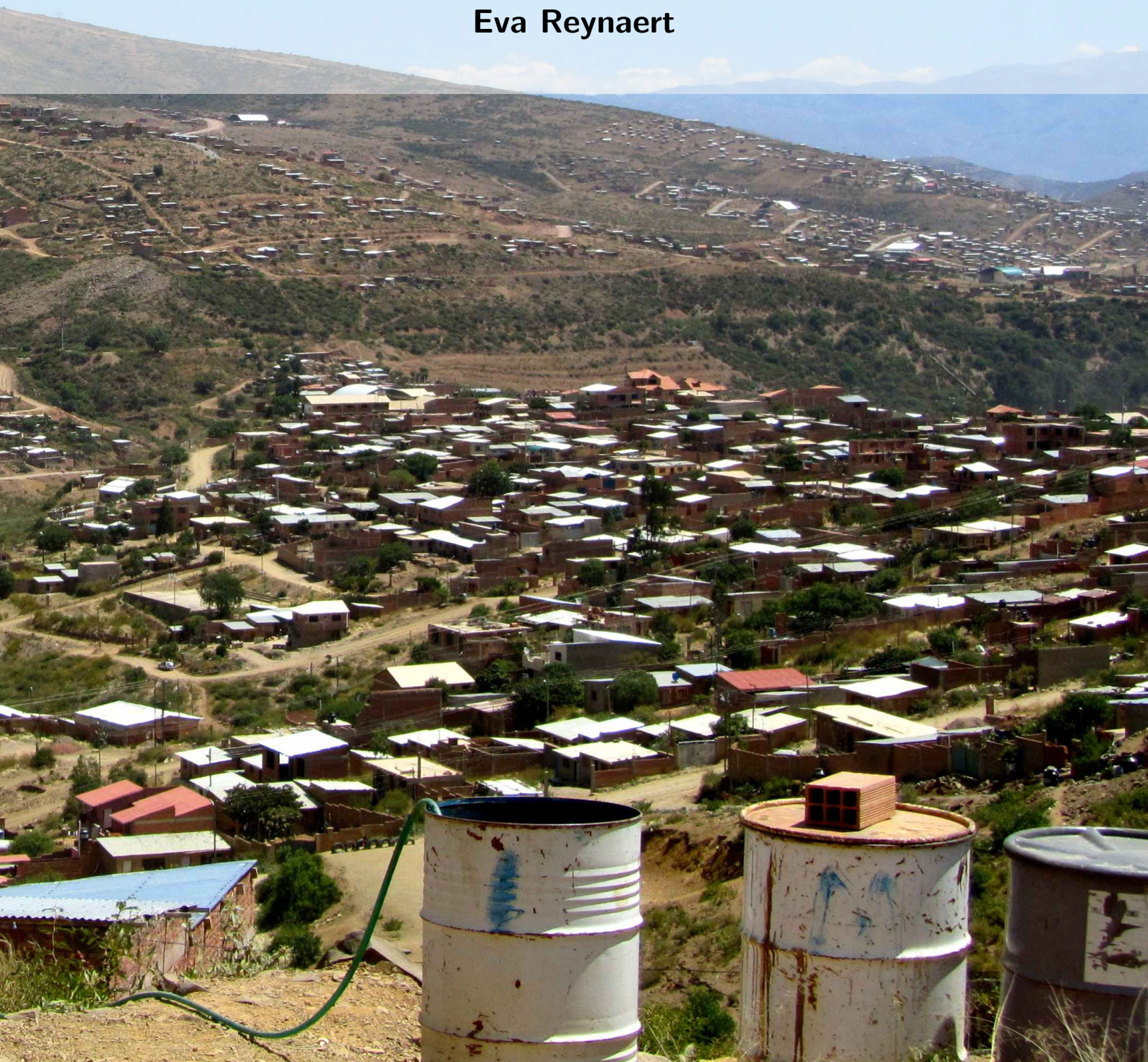


Assessment and further development of a management scheme for a UDDT based sanitation system in Arbiето (Valle Alto de Cochabamba, Bolivia)

Internship Report
(10.02-10.06.2016)

Eva Reynaert



Executive summary

The present report illustrates the importance of adequate planning for the provision of a sanitation service in a periurban zone of Cochabamba, Bolivia, and presents selected scenarios how a new service could be implemented in the future.

Context

District 4 of the Municipality of Arbieta (Valle Alto de Cochabamba), located south of the Municipality of Cochabamba, has recently experienced a strong population growth as a consequence of the city's rapid development attracting migrants from all over the country (Section 3.1). In 2014, an international non-governmental organization (NGO) built 500 urine-diverting dry toilets (UDDTs) in seven neighbourhoods (so-called OTBs) of the District, along with a composting plant for the faeces. As a result of poor planning, the NGO abandoned the project before a collection service for the faeces and urine was implemented (Section 3.2).

Working methodology

As specific documentation or official information about the zone of interest is inexistent, new data was gathered using semi-structured interviews and surveys. The data collection was organized in three steps (Section 3.3):

1. **Interviews with the engineers in charge of sanitation** in the Municipality of Arbieta and first field visit as a base to develop the questionnaires for the OTB representatives and the households.
2. **Interviews with the OTB representatives** (Presidents and Water Committees) to get an overview of the water and sanitation situation in the OTBs and refine the household surveys.
3. **Household surveys** to collect information about the current use of the UDDTs and the perception of the water and sanitation situation (108 households that own a UDDT and 10 households that don't), along with a direct observation of the toilets.

Evaluation of the current situation

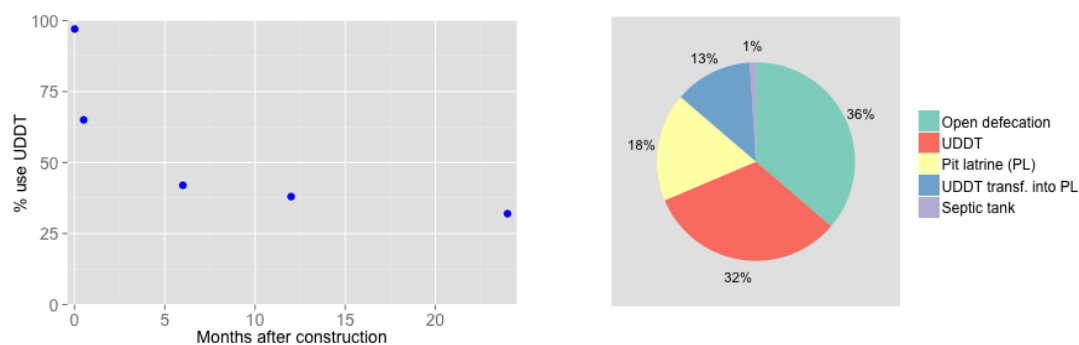
The project area faces serious challenges regarding water provision, solid waste management and the use of the UDDTs (Section 3.4).

With the help of the same NGO, a **water supply network** was implemented in the seven OTBs. As a result of poor administration and the dessication of the water source, the water supply currently doesn't work in the majority of the OTBs, as presented in the table below. Many inhabitants depend on water from water trucks, however, this water provision service is expensive, irregular, and doesn't guarantee the water to be safe for consumption. There are various conflicts about the distribution of the water between the OTBs, along with disagreements about the financing between the residents and the Water Committees responsible of the water provision.

