.1. On the other hand, SEMAPA reportedly shows little interest in the PMM; according to e.g. Engineer Julio Rodriguez, consultant for the PMM, SEMAPA barely attended the organisatory meetings during the planning of the plan.

The situation is similar with Misicuni. The symbiosis between SEMAPA and Misicuni is of paramount importance for the progress of the Misicuni project and hence for the future of Cochabamba, but as was already mentioned in section 5.2.3, the interaction is problematic. According to the current general manager of Empresa Misicuni, Leonardo Anaya[23], SEMAPA consistently fails to comply with their obligations, and as a means to achieve the goals set in the project plan, Empresa Misicuni has been forced to authorise SEMAPA to use money that they owe them to finance the implementation of a certain part of the infrastructure that they are required to build, as it constitutes a bottleneck in the continuation of the project.

The implications of these conflictive interactions SEMAPA are discussed further in section 7.1.1.

[23] Interview, 2014

7 Problems

Chapter 5 listed the different actors present in or relevant to Distrito 8 and described their main characteristics and modus operandi. In this section, an in-depth analysis of the principal actors is performed, using the data collected in the field study. The purpose is to identify problems that affect the interaction between them.

7.1 Administration and management problems

7.1.1 SEMAPA

El Cercado's municipal water provider SEMAPA only covers 47% of the city, and the quality of the service varies a lot. The water availability is generally better in the central and northern parts of the city and it decreases as it reaches the more marginalised areas of the south. The immediate focus of SEMAPA lies on expanding the current network. Nevertheless, the areas with high coverage and frequent service are burdened with problems as well.

Losses due to leaking pipelines and clandestine connections are estimated to be between 40 and 55%, depending on the source (Pitman and Ringskog, 2002, Shultz and Draper, 2008); water systems consultant and former SEMAPA engineer Julio Rodriguez evaluates it to 46%[24]. Most of SEMAPA's network was built in the 70's, using low-quality asbestos cement pipes and polyethylene connexions that time has worn out. Rodriguez describes the present situation of SEMAPA's pipelines as "disastrous", and calls the polyethylene pipes "extremely bad". Figure **Error! Reference source not found.** displays a sample of such a pipe that is, according to Rodriguez, representative of the average connection in the city centre.

Figure 7-1 - Polyethylene connection originating from the SEMAPA network in the city centre, with the inside covered in a layer of residue (photo: Carl-Johan Södersten, 2014)

One of the direct consequences of the worn-out connections is that the system cannot, in its current state (Gobernación de Bolivia, 2014), withstand the high pressure that is necessary to achieve a fully functional water distribution system (Alperovits and Shamir, 1977, Lambert, 2001). A pressurised system is also a prerequisite for minimising leakage and thereby water contamination (Friedman et al., 2004). Figure 7-2 shows a bottle containing water obtained from a tap in the centre of El Cercado. Admittedly[25], the water is safe to drink, and the turbidity is due to non-toxic particles.

[24] Interview, 2014
[25] Interview with J. Rodriguez, 2014

Hence, most of the existing network is in need for repair or replacement, and the costs of the necessary restoration in the city alone are estimated to be around US$200 million[26].

Moreover, lack of adequate surveillance makes it relatively easy to connect to the network illegally. In the SEMAPA assessment contained in the PMM documents, 20% of the connections are estimated to be illegal (2014). SEMAPA engineer Samuel Gareca retells in an interview of an episode that confirms this. While SEMAPA technicians visited a four-star hotel located a few blocks from their headquarters to perform some maintenance work, they discovered that the hotel had seven independent connections to the municipal water network, out of which only one was metered. According to Gareca, such examples abound, and as fines for stealing water are reportedly very low, they are likely to keep doing so.

Figure 7-2 - A bottle containing water straight out of the tap from a residential building in the city centre of Cochabamba (photo: Carl-Johan Södersten, 2014)

Several reasons can be listed for the low coverage and the slow rate of improvement of SEMAPA. The rapid and unplanned growth of the city in the end of the century made it difficult, if not impossible, for the municipal water company to keep up with the emergence of dwellings and neighbourhoods. Moreover, lack of adequate funding by the state hampers the implementation of the various repairs and network expansions that are needed.