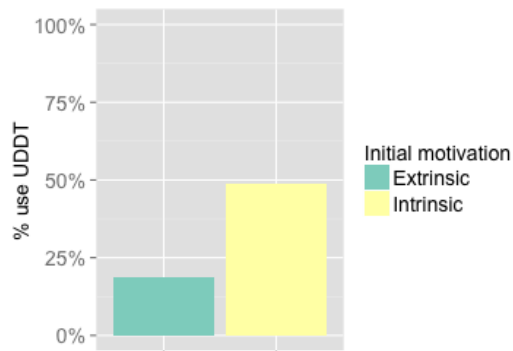
OTB	Days with piped water	Tariff piped water	Tariff water truck
20 de Mayo	0	f: 15 Bs./month	v: 30-35 Bs./m ³
Cristal Mayo	0	-	v: 40 Bs./m ³
Florida	0-1 days/week	f: 15 Bs./month	v: 35 Bs./m ³
Fortaleza	7 days/week	f: 20 Bs./month	v: 35 Bs./m ³
Llave Mayo	1-2 days/week	f: 20 Bs./month	v: 35-40 Bs./m ³
Villa Montes	7 days/week	v: 22.50 Bs./m ³	-
Yuraj Jallpa	7 days/week	v: 20 Bs./m ³ , f: 10 Bs./month	-

There is no **solid waste collection** service in any of the OTBs and a majority of the residents burns its waste on-site. Even without receiving any type of service, they pay a tax for waste management with the electricity bill. As a consequence of a territorial conflict between the Municipalities of Arbieta and Cochabamba, however, this tax goes to Cochabamba rather than to Arbieta.

Since the implementation of the project, the number of **UDDT users** has constantly decreased (graph below, left). Initially, not all households finished the construction of the latrines. Many stopped using their toilets after a few weeks, when they realised no collection service would come. Others lost their motivation as a consequence of bad smells or flies in the toilet, or because they had to bury the faeces or eliminate them otherwise. Currently, only a third of the population indicate that they use their UDDT (graph below, right).



The motives for building the UDDTs can be classified in two types: intrinsic (own a toilet, protection of health and environment) or extrinsic (toilet for free, publicity by the implementing NGO, pressure from the OTB leaders). The graph on the right shows that the **initial motive significantly influences the current use** (Chapter 4). This is strong evidence that putting pressure on the residents works only at short term; for a sanitation service to be sustainable, it is crucial that there is a real demand from the population.



The Mayor of Arbiето explicitly mandated the upstart of the faeces treatment plant (Section 3.5) and the Municipality’s Annual Operational Plan specifically reserves 40’000 Bs. for the project (Section 3.6). However, increasing the access to **water and sanitation** doesn’t generally seem priority for at municipal level, as the planned investments for the development and promotion of sports are almost four times larger.

Service scenarios

Two main service scenarios were investigated (Chapter 6):

- 1 Collection and treatment of the faeces
- 2 Collection of all solid waste (including the faeces) and treatment of the faeces and organic waste

Inside of these scenarios, there are two options for organizing the collection:

- a Door-to-door collection
- b Collection points

The main advantages and limitations of the total four scenarios are presented in the graph on the left. The current composting plant has not the capacity to treat the organic waste, so that the only realistic option is a **door-to-door collection of the faeces**.

	Door to door	Collection points
Faeces	<ul style="list-style-type: none"> ✓ Convenient service ✗ Reduced number of clients 	<ul style="list-style-type: none"> ✓ Simple organisation ✗ Reduced number of clients ✗ High fixed costs ✗ Limited acceptance of the clients
Faeces and solid waste	<ul style="list-style-type: none"> ✓ Serves all residents ✓ Convenient service ✗ Insufficient plant capacity ✗ Insufficient vehicle capacity 	<ul style="list-style-type: none"> ✓ Serves all residents ✓ Simple organisation ✓ Cost-effective service ✗ Insufficient plant capacity ✗ Limited acceptance of the clients

The box below details the conditions of the selected service, supposing that 50% of the households owning a UDDT will use it. The costs include the amortization of additional composting pits that need to be built in order to treat the quantity of faeces produced.

Description of the selected service

- **Type of service:** Collection of the faeces, cleaning of the buckets and treatment in the composting plant
- **Collection frequency:** 1/week
- **Number of employees:** 2 (full-time)
- **Organization of the work:** collection in the morning, composting in the afternoon
- **Parts of the OTBs deserved:** streets in good condition
- **Task of the users:** deposit the buckets in front of the housing or in a street where the vehicle passes
- **User tariff:** 10 Bs./month per household
- **Tariff collection:** 1/month by the collectors
- **Cost for the Municipality:** 43'000 Bs./year

Recommendations

For the future, three continuations can be imagined (Chapter 7):

1. Upstart of the **centralized treatment plant** with the implementation of a door-to-door collection service of the faeces
2. Implementation of **decentralized composting centres** in each OTB
3. Support for the **conversion of the UDDTs into pit latrines**

If the upstart of the centralized plant is selected, it seems advisable to **start the treatment with the current capacity** (50 households) and increase the number of clients parallelly to the construction of new composting pits. It is also recommended to combine the collection of the faeces with a sawdust provision service in order to reduce smells in the toilets and improve the composting treatment.

The main advantage of decentralized composting centres is that it offers an opportunity for the implementation of **participative processes** allowing the development of solutions adapted to the distinct contexts of each OTB. The cost per household is similar to the cost of a centralized treatment in the current plant.

Finally, it is important to note that the UDDTs are only accepted as a **temporary solution** for most residents, until the water provision is improved and pit latrines or sewerage can be implemented. It seems likely that many residents will turn their UDDTs into pit latrines in the future, so that support for the construction of safe pits might be the most environment-friendly solution at long term.

Acknowledgements

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1.1 Context and objectives

Mandated by the Swiss Agency for Development and Cooperation (SDC), an alliance formed by Helvetas Swiss Intercooperation, CSD Engineers and the Fundación Aguatuya is responsible for the implementation of the Project *Gestión ambiental municipal* (GAM). The project aims at solid waste management and wastewater treatment in small and medium-size cities. Eawag/Sandec's contribution to the project lies in the adaptation and validation of environmental sanitation planning tools to the context of medium-sized Bolivian cities.

A region targeted by the project is the Valle Alto de Cochabamba. One of the municipalities covered in the region is Arbieta, located south-easterly of the city of Cochabamba. District 4 of Arbieta is situated directly at the limits between Arbieta and Cochabamba, but doesn't benefit of the same level of water and basic sanitation services as in the city. In 2014, an NGO constructed 500 urine-diverting dry toilets (UDDTs) as well as a treatment plant for the faeces, but abandoned the project before a recollection service was implemented.

The present report summarises the main results from an internship completed in the framework of the GAM Project with the Fundación Aguatuya in Cochabamba from 10.02-10.06.2016. The aim was to assess and further develop a development scheme for the UDDT-based sanitation system in District 4 of Arbieta.

The four main objectives of the internship were:

1. Review the available literature and perform a stakeholder analysis
2. Evaluate the perception of the users towards the UDDTs
3. Study the intended management plan
4. Formulate recommendations for the start-up of the treatment plant and alternatives

1.2 About the report

The present report is to a large extent translated from the Spanish report *Evaluación y desarrollo ulterior de un sistema de saneamiento basado en baños ecológicos secos en Arbieta (Valle Alto de Cochabamba, Bolivia)*. It is divided into seven main parts:

- **Chapter 2** gives an overview of the drinking water provision and sanitation situation in Bolivia, with special attention on the legal and regulatory framework.
- A detailed assessment of the current situation in the project zone can be found in **Chapter 3**. It includes in particular an evaluation of the drinking water and sanitation conditions, a stakeholder analysis and an assessment of the enabling environment.
- The perception of the residents towards the UDDTs is presented in **Chapter 4**.
- **Chapter 5** summarises the lessons learnt from other composting and UDDT projects in Bolivia.
- **Chapter 6** presents the costs and feasibility of four service scenarios, as well as a proposition for a tariff system.
- Recommendations for the start-up of the treatment plant are given in **Chapter 7** along with alternatives to the centralized treatment.
- Finally, **Chapter 8** aims at putting the case of Arbieta in a more general context, assessing the adequateness of UDDTs as a sanitation technology in periurban zones.

The Appendices were not translated and correspond to the original Spanish version.

Drinking water provision and sanitation in Bolivia

The present chapter gives a brief overview of past actions in the sanitation and drinking water sector on the national level and introduces the legal structures in charge. It lists the most common failure factors for sanitation projects, and, based on a case study, factors that seem essential for the successful implementation of such a project.

2.1 Short overview of past actions

Until the mid 1990s, the Bolivian government's focus in the water supply and sanitation sector lay primarily on infrastructure projects. The common perception was that important infrastructure investments (including the construction of dams, aqueducts and bulk water facilities) would improve the access to water and sanitation. At the same time, the country lacked a coherent sector policy and regulation, and most of these investments did not substantially improve the poor service delivery. The inadequate management performances of most water utilities in terms of operative efficiency and maintenance, financial sustainability and user satisfaction made the government and donors realize that major sector reforms were necessary [24].

Under the pressure of the World Bank, the state-run water utility of La Paz and El Alto was privatized in 1997. The utility of Cochabamba followed three years later. Parallely, a regulatory authority for the water sector was created. However, capacity development still mainly consisted of short-term technical assistance and law enforcement remained weak. A period of major civil unrest caused by the increase of water tariffs, culminating in the so-called Water War in Cochabamba in 2000, finally forced the government to back out of its privatization strategy [24].

In the following years, aiming to fulfill the Millenium Development Goals (MDG) in water and sanitation, the government established a water supply and sanitation plan that included first principles of capacity development and the promotion of social participation [24].

When Evo Morales was elected president in 2006, he put a strong emphasis on the water and

sanitation sector, declaring the access to safe water and basic sanitation a human right in the new constitution from 2009 (Art. 20 CPE). The new National Plan for Basic Sanitation insisted on the importance of community participation and set the focus on the underdeveloped rural areas [13]. In the first years after his election, the ministries and units responsible for the development and implementation of these new principles were restructured multiple times, resulting in the framework described in Section 2.2.1. This restructuring was accompanied by a decentralization process, giving increased responsibility to lower administrative levels [9].

In spite of these major changes in sector strategies during the past 20 years, most indicators related to water and sanitation have only improved slightly. Figure 2.1 presents the evolution of the access to piped water and latrines between 2001 and 2012 (INE¹). Even with the new government focus on rural areas, the discrepancy in access to water and sanitation between the rural and urban population persists. Overall, Bolivia remains the country in South America with the lowest coverage levels in both sectors [5].

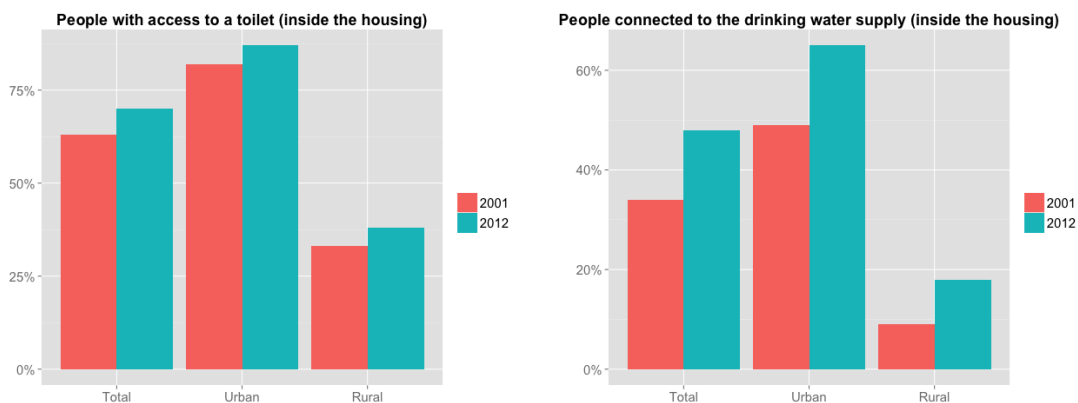


Figure 2.1: Evolution of two sanitation indicators between 2001 and 2012 (INE): access to a toilet and to piped water.

From a financial point of view, the changes in sector strategies have been accompanied by an important reduction of the proportion of costs covered by the international cooperation. While more than 60% of the public investments originated from foreign sources only 10 years ago, they represent only 30% today. This reduction is not due to a decrease of the total international funding, but to a quadruplication of the total national investments [2].

2.2 Legal and regulatory framework in Bolivia

The present section presents the legal structures responsible for water and sanitation in Bolivia, analyses whether the legal framework is effectively enforced and evaluates government support for water and sanitation projects.

¹Instituto Nacional de Estadística (INE), available on:<http://www.ine.gob.bo/indice/indice.aspx?d1=0403&d2=6> (29.02.2016)

2.2.1 Legal structures in charge of basic sanitation

There are four levels of administrative division in Bolivia: Department, Province, Municipality and Canton. The National government, the Municipalities and, to a lesser extent, the Departments are all involved in the sanitation sector. Basic sanitation includes drinking water supply, sewerage, disposal of excreta and solid waste and stormwater discharge.

At the **national level**, the sanitation sector is under the responsibility of the Vice-Ministry of Drinking Water and Basic Sanitation (VAPSB²) that is part of the Ministry of Environment and Water (MMAyA). The VAPSB is divided into three units with the following responsibilities (according to [7]):

- The Authority for Financial and Social Control of Drinking Water and Basic Sanitation (AAPS) controls, supervises and regulates activities related to the water and sanitation sector.
- The Executing Agency for Environment and Water (EMAGUA) executes, monitors and evaluates the projects initiated by the MMAyA.
- The main role of the National Support Service for the Sustainability of Basic Sanitation (SENASBA) is to strengthen institutions and community development, notably through capacity building.