However, a major problem remains within the company itself; systematic corruption and poor management within SEMAPA has led to inefficient use of resources[27] and increasing debts (Finnegan, 2002). According to Ledo García, SEMAPA had accumulated US$12 million in debts between 2003 and 2008, and the total debt in 2008 was US$27.5 million (2008). In 2011, the costs exceeded the income by over 33% (Gobernación de Bolivia, 2014). Moreover, there exist major flaws in the administration and organisation of information. According to the PMM assessment, SEMAPA does not possess a registry of its main valves, and it states that there are "serious limitations to access all the information that would be necessary to incorporate the elements [required to accurately model the water distribution system]" (2014, p.286). Furthermore, the PMM mentions obsolete software and IT systems as another obstacle to efficient water administration and management.

Problems related to corruption are often mentioned as a barrier to efficient allocation of funds. In an attempt to address these problems, three civil representatives were added to the 5-person board of SEMAPA when it was reinstated in charge of water distribution after the Water War. These new members of the board were elected by the people and represented the

[26] Interview with S. Gareca, 2014
[27] Interview with J. Rodriguez, 2014

northern, central and southern parts of the city, respectively. However, as their involvement led to disagreements in the decision-making processes, they were "removed" from the board[28].

Another consequence of the systematic corruption within SEMAPA has been the frequent change of president, often for reasons related to funds mismanagement. Gareca asserts having experienced 18 board presidents during his 14 years at SEMAPA, which hinders the establishment of continuity in the administration and company strategy.

Improvements have been made though. A former problem included lack of surveillance in the recruitment process, which led to a large share of employees being recruited informally and illegally (e.g. friends and relatives of employees). In the last years, the number of SEMAPA employees has decreased from over 500 to 326[29] (Gobernación de Bolivia, 2014).

7.1.2 OTBs and water committees

Communal water management is common in the El Cercado's *zona sur*, and there is a strong desire to maintain the water distribution under the management of OTBs and water committees. There are, however, several problems with community-based management, as was explained in Chapter 4, and many of these can be discerned in the current situation in Distrito 8.

Many of the interviewed OTBs admitted having had a problematic and tumultuous past, with internal conflicts within the OTB, collaboration difficulties with the water committee and corrupt decision-making processes being the norm. According to M.E. Flores, this is one of the main reasons for why the water distribution network of Distrito 8 is much less developed than in other district of the *zona sur*. As is shown in Figure 5-2, three OTBs have abandoned a fully functional piping system due to earlier problems of mismanagement. The corruption situation has admittedly improved in recent years, as a new generation of OTB presidents has emerged, but the lack of managerial skills is still a problem[30]. Another obstacle to efficient communal management is the lack of managerial and administration skills. Also, many of the communal systems lack the technical proficiency needed to properly build and maintain a pressurised piping system, which has led to cases where the installed system is incompatible with the main SEMAPA pipelines, often because the communal system has chosen materials and designs that do not meet the required standards.

Another problem with many of the OTBs and water committees of Distrito 8 is the inefficient use of labour resources. A water committee, for instance, needs a certain amount of employees in order to function, such as president, a secretary, a treasurer, commissioners, technicians, a plumbers, etc. Hence it is often not efficient to have such a workforce for a community that only hosts a few hundred people, as some of the OTBs of Distrito 8 do. To face this problem, it has been suggested that several OTBs or water committees join their water distribution administrations to create bigger entities[31], but several interviews with OTBs have indicated that such a process would imply a range of complications concerning priorities, choice of board members, etc.