This subdivision is defined in the Supreme Decree DS 29894 (2009), that emended the Law 2066 from 2001.³ Closely related to the Law 2066, the National Plan for Basic Sanitation (PNSB) was promulgated in 2008 (with adaptations in 2009). It is an instrument of the National Development Plan (PND) and forms the base for the cooperation between the national, departmental and municipal governments. Finally, the Sectorial Development Plan for Basic Sanitation (PSD-SB), published in 2011, is an actualization and complement of the PNSB.

The importance of the **departments** in the sanitation sector is limited, as their main role is the coordination between National and Municipal governments. They also establish Departmental Development Plans for water and sanitation and are responsible for the quality control of publicly funded services [3].

The **municipalities** are, directly or through a Public Social Enterprise for Drinking Water and Sewerage (EPSA⁴), responsible for the administration and operation of the services. In coordination with the departments, they establish Municipal Development Plans [4]. The municipalities participate in the design and the funding of sanitation projects, where their financial share is established according to the Mechanism for Investments for the Coverage in the Drinking Water and Sanitation Sector (MICSA) [7].

The Bolivian legal framework differentiates between privative, exclusive, concurrent and shared competences. These four types of competences define which domain is under the responsibility of which governmental level (national, departmental, municipal or AIOC).

²All abbreviations are listed in the Chapter *Abbreviations* at the end of this document.

³*Ley 2066 de Servicios de Agua Potable y Alcantarillado Sanitario*

⁴EPSA are public, social, cooperative or communitarian entities responsible for the service delivery in the water and sanitation sector [7].

- **Privative competences:** all three competences, legislative, regulatory and executive, fall into the domain of the national government
- **Exclusive competences:** one governmental level holds the responsibility for all three legislative, regulatory and executive competences
- **Concurrent competences:** the national government holds the legislative competences, and the regulatory and executive competences are shared among the departmental and municipal governments.
- **Shared competences:** The national government defines a basic legal framework and the regulation and execution is under the responsibility of the AIOC

The following boxes detail the different responsibilities of the national, departmental and municipal governments in the drinking water and sanitation sector as defined in the Law 2066 [10].

1. National competences

- Define policies, norms and regulations related to drinking water and sewerage
- Issue concessions and regulate drinking water and sewerage providers

2. Departmental competences

- Establish departmental plans and programs for the expansion of drinking water and sewerage services
- Coordinate the national and the municipal governments
- Control the execution and quality of drinking water and sewerage infrastructure financed with public funds
- Promote the association of inhabitants to form interest groups for drinking water and sewerage
- Inform the national government about ONG and other organizations implementing drinking water and sewerage services
- Provide technical assistance to the EPSA

3. Municipal competences

- Guarantee drinking water and sewerage services, directly or through an EPSA
- Establish municipal development plans for the expansion of drinking water and sewerage services
- Consider the requests for expropriation related to water and sanitation projects presented by the national government
- Assist the evaluation and monitoring of the EPSA working in the municipality and communicate the results to the national government
- Regularly provide the national government with reports about the drinking water and sewerage coverage, especially when the municipality is responsible for providing these services

- Collect the service fees if the drinking water and sewerage services are provided directly
- Ensure that other infrastructure projects or activities do not affect the sustainability and quality of drinking water and sewerage services
- Inform the national government about ONG and other organizations implementing drinking water and sewerage services on municipal territory
- In consultation with the habitants (popular participation), emit a technically funded report to the national government for the approbation of calls of proposals and planned tariffs.

2.2.2 Law enforcement

Most water and sanitation laws and plans were established less than ten years ago. It is thus relatively early to assess the relevance of these new water and sanitation frameworks, and only limited literature on the topic is available. Moreover, the legislation does not include any quantifiable targets that would allow an easy assessment of its actual implementation.

For these two reasons, the present analysis will be based primarily on global (national) law enforcement indicators. The World Bank publishes governance indicators combining the views of a large number of enterprise, citizen and expert survey respondents.⁵ Those indicators relevant to the implementation and enforcement of sanitation laws are presented in Table 2.1.

The indicators can give a rough statement of the implementation and enforcement of water and sanitation laws in Bolivia, but should be interpreted with caution. For instance, the *Regulatory quality* in the water and sanitation sectors might be too pessimistic, since the indicator is also based on the promotion of the private sector (which is indeed not allowed to participate in these sectors, as mentioned in Section 2.2.1). The same applies to the *Rule of law* that might have been influenced by nationalizations by Evo Morales' government, as the indicator puts emphasis on property rights. Overall, the regulatory environment in Bolivia remains, however, poor, with a low government effectiveness and rampant corruption.

Parallels could be drawn between the implementation of the progressive water and sanitation legal framework and the anti-corruption frameworks. Similar to the access to water and sanitation, the current government has put the fight against corruption high on its priority list. The laws and regulations promulgate zero-tolerance for corruption, however, the insufficient institutional capacity and resources of the administration make the implementation of the anti-corruption structures weak [25].

Considering the low government effectiveness combined with the national government's lack of funding for the water and sanitation sector,⁶ chances are high that many of the good intentions stated in the national laws and plans will not or only partially be implemented. It is also important to mention that the current funding for water and sanitation is likely

⁵The indicators are available on: <http://govindicators.org> (29.02.2016)

⁶In 2009, for instance, investments of additional US\$ 20 million would have been required in order to reach the MDGs according to [7]

to decrease during the next years. During the last ten years, the country benefited from increased mineral and natural gas exports. In combination with a prudent macroeconomic policy, the country managed to significantly expand public investments while maintaining current account and fiscal surpluses. In the context of low international oil prices and decreasing prices for gas, however, the government might be forced to cut its spending in the near future [26]. Finally, the risk of political instability should also be mentioned. President Evo Morales will be in office until 2020. After the referendum from February 22nd 2016, he will not be able to run for presidency another time. At this moment, it is impossible to predict how the political situation in Bolivia will evolve and how this will affect water and sanitation regulation.

Table 2.1: Worldwide Governance Indicators relevant for the implementation and enforcement of water and sanitation laws (2014).

Indicator	Value	Meaning
Voice and accountability	48.3 /100	Extent to which the citizens are able to participate in selecting their government.
Government effectiveness	29.8 /100	Quality of public and civil services, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.
Regulatory quality	20.2 /100	Perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.
Rule of law	12.5 /100	Extent to which agents abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts.
Control of Corruption	29.8 /100	Extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.

2.2.3 Failure factors for the implementation of sanitation systems

This section presents three types of factors (technical, financial and social) that can prevent the large-scale implementation of sustainable sanitation systems in Bolivia, with a special focus on small towns. If not noted otherwise, all failure factors are taken from [14].

1. Insufficient technical and administrative capacities

- The majority of municipal governments, EPSA and EMA lack sufficient technical personal and the capacity for project management.
- In many municipalities, there are frequent changes of governments, which lead to short mandates of the technical advisors.
- A poor assessment of the technological options at the beginning of the planning process often leads to the use of insufficient or inappropriate technologies for a given context.