[28] Interviews with C.Crespo, S. Gareca, 2014
[29] Interview with S. Gareca, 2014
[30] Interview with M.E. Flores, S. Gareca, R. Rios, 2014
[31] Interviews with C. Oropeza, R. Rios, 2014

7.1.3 Misicuni as a potential water administrator

In order to surmount the administration and management problems described in sections 7.1.1 and 7.1.2, a recurrent suggestion was encountered throughout the course of the field study[32], namely to instate a new main actor in the water distribution system of El Cercado, a municipal entity akin to SEMAPA. One way of doing that would be to expand Empresa Misicuni into a company in charge of not only of infrastructure, but of water administration and management as well[33]. The implications of that have however not been investigated further in this study.

7.2 Distrust between the different actors

Chapter 6 outlined several problematic interactions between the main actors in the Cochabamba waterscape. This has resulted in a growing sentiment of distrust, and in some case of split incentives, among the stakeholders, which hinders progress further. Since the events of the Water War, people have nurtured a pessimistic attitude towards the state and are today very prone to protest; negative aspects are emphasised while positive development is discounted. This makes it difficult to approve new projects and achieve goals[34]. For instance, a network expansion project that was to be put into action in 2006-2007 was met with resistance from the leaders from various OTBs not wanting to lose their share of power in the area. The US$6 million project, which had already been approved and funded, was cancelled at the last minute due to strong opposition from the local communities, and SEMAPA ended up losing US$2 million in legal fees[35]. Likewise, a pipeline upgrade work in April 2014 had to be assisted by constant police protection due to protesting neighbours[36].

The PMM describes a suggestion for a logistical solution to the water distribution in the Cochabamba valley. It does not, however, explicitly advocate for a particular form of water governance; it is based upon a list of premises, several of which focused on aspects related to public participation (see appendix D), and it recurrently mentions the importance of respecting autonomous and communal systems. Nevertheless, many of the interviewees appeared sceptical towards the implications of this.

7.3 External problems

7.3.1 Property rights on water

One of the major identified problems is the issue of property rights on water. It has not been brought up in the report since it concerns the greater Cochabamba rather than Distrito 8, but it constitutes one of the main barriers to an efficient water distribution[37]. The problem is grounded in constitutional legislation, and is related to the fact that one can claim ownership over a water source. The potable water in the Cochabamba valley is very unevenly distributed among the different cities. El Cercado is by far the largest, but only 6% of the water that its

[32] Interviews with R. Bustamanete, O. Fernandez, C. Oropeza, A.M. Romero, 2014
[33] Interviews with R. Rios, L. Anaya, 2014
[34] Interviews with A.M. Romero, R. Rios, J. Rodriguez, S. Gareca, J. Baldillón García, 2014
[35] Interview with J. Rodriguez, 2014
[36] Interview with S. Gareca, 2014
[37] Interviews with C. Crespo, R. Bustamante, A.M. Romero, L. Salazar, 2014

inhabitants consume originates from within the city limits[38]. The additional 94% stems from superficial sources and wells that belong to neighbouring cities.

The property rights issue implies additional complications for the Misicuni project and the PMM. Since a city owns the right to the water that passes through it, the abductions that will connect Misicuni to El Cercado will run through the city of Tiquipaya, and will hence need to be negotiated. This puts Tiquipaya in a position of power, and the city has reportedly asserted that it claims a disproportional (with regards to its population) share of the Misicuni water[39]. Nevertheless, the option is more economically viable than the current situation, and the plan for El Cercado is to rely exclusively on Misicuni water (as well as inner city wells)[40], a plan that has been questioned because of the uncertainties involved with the Misicuni project and the systematic complications encountered during the construction[41].

Moreover, the legislation on water property rights has further complicated the distribution and administration of the water resources in the Cochabamba valley, as actors in the different areas are reluctant to sharing their available resources[42], and it hence constitutes an underlying barrier for efficient water distribution.

7.3.2 Lack of water sources

The lack of water is obviously a central problem in the Cochabamba valley. Superficial waters are scarce, especially during the dry season, and groundwater is contaminated in many areas. The lack and uneven distribution of water sources has been surmounted with the widespread use of *aguateros*, but such a solution is neither efficient nor sustainable.

That being said, other interesting opinions have been encountered throughout the field study. Salazar[43] raises an interesting issue, namely that there is a general idea among Cochabambinos that there just never is enough water, notwithstanding the improvements done, and that the issue is therefore likely to remain problematic even if the PMM eventually does manage to fulfil people's basic water needs. This has helped create the aforementioned *cultura del tanque*, i.e. that people fill up huge domestic tanks (sometimes several of them) as soon as they have the possibility to do so. This, in turn, has negative consequences for the current piping system, which is not pressurised and where water is not constantly available. When water is available, the demand instantly peaks as every household focuses on filling up its multiple-cubic metre tank. Hence the entire network system is drained, which makes it prone to contamination and subsequently leads to air flowing through the mediators, thereby increasing the consumers' bills. This is particularly problematic in areas where the frequency of water availability is low, such as in the few OTBs in Distrito 8 that are connected to SEMAPA's network.

Likewise, Bustamante[44] brings up another issue of interest regarding the water usage. In a region that is climatologically almost classified as a desert, the human settlements need to

[38] Interview with R. Bustamante, 2014
[39] Interviews with L. Salazar, A.M. Romero, 2014
[40] Interviews with R. Bustamante, L. Salazar, R. Rios, 2014
[41] Interviews with R. Bustamante, A.M. Romero
[42] Interviews with S. Gareca, R. Rios, 2014
[43] Interview, 2014
[44] Interview, 2014

adapt to the surroundings; that includes e.g. that it may not be realistic for everyone to cultivate a garden or for private homes to install swimming pools. She goes as far as stating that the water availability in Cochabamba would actually suffice if it were to be used and administered in an efficient matter; this implies e.g. minimising losses and modernising the current infrastructure (for example by installing water-saving toilets, treating wastewaters in order to reuse it for irrigation, etc).

The Misicuni project is seen by many as the final solution to the water scarcity problems of the Cochabamba valley, but some remain sceptical regarding the extent of which it will, really, solve the situation.

7.3.3 Lack of funding

As was mentioned in section 3.1, Bolivia is the poorest country in South America, and this lack of funds obviously constitutes a hindrance for the development of infrastructure. Most of the bigger development projects have been subsidised by external entities, such as the Inter-American Development Bank (IDB), foreign investors, NGOs, etc. The situation is particularly difficult in Cochabamba, a city that grew quickly in size during a relatively short period of time.

8 Discussion

Throughout the course of this report the water situation of Cochabamba has been assessed, and focus has been laid on Distrito 8. The main actors of the waterscape were described and the interactions between them analysed. Subsequently, several problems were listed. The main outcome is that the water supply system in Distrito 8 does not work, and that the water distribution situation is problematic.

The coverage by the municipal water distribution company SEMAPA in Distrito 8 is low. As several of the interviewed OTBs have been connected to it in recent years, the 2004 coverage estimate of 1% has since then increased. The quality of the provided service is, however, poor, and it ought to be questioned whether or not those newly connected areas can actually be considered as "covered", as water access is limited to a few hours per week and people therefore need to store water in large domestic tanks and/or resort to *aguateros* to fulfil their water needs.

The reasons for SEMAPA's low coverage can be linked to malfunctioning and inappropriate administration and management. Decades of inefficient use of resources and funds have postponed necessary repairs and expansion of the network; as a result barely half of the city is covered, and Distrito 8 emerges as the district with the lowest coverage.

The administration and management problems have a severe impact on the relations and interactions between SEMAPA and the other actors in the water distribution system; these, including the majority of the OTBs in Distrito 8, have a negative opinion of SEMAPA and seem reluctant to work with the company. This is a problem not only for the current situation but also for the future, especially if the PMM is to be implemented, since it implies collaboration between all involved actors in the Cochabamba valley.

Water administration and management was also found to be a main problem within many of the OTBs. This concurs with much of the literature regarding it (e.g. Abdullaev et al., 2010, Agrawal and Gibson, 1999, Blaikie, 2006, Walnycki, 2013). Although the idea of communal water management may seem visionary, it has turned out to be difficult to carry out in practise. In Distrito 8, intra-communal conflicts have been common as money and power were involved, and this has had crippling consequences for many OTBs.