In summary, many municipal governments, EPSA and EMA **lack the technical capacity** for the large-scale implementation of sustainable sanitation systems. This particularly affects small towns, where it is often the municipal governments that are responsible for service delivery. Larger EPSA may have better capacities, but are overstrained with the additional support of small EPSA und municipal governments. It can also be challenging to find technical solutions adapted for small towns that don't exceed the local financial and human capacities. This is a difference to cities, where there are usually better developed institutional and technical fundaments onto which sanitation projects can be based, often combined with more funds than in small towns.

2. Insufficient funding

- National investments in the water and sanitation sector are scarce and do not meet the needs to reach the sector objectives.
- Due to their limited financial resources, the municipal governments can often not contract enough or well-trained technical advisors.
- Many (especially the small) EPSA struggle economically and financially, as a consequence of their technical and administrative deficiencies.
- There is often a low payment rate for the services, for instance because services are not recorded or no bills are issued.

There is a general **lack of funding** for the implementation and operation of sanitation systems. Tariffs for water and sanitation are often too low to cover even the running costs of the services, not to mention maintenance and depreciation costs [10]. Since the national government prioritizes investment in rural and urban metropolitan areas, there is even less funding available for small towns [13]. Investments costs per inhabitant are usually higher for periurban zones that have lower population densities than cities. In combination with the rapid increase of informal settlements in these zones, municipal investment capacities are often exceeded [10].

3. Insufficient user participation

- In many cases, participation is limited to a few privileged groups.
- Insufficient user participation in the planning process can lead to inappropriate technology choices (lack of social acceptance).
- The quality of the services is often low, reducing the user's willingness to participate and pay.

There is often a **lack of real participation** in the planning process. Organizing the users in small towns is more challenging than in rural areas, where there are often clearly-defined community structures.

2.2.4 Success factors for the implementation of sanitation systems

After this short overview of the factors that can lead to the failure of the large-scale implementation of sanitation systems in small towns, it is interesting to look at a few cases where the implementation succeeded.

Case study: Wastewater treatment plant in Cliza

Cliza is a municipality located 40 km southeasterly of the city of Cochabamba with an urban center of around 8'400 inhabitants.^a In 2012, the municipal government approached the Fundación Aguatuya, wishing to implement a Wastewater Treatment Plant (WWTP), as the sewerage was then released into the Río Cliza without any treatment, contaminating the environment and endangering human health.

In 2011, Aguatuya had implemented its first WWTP in Lomas del Pagador, a periurban zone of Cochabamba, which had served as a model plant aimed at the leaders of other districts of Cochabamba and from other municipalities. The treatment system was based on parallel lanes of Upflow Anaerobic Sludge Blankets (UASB) followed by biofilter units. This system was upscaled for the WWTP of Cliza, as it was to serve almost ten times more people. The project was funded by the municipal government and the Swedish Embassy.

Already during the construction phase, Aguatuya organized training events, mainly focalised on the operation and maintenance of the plant, but also underlining the benefits of treating the wastewater and the importance of paying for the service.

Currently, there are 1'900 connections to the plant, for each of which the municipality pays a fixed fee to Aguatuya. In return, Aguatuya is responsible for the operation and maintenance of the plant, which is done through two caretakers. The treated water is reused for the irrigation of urban areas, forests and agricultural lands.

^aInstituto Nacional de Estadística (www.ine.gob.bo), 2012.

As we can see from the case study, there are multiple factors that contributed to the success of this project.

- Aguatuya was experienced in the implementation of decentralised wastewater treatment systems using a **technology that is simple to maintain and modular** (i.e. possible to upscale).
- The municipality of Cliza was aware of the environmental and health problems linked to the lack of treatment of the wastewater, so that there was a **strong governmental support** of the project.
- Aguatuya had a professional **communication strategy** (demand creation and exposure) and a reliable network (contacts with municipalities, department, national government), so that the municipality knew whom to contact.
- Additionally, Aguatuya had also good **contacts with potential donors** (Swedish development aid).

- The **training** of the operators was an important part of the project, along with the **sensitization** of the users.
- Aguatuya needs to cover its costs, making them fix realistic **tariffs that allow a long-term operation** and maintenance of the plant.
- From the beginning, the focus was not set on the implementation of infrastructure but on the **long-term service delivery**.

Detailed assessment of the current situation

This chapter briefly presents the Municipality of Arbieta and introduces the UDDT project that will be the focus of the present report. The strategy used for data acquisition is described. Based on the collected data, the current drinking water and sanitation situation in the project zone are analysed. The stakeholder analysis summarises the main characteristics of the municipal authorities, civil society and ONGs present in the zone. Finally, the assessment of the enabling environment reviews the conditions for the implementation of a new sanitation service.

3.1 Geographic context

The Municipality of Arbieta is located in the Valle Alto de Cochabamba (Provincia Esteban Arce), south-easterly of the city of Cochabamba (Figure 3.1). The entire region is characterized by a temperate climate with relatively constant temperatures (in average 18 °C) and a rainy season from December to February. The total yearly precipitations are around 450 mm.¹ The main activities in the region are agriculture (mainly maize, wheat, fava beans, peas and potatoes) and sheep and pig farming. During the dry season irrigation is necessary [16]. There is a dense network of small rivers in the zone (the most important are the *Río Sulty* and the *Río Cliza*), but all of them run dry in winter. At the same time, intense precipitations during the rainy season often flood the river banks, leading to the loss of cultivable



Figure 3.1: Location of the Municipality of Arbieta in the South-east of Cochabamba (UDAPE)

¹Climate data from www.worldclimate.com (02.03.2016)

soils.

According to the national census of 2012 (*Instituto Nacional de Estadística, INE*), the municipality had just over 17'400 inhabitants, of which 5'400 lived in the urban centre. The remaining 12'000 inhabitants lived in areas classified as rural.²

Arbieto politically consists of 57 so-called social organizations (*Sindicatos Agrarios, OTBs*³ and *Urbanizaciones*⁴) that are grouped in five *Distritos* and seven *Subcentrales* [17].

District 4 (Llave Mayu), part of the Subcentral Zona Norte, will be the focus of the present report. The district is located directly at the limits with the Municipality of Cochabamba (Figure 3.2). Given the proximity to Cochabamba and the orientation towards the city for all economic activities, the zone can be classified as periurban. With 6'900 inhabitants, it is the most populated district in the municipality [17]. The terrain is hilly and can be accessed only over un-

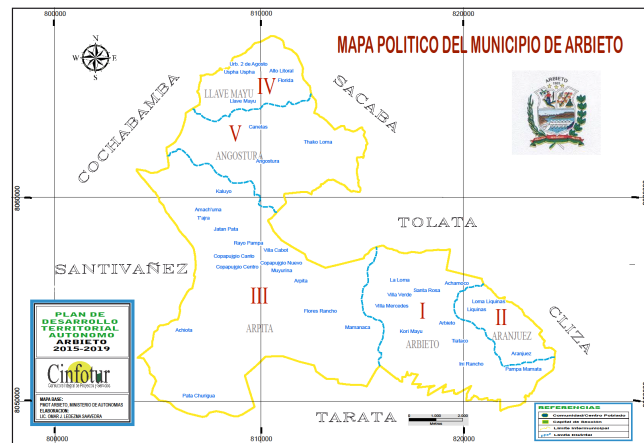


Figure 3.2: Location of District 4 neighbouring the city of Cochabamba (PDTA)

paved roads. Considering the topography, the distance to the urban center of Arbieto and the low population density (see Figura 3.3) doesn't count on the same level of infrastructure as in the center. This part of the municipality has grown very recently. Most plots that are nowadays covered by a multitude of dwellings were empty only 10 years ago.