The results from the field study indicate that the water distribution situation varies substantially within Distrito 8 (see Figure 5-2). While one OTB may have double water piping systems installed, the neighbouring OTB still relies on *aguateros* and roadside barrels to obtain water. This discrepancy even occurs within OTBs, i.e. that only some of the households are connected to the network. This result is also concurrent with existing literature claiming that CBNRM does not necessarily lead to equitable distribution of natural resources (e.g. Walnycki, 2013).

Another of the main identified problems concerns the distrust between different actors. SEMAPA has been characterised by inefficient and corrupt management for decades, which has helped shape an overall feeling of distrust towards the company. Although SEMAPA appears to have undergone some positive changes in recent years, it will likely take many years before it will regain trust among citizens and other actors in the water distribution system.

Moreover, this report describes problems with the water distribution network of Cochabamba, not inherent to Distrito 8. First, the Bolivian legislation on water property rights poses a problem when attempting to reach agreements across city boundaries. Second, the lack of water sources is a problem, although the efficiency of the current use is without doubt questionable. Third, lack of funds further complicates the process of achieving a well-functioning system.

Another point that ought to be raised is how little importance the ecological and sustainability aspects received from the interviewed stakeholders. Few were the people who even mentioned concepts of e.g. ecological limits or environmental sustainability. Half of the water consumed in El Cercado originates from groundwater, but not much thought seems to be given to the fact that it does not replenish itself in the way that superficial water sources do. The concept of peak non-renewable water that was discussed in the introductory chapter of this report would be a highly relevant aspect to introduce in future studies of the Cochabamba valley. The question is whether the apparent disregard for the ecological aspects is due to lack of knowledge or data, or if it is purposely ignored because it constitutes yet another complication.

A few additional observations have been made. One of these concerns the opinions on the communal water systems. Despite decades of mismanagement and inefficiency, they are still considered as the favourable option by many of the independent actors interviewed, e.g. academics and NGOs, and it seems, at times, that these opinions are a little biased and that the community-based systems are being overly romanticised. Whether this is because the tumultuous past of Cochabamba has given them unquestionable legitimacy or because they are simply considered better than the SEMAPA alternative, remains unclear. These opinions do not concur with results presented in the literature mentioned in Chapter 4, in which the negative aspects of CBNRM often seem to outweigh the positive, and results from several case studies indicate that functioning CBNRM is difficult to implement in practise (Nelson et al., 2008, Mosse and Sivan, 2003, Cleaver et al., 2001, Abdullaev et al., 2010).

Distrito 8 and Cochabamba are a long way from a sustainable, efficient and functioning water distribution system, and the many problems and weaknesses of the current system do not make the near future look particularly promising. The need for a major change is clear, and it seems unlikely that it will happen through small entities such as communal water systems, but rather through a macroscopic approach such as IWRM. Water is different from other natural resources; it cannot be cultivated locally like crops and trees, nor does it occur in fixed, independent quantities like minerals. Water is mobile and follows a global cycle comprising many complex and interrelated processes. The underground sources are large and stretch over municipal boundaries, and the superficial sources are often unequally distributed. Theories such as IWRM advocate for a systems perspective, suggesting that it is a more effective way to reach a sustainable solution (Scoullos et al., 2002, Grigg, 2003, Global Water Partnership, 2000). By adopting local, community-based solutions, this systemic perspective risks being overlooked.

This report supports a centralised management approach for a large metropolitan area such as the Cochabamba valley, rather than decentralised, community-based solutions. Nevertheless, it is crucial that the entities in charge of managing and administrating the water distribution

system do so efficiently and sustainably, and it is therefore important that adequate resources are being instated to ensure this. Also, it is vital to take into account the citizens' and communities' opinions in the decision-making processes of a centralised approach, i.e. that it strives to be democratic and equitable. Failure to do so may lead to dramatic consequences, as the city of Cochabamba experienced in the year 2000 with the Water War. A theoretical framework such as IWRM is often not sufficient (Biswas, 2008, Rahaman and Varis, 2005, van der Zaag, 2005); clear, practical and implementable guidelines are necessary to obtain a real change of the situation.