More specifically, the focus lies on 7 OTBs, where an international NGO constructed 500 UDDTs and a faeces treatment plant. (An A4 map showing the localization of the OTBs and the UDDTs can be found in Appendix B). The OTBs are located directly at the limit between Arbieto and Cochabamba. This limit is, however, not well defined, as there is currently a conflict between the two Municipalities with Cochabamba claiming a part of District 4 as its own territory.

²censosbolivia.ine.gob.bo (02.03.2016)

³*Organización territorial de base*. OTBs can be *pueblos indígenas, comunidades campesinas* or *juntas vecinales*. In our context, it is the *juntas vecinales* (neighbourhood councils) that are of interest. The bodies are defined in the statutes. For the implementation of a sanitation project, it is important to coordinate the work at least with the President and (if existent) the Head of the Water Committee.

⁴OTBs and Urbanizaciones are both legal persons. While the OTBs have well-defined responsibilities in the Municipality (and receive Municipal funds in exchange), the Urbanizaciones generally have a more private character defining the conditions of auto-organization of urban neighbourhoods.



Figure 3.3: Photo of District 4 of Arbiesto, a periurban zone neighbouring the city of Cochabamba.

3.2 Synthesis of ADRA's UDDT project

This part of the report is based on the official project documentation and the interviews with the OTB representatives. An important share of the information was provided by Willy Zambrana, who was responsible for the coordination between the OTB Llave Mayu and the executing NGO. Regrettably, the NGO was not willing to share their project documentation.

Financed by the Spanish Agency for International Development Cooperation (AECID), the Adventist Development and Relief Agency Bolivia (ADRA Bolivia) executed a project for drinking water and basic sanitation in rural areas in Bolivia between 2010 and 2014. This project comprised the construction of 4'044 UDDTs in the Departments of La Paz and Cochabamba [1].

In 2010, ADRA started working in the drinking water sector in District 4 of Arbiesto. With a financial counterpart of the Municipality and workforce from the community, ADRA implemented a piped water network. According to Willy Zambrana, the wish for the construction of toilets was addressed by the OTB representatives soon after the construction works for the water network were finished. ADRA accepted the request, and, for the lack of water in the zone, decided to build UDDTs [23].



Figure 3.4: Location of the 7 concerned OTBs, directly at the limit between the municipalities of Arbieta and Cochabamba. The points represent the UDDTs.

In 2014, ADRA started the construction of 500 UDDTs (fotos in Figure 3.6 and supplementary explanations in the box below) in the OTBs 20 de Mayo, Florida, Llave Mayo, Villa Montes and Yuraj Jallpa.⁵ The NGO also constructed a treatment plant for the faeces that is partially equipped.

¿What is a urine-diverting dry toilet?

A urine-diverting dry toilet (UDDT) is a type of toilet that **separates the urine and the faeces**. The toilet **doesn't need flush water** and uses **dessication and compostation** to degrade the faecal material.

In the UDDTs implemented by ADRA, the urine is collected in 20 L jerrycans and the faeces in 100 L buckets. It is important to add drying material (like paper, sawdust or ash) to accelerate the dessication of the faeces and avoid smells. The faeces are composted in a centralized treatment centre to reduce pathogens, which means that the organisation of a **collection service** is required. The urine can be treated, infiltrated into the soil, or reused directly at household-level.

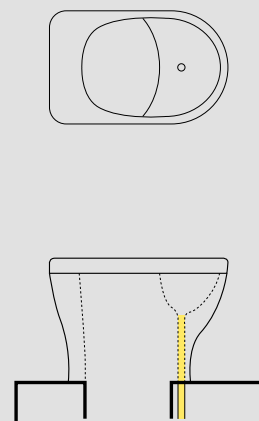


Figure 3.5: Schematic of a UDDT from [22].

⁵Last year (2015), Llave Mayo was divided into three OTBs: Llave Mayo, Cristal Mayo and Fortaleza.

The system implemented in Yuraj Jallpa, the OTB located furthest from the composting centre, is different: the faeces are composted directly in the chamber (without bucket) and the urine is directly infiltrated (without jerrycan). Usually, this system is based on two chambers, so that the faeces are composted in one chamber while the other is in use. However, the toilets in Yuraj Jallpa have one single composting chamber.



Figure 3.6: Clockwise: Exterior of a UDDTs built by ADRA, chamber for the faeces bucket and urine jerrycan, faeces treatment plant in Llave Mayu.

The project aimed to supply all families in the five OTBs with toilets. The matter was discussed in various OTB reunions in order to determine which families were interested. ADRA organized a survey among the interested families to ascertain that they actually lived in the OTBs permanently and would use the toilets. Based on the survey, ADRA decided how many UDDTs they would finance in each OTB. The toilets were built in three phases, but the last one was never completed, so that there are households still waiting for their construction material. As an incentive, the households that built their toilets during the first phase in Llave Mayu also received a shower. In other OTBs, the representative requested that all toilets include a shower. In all OTBs, workforce was provided by the beneficiaries and in some of the OTBs, ADRA also requested a financial counterpart. During the construction period, ADRA organized training workshops to explain the correct use of the UDDTs.

Willy Zambrana also mentions a conflict between ADRA and the Municipality about who was to pay for the collection and treatment of the faeces. ADRA finally left the project before a collection service was organized. Since this premature departure, there has been no contact between the ONG and the Municipality.

Synthesis of ADRA's activities

2010-2012: Implementation of a **piped water network** in the 7 OTBs

↔ Workforce and financial counterpart from the households (500 Bs./household)

2013: Request from the OTB representatives for the construction of toilets

2013-2014: Construction of **500 UDDTs** and a **faeces treatment plant**

↔ Workforce and in some OTBs financial counterpart from the household (150 Bs./household)

2013-2014: Workshops about the correct use of the UDDTs

2014: End of the construction of the treatment plant and **departure of ADRA without organising a collection service** of the faeces

3.3 Data acquisition

A reviews of the existing documentation allowed the definition of the legal and regulatory framework, as well as the water and sanitation situation at National and sometimes Municipal level. However, there was no specific documentation or official information about the project area, so that the collection of local information using interviews and surveys was necessary. The data was collected in three steps:

1. **Interviews with the Municipal engineers** in charge of sanitation and first field visit as a base to develop questionnaires for the OTB representatives and for the households.
2. **Interviews with the OTB representatives** (Presidents and Water Committees) to get an overview of the water and sanitation situation in the OTBs and adapt the household survey.
3. **Household survey** to gather information about the current toilet use and the perception of the water and sanitation situation (survey for households who have a UDDT and households who don't), including a direct observation of the toilets.