The PMM appears to be a step towards IWRM, but there are still many problems to be solved before it can effectively be implemented. The peculiar nature of the property rights on water in Bolivia constitutes a bottleneck in the process, making it particularly challenging to adopt a macroscopic solution.

Finally, a few words regarding the validity of this study and the legitimacy of the performed interviews in terms of reflexivity are due. Did the interviewees answer the questions differently due to the interviewer's background? If so, how, and how does it affect the results? Does an independent foreign interviewer obtain more honest answers because the people feel free to speak their minds? Or are they even more biased, hoping for more attention? Entire academic fields are dedicated to answering these questions, and the issue lies beyond the scope of this study, but it is, nevertheless, important to bear such aspects in mind.

9 Conclusion

Cochabamba, which means “valley of the lakes” in the country’s native language Quechua, is a prime example of the consequences that irresponsible and unsustainable water management can imply. It used to have huge, clean freshwater reservoirs, which were sustained by ample supplies from the many rivers stemming from the nearby mountains. In just a few decades, the city – or rather region – managed to destroy these favourable prerequisites, leading to extreme consequences for its citizens and the environment.

This thesis provides a detailed study of the water distribution system of Distrito 8. By describing the main actors of the water distribution system and conducting interviews with them, the interactions between stakeholders have been analysed and a set of problems have been identified.

The water distribution system of Distrito 8 and Cochabamba is in need for change, as the current system is inefficient. Based on the information obtained during the field study, this thesis suggests a centralised, IWRM solution rather than a community-based one. However, it does not aim at formulating explicit suggestions for improvement or precise directives to follow, as a field study of this kind is far too narrow to be able to achieve such a goal. The purpose is to provide an objective assessment of the situation in Distrito 8. This report is meant to be used as a platform for further research on the subject. The issue of water distribution, administration and management in Cochabamba is a very complex one; indeed, a multitude of studies have been performed on it, dozens of master theses, doctoral theses and articles have been written about it, lots of independent assessments have been done, including suggestions for improvements. Nevertheless, practical improvements have been few and the situation is still problematic and conflictive.

10 References

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Appendix A – List of interviewees

The table below provides a list of the interviews that have been referred to or in some way utilised throughout this report. The list is not comprehensive of the fields study; some of the performed interviews were excluded as they were deemed either off-topic or irrelevant.

Relevant stakeholders and experts		
Name	**Organisation**	**Title**
Cossio, Claudia	Water for People (NGO), CASA	Engineer
Romero, Ana Maria	CASA	Director
Mercado, Alvaro	CASA	Engineer
Rodriguez, Julio	Private engineering consulting company	Engineer, consultant for the PMM
Vargas, Leoncio	SEDES	Responsible for Programa de Agua
Crespo Flores, Carlos	UMSS	University Professor
Archidiacono, Stefano	CeVI (NGO)	Manager
Olivera, Marcella	Food & Water Watch (NGO)	Latin American Coordinator
Flores, Maria Eugenia	Fundación Abril (NGO)	Assistant
Bustamante, Rocio	CASA	Teacher and researcher
Actors directly involved in the water distribution		
Name	**Organisation**	**Title**
Oropeza, Carlos	ASICA-SUDD	Manager and engineer
Gareca, Samuel	SEMAPA	Engineer, director of technical and academical matters
Anaya, Leonardo	Misicuni	Engineer, general manager
Julio Selaez Quispe	Mayor's office of Alejo Calatayud (Distrito 8)	Assistant mayor
Salazar, Luis	Government	Engineer, head of the water planification and management unit
Rios. Ramiro	Government	Engineer, in charge of water and sanitation services
Herbas P., Alfredo	Private	Water seller
Herbas P., Jose	Organisation of water sellers	President
Severiche, René	Union of *aguateros*	President
Fernandez, Omar	Union of farmers	Former director
OTBs and water committees		
Name	**Organisation**	**Title**
Gutierrez, Juvenal	OTB Valle Hermoso Central	President
Calani, Wilfredo	OTB 10 de Febrero	President
Ballesteros, Jose Luis	OTB Nuevo Amanecer	President
Villca, Augusto	OTB Alto Valle Hermoso 5 de Octubre	President
Alvarez, Damian	OTB Barrio el Molino	President
Lizarraga, Roberto	OTB Universitario Alto	President
Itusaca, Octavio	OTB Chaskarumi	President
Laime, Juan Carlos	OTB Ticti Sud	President
Falco, Guido Jaldin	OTB 14 de Abril	President
Mancilla, Constantino	OTB El Salvador Valle Hermoso	President
Patiño, Julio	OTB Villa San Miguel Alta Tensión	President
Tupa, Maria	OTB Rumi Cerco	President
Orellana, Pedro	OTB Villa Salvador Alto Ticti	President