The four questionnaires (in Spanish) can be found in Appendix A. To ensure that the results are representatives for each OTB, the number of surveyed households corresponded to 20% of the number of UDDTs in the OTBs, but at least 15 households per OTB. Table 3.1 presents the number of residents, households, UDDTs and surveys done in each OTB. In total, we surveyed 108 households who own a UDDT and 10 surveys who don't.

The surveys were performed orally, walking from household to household to evaluate the condition of the toilet simultaneously. To ensure that the surveys are distributed uniformly across the territory, we divided the OTBs into equally sized sub-parts. Starting from the center of each of these parts, we walked into the four directions, surveying every fifth household (corresponding to 20% of the population). This method is known as "random walk". The procedure is not entirely random, as it relies on a division of the territory and

a selection of departure points depending on the interviewer. It is, however, a compromise between its simplicity and a simple random sample, where we'd have randomly selected 20% of the households from a complete list of the residents. As some families were not permanently present in the zone, it was not always possible to survey exactly every fifth households, which might distort some of the results.

Table 3.1: Number of residents, households and UDDTs in the 7 OTBs as communicated by the OTB representatives. Number of households with UDDT surveyed: 20% of the households owning a UDDT, but at least 15 in each OTB. Number of households without UDDT surveyed: 5 in two OTBs.

OTB	Residents ^a	Households ^b	UDDTs ^c	# of surveys with UDDT	# of surveys without UDDT
20 de Mayo	500	74	48	15	0
Cristal Mayu	500	130	13	0 ^d	0
Florida	500	133	40	15	0
Fortaleza	350	87	50	15	5
Llave Mayu	1500	250	120	24	5
Villa Montes	400	135	117	23	0
Yuraj Jallpa	500	104	80	16	0

^aEstimated by the OTB representatives, as no official information exists.

^bThe number of households corresponds to the number of OTB members (*socios*). However, not all OTB members live permanently in the area.

^cThe number of UDDTs is overestimated, as some households received construction materials from ADRA without building the toilets.

^dWe could not survey any household in the OTB Cristal Mayu, as there were no people present during the survey campaign. However, there are only 13 UDDTs in the OTB.

3.4 Water and sanitation services in the project area

The most recent official information about the access to drinking water and sanitation services at municipal level are from 2001 (INE). 67% of the population had a toilet or latrine in the housing, 58% had access to piped water (in the housing or from a public tap) and only 1% were connected to a sewer (Figure 3.7). Given the short rainy season, the Municipality mostly depends on groundwater for consume and irrigation. Arbiето relies on wells, some of which are equipped with elevated tanks

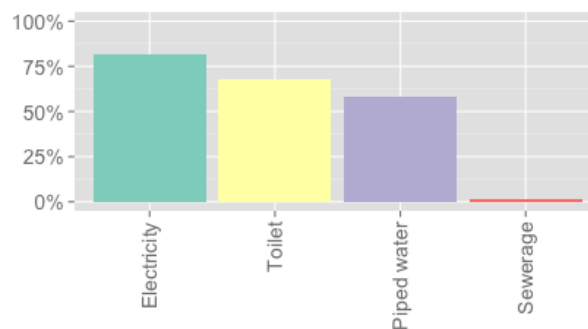


Figure 3.7: Access to basic services in the Municipality of Arbiето (INE, 2001)

for the water distribution. As for now, this water source is not monitored and the Municipality doesn't have information about its exploitation or quality. Spring water is also an important water source, but many have been dessecating recently, especially during the dry

season [17].

The INE published indexes about the disposal of solid waste in 2012, when only 5% of the inhabitants deposited their waste in public containers or used a public collection service. In contrast, 14% dumped it into the rivers and 71% burnt it (Figure 3.8). There's no sanitary landfill in the Municipality, so that all collected waste ends up in a dump [17]. According to a diagnostic by the GAM Project, the recollection service only serves 4% of the population, which is the lowest coverage among all municipalities in the Valle Alto [8]. Moreover, the collection system is not viable, as all costs are covered exclusively by the Municipal government [17].

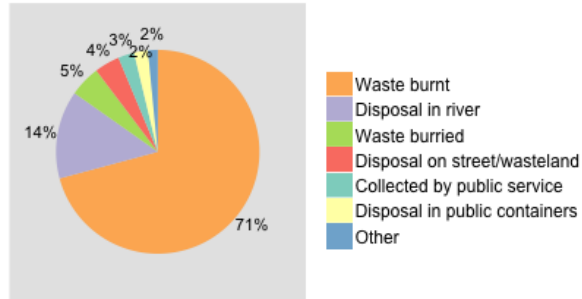


Figure 3.8: Disposal of solid waste in the Municipality of Arbieta (INE, 2012).

The Municipality does not have indexes related to water and sanitation services per district or per OTB, so that all information presented in the following sections is based on the interviews with the OTB representatives and the household surveys.

3.4.1 Water supply

As mentioned before, ADRA implemented a piped water network in the zone, so that the majority of the inhabitants have tapped water in the housing (Figure 3.9). As a consequence of poor administration and the dessication of the water source, however, this network doesn't work in the majority of the OTBs. Moreover, especially the OTB Llave Mayu has grown substantially during the last years. In Llave Mayu, there is officially piped water once a week, but only in a part of the OTB. The OTBs Florida and 20 de Mayo rely on the same water source than Llave Mayu, but most households haven't had water during the past months. Currently, most inhabitants from these OTBs buy water directly from water trucks (*aguateros*). The lack of water causes two types of conflicts:

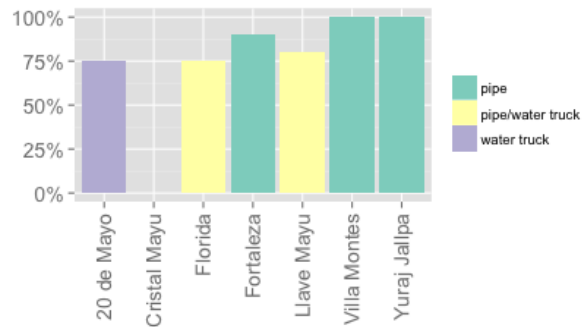


Figure 3.9: Percentage of the inhabitants that have piped water in the housing (column) and main water source (colour).

1. Conflicts between the OTBs: The water source is located in the OTB Llave Mayu, which receives the largest share of water. Especially the OTBs Florida and 20 de Mayo are frustrated by the current situation, as Llave Mayu doesn't respect the arrangement that guaranteed them water at least twice a week. Cristal Mayu and Fortaleza formed their own OTBs as a consequence of the water conflict.
2. Conflicts between the inhabitants who don't have a regular water supply and the Water Committees responsible of providing the service. Many inhabitants are not ready to pay the monthly fee for the maintenance of the network when there's no water supply most of the time.



Figure 3.10: Consequence of the conflict between a resident and the water committee: unmounted water meter in the OTB Llave Mayu.

These conflicts have emerged relatively recently. Directly after the implementation of the water provision network, the water source produced a sufficient amount to constantly provide water to all connected OTBs. The dessication started around two years ago, causing the described conflicts.

The OTBs Villa Montes and Yuraj Jallpa have never had their own water source. They depend on water trucks that fill the tanks from where the water descends to the houses. Agreements with the *aguateros* guarantee a water supply 24 hours a day. This agreement is usually respected, even though short periods without water provision can sometimes occur.



Figure 3.11: Water tank in the OTB Yuraj Jallpa (filled by water trucks).

Based on the information provided by the OTB representatives (confirmed by the household survey), Table 3.2 summarises the frequency of the piped water supply along with the water prices for piped water and water supplied by *aguateros*. The prices for the water provided by *aguateros* are fixed by a trade union, while it is the Water Committees that set the prices for the piped water supply with the approval of the OTB members. The tariff collection is also part of the Water Committee's responsibility. As mentioned, there are frequent conflicts between the residents and the Water Committees over water tariffs, since the residents are not ready to pay for an irregular and unreliable service. In Villa Montes and Yuraj Jallpa, where a member of the Water Committee comes to read the meters every

month and emits bills in function of the consumption (Figure 3.12), many residents complain about the high tariffs. Apparently, the water meters overestimate the consumption, so that Yuraj Jallpa has started replacing them.



(a) Water Bill in the OTB Villa Montes. (b) List of the households that haven't paid their water bills as a tool for social pressure. (c) Mensual tariff collection in the OTB Yuraj Jallpa.

Figure 3.12: Organization of the water tariff collection.

Table 3.2: Frequency of the water supply and water tariffs (f: fixed, v:variable)

OTB	Days with piped water	Tariff piped water	Tariff water truck
20 de Mayo	0	f: 15 Bs./month	v: 30-35 Bs./m ³
Cristal Mayu	0	-	v: 40 Bs./m ³
Florida	0-1 days/week	f: 15 Bs./month	v: 35 Bs./m ³
Fortaleza	7 days/week	f: 20 Bs./month	v: 35 Bs./m ³
Llave Mayu	1-2 days/week	f: 20 Bs./month	v: 35-40 Bs./m ³
Villa Montes	7 days/week	v: 22.50 Bs./m ³	-
Yuraj Jallpa	7 days/week	v: 20 Bs./m ³ , f: 10 Bs./month	-

Figure 3.9 summarizes the main water source. Most residents use the same water source for all activities, depending on which is available. A fifth of the population uses bottled water for consumption, paying 12 Bs. for bottles of 20L for a door-to-door delivery service. This is mostly the case of households relying on water trucks, as there isn't any control of the water quality. A few households also wash their clothes in the river or in the Angostura Lagoon to save water.

Most residents adapted to the absence of a reliable water provision, buying private storage tanks of 450L or 900L (Figure 3.13a). This is particular important for households that depend on water from the aguateros, as the service isn't regular: depending on the season, there can be only one aguatero per week attending the zone (during the dry period) or various a day (during the rainy season). The lack of a schedule is a problem in this periurban zone, where the majority of the residents isn't at home all day. Moreover, the aguateros don't serve the more remote areas of the OTBs, so that some families have to manually transport the water barrels to their houses. A few families also invested in much larger tanks, with a capacity

of 12'000L to 13'000L, allowing them to benefit from lower prices (200 Bs./tank, or around 16 Bs./m³, Figura 3.13b). As a consequence of the long storage time in these tanks, however, the water is only used for washing or irrigation, but not as drinking or cooking purposes.



(a) 450L private water tank in the OTB Villa Montes.



(b) Construction of a 12'000L private water tank in the OTB Llave Mayu to benefit from lower water prices.

Figure 3.13: Private water tanks

Given the different water sources (piped water or water trucks) and the absence of functioning water meters in the majority of the OTBs, it's difficult to estimate the quantity of water used by the households. We can calculate the average consumption of households using exclusively piped water (Villa Montes and Yuraj Jallpa) or exclusively water from *aguateros* (households in Llave Mayu, Florida and 20 de Mayo):

- Water truck: **20L/person·day**
- Piped water: **35L/person·day**

Monthly water costs

Based on the mean water consumption and prices, we can calculate the monthly water costs:

- Water truck (OTB 20 de Mayo): **20 Bs./person·month**
- Piped water (OTB Villa Montes): **20 Bs./person·month**

As shown in Figure 3.14, there's no custom to treat the greywater. As a consequence of the lack of water in the zone and the high water tariffs, the households that have small gardens re-use the wash water for irrigation. A few families also use greywater from the shower to clean the house or the toilet. The households that don't have gardens usually dump the greywater directly onto the street. Apparently, the soil capacity is sufficient for the infiltration, even during the rainy season.

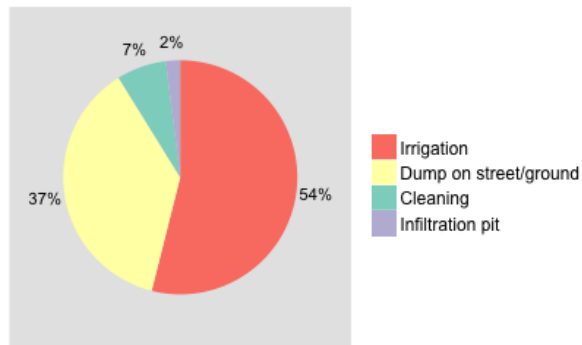


Figure 3.14: Disposal of greywater based on the auto-declaration of the respondents.

3.4.2 Solid waste management

According to a diagnostic by the GAM project, the monthly waste production is around 12.7 kg/inhabitant in the urban centre of Arbiето. 72% of the waste are organics and 17% recyclables [8]. The waste production is probably lower in District 4, since a part of the inhabitants are not present during the day.

There is no waste collection service in any of the OTBs, neither public nor private. The inhabitants are not used to recycle plastics, paper and metals. As depicted in Figures 3.15 and 3.16a, many residents incinerate their waste on-site (plastics and paper). For the respondents, this is the most environmental-friendly solution and even compulsory in some of the OTBs (for instance there are financial sanctions for residents dumping their waste into the rivers in Fortaleza). A few households who have a car also deposit their waste in public containers in the city. The contamination of the environment, and especially of the rivers, is common in all OTBs (Figure 3.16b).

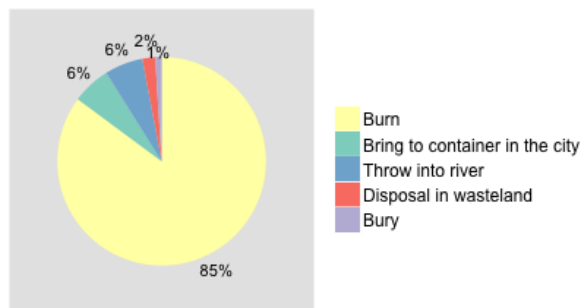


Figure 3.15: Solid waste disposal based on the auto-declaration of the respondents.



(a) Incineration of solid waste in the OTB Llave Mayu.



(b) Dump of solid waste in a river bed in the OTB Florida.

Figure 3.16: Examples of solid waste disposal.

Most surveyed residents believe that they don't pay a tax for waste management services, as there are no such services in the project zone. In reality