Mamani, Justo Sajama	OTB Villa San Jose	President
Montecinos, Marcelino	OTB Villa San Miguel km 4	President
Cardozo, Pacifico	OTB Villa Alto Salvador	President
Pascal, Flaviano	OTB Nuevo Jerusalem	President
Guaman, Rogelio	OTB Las Rocas	President
Zambrana, Luis	OTB Ushpa Ushpa	President
Romero, Waldo	OTB San Francisco	President
Rios, Felix	OTB Mineros San Juan	President
Rosas, Juan	OTB Las Rosas	President
Ricaldez, Miguel	OTB Loma Pampa	President
Bizarro, Eliodoro	OTB Alto Mirador Ticti Sud	President
Quinteros, Waldo	OTB Nueva Esperanza Kiñi Loma	President
Rodriguez, Melquis	OTB Salvador Bajo	President
Murillo, Alfredo	Water committee Valle Hermoso Central	President
Choquecallata, Anacleto	Water committee Villa San Miguel Alta T.	President
Ballesteros, Jose Luis	Water committee Nuevo Amanecer	President
Villca, Augusto	Water committee A. V. Hermoso 5 de Oct.	President
Baldillón, García Janet	Water committee El Salvador Valle Hermoso	President
Rodriguez, Veto	*Junta vecinal* San Carlos	President

Appendix B – Example of topic guide for interview

How many people live in the OTB? When was the OTB founded?

Is there a water committee? If yes, how does the collaboration between committee and OTB work?

How does the water distribution work?

1) If piping:
   How old are the pipes?
   How well does it work?
   Do you use it?
   Who constructed it?
   Who administrates it?
   Who supplies the water?
   How does the paying system work?

2) If water tanks:
   Individual or communal tanks?
   How big is/are they?
   Who constructed it/them?
   Who paid for them? What were the costs?
   Who fills the tanks?
      If *aguateros*: are they particular or from SEMAPA?
   Who administrates it?
      If administered by SEMAPA:
      Are you happy with how it is administered?
      Do you want to continue the collaboration or do you want to administer yourself?

What share of the household has access to the distribution system?

Are you somehow connected to/cooperating with SEMAPA?
   If yes: How does the collaboration work?
   Would you like to continue the collaboration?

What are the future plans?

What do you personally think about the Misicuni project? What are your thoughts regarding the future administration of Misicuni?

What about the PMM?

Do you think that committees will disappear in the future, in connection with the Misicuni project/PMM?

Appendix C – Back-of-the-envelope calculations

This appendix demonstrates two back-of-the-envelope calculations that led to results mentioned in the text.

Appendix C1 – Calculation of water flows from *aguateros*

The following calculation provides an estimation of the volumes of water transported on a in the city of Cochabamba. It is intended to give an upper bound evaluation: the premises correspond to a busy day for *aguateros*, i.e. a Sunday (when water consumption is the highest[45]) during the dry season. The numbers used are obtained from interviews.

- Number of water trucks operating: 250 (that number is obtained by adding the amount of registered trucks plus a personal estimation of the unregistered amount of trucks operating, based on observations)
- Number of delivery trips per day: 3
- Volume of water per truck: 11000L (rounded number; some admittedly contain 10000L, some 12000L)
- Total amount of water distributed by *aguateros* during one day: 250*3*11000=8,25*10^6L

Appendix C2 – Calculation of income from water selling

This calculation approximates the income that one of the interviewed water sellers ought to be making per day, based on the facts given by the seller himself during an interview[46].

- Number of served *aguateros* per day: 10
- Times one *aguatero* is served per day, weekly average: 2
- Cost of filling one cistern: 30Bs
- Total income per day: 10*2*30 = 600Bs (approximately US$87)

[45] Interviews, 2014
[46] Interviews with A. Herbas, 2014

Appendix D – PMM premises and objectives

The following is an extract from the PMM main document (Gobernación de Bolivia, 2014, pp. 1-3).

The Metropolitan Master Plan for Water and Sanitation of Cochabamba includes some general and fundamental premises, inter alias:

- Consider drinking water as a human right
- Adopt the indications of the Programa Nacional de Bolivia related to efficient water use
- Get converted into the principle document for the strategic planning of the hydrological resources, involving other actors that are directly or indirectly involved with urban development plans in the region
- Increase the coverage of drinking water and sanitary systems, including in peri-urban zones; an essential aspect in the change process of the communities
- Respect social, cultural and communal aspects of the population, understanding their importance for the success of the plan
- Promote mechanisms for the state, through the Servivio Nacional de Apoyo a la Sostenibilidad del Saneamiento Básico (SENASBA), providing the necessary financial aid to the peri-urban operators, the technical assistance , the institutional strengthening to improve paperwork and the communal development as well as the organisation between them
- Strengthen and promote communities' participation in order to guarantee the adequate use of sanitation facilities, improve the healthiness of the population and the conservation of the environment
- Contribute to improve the public perception related to water and sanitation services, through mechanisms which raise consciousness, participation and approbation of the benefitted communities.

PMM goals:

- Evaluate the current situation of the water and sanitary systems in the metropolitan area of Cochabamba, taking into account not only the physical state of the existent infrastructure, but also their operating conditions
- Determine the current situation of the hydrological resources in the close-by basins and their potential future agreement with the increasing demand of the population, considering possible climate change
- Make all involved organisations and actors aware that the performance of the drinking water supply and the sanitary system has to be coordinated and that the quality of the services that are planned to be provided to the community should be the best possible, without forgetting that in order to achieve this, one has to pass through other phases
- Propose works and corrective actions to realise gathering, purification and distribution of drinking water, in order to improve the quality of life in the communities and to ensure an adequate and efficient future service, both in water quality and continuity of service

- Suggest tasks that need to be done in order to solve the encountered problems, concerning residual water collection, conduction and treatment, the latter being of vital importance in order to preserve the environment, improve the health of the population and guarantee sustainable urban planning.
- Evaluate environmental and social impacts related to the suggested construction works
- Establish reuse strategies for the residual water that should be treated, such as irrigation or any other end use, in accordance with water quality and current norms
- Estimate the costs of the suggested construction works; elaborate the investment plan as well as schedule for the works that are considered necessary for the immediate restoration and improvement of the existing infrastructure, for short, medium and long term amplification
- Determine financing strategies to cover the planned construction works, determine the capacity of the companies and organisations of contributing to the investment with their own resources and the requirements for subventions on state, departmental and municipal level
- Diagnose the current state of the entities responsible for the provision of the services, analysing their institutional problems, including the municipal, self-managed and communal (EPSAS) and other associations, evaluating their relationship with the Autoridad de Fiscalization y Control Social de Aguas Potables y Saneamiento (AAPS).
- Suggest measures ans actions to improve and fortify administrative work, operation and financing of the principle organisations, as well as of those that promote institutional cooperation and integration.
- Integrate, participate and establish a constant link, during the elaboration of the PMM, between the executing professionals, the different EPSAS and the population, so that the cultural, social and economic factors found in the metropolitan area of Cochabamba are converted into a greater good, allowing the plan to be successful and allowing the development of the region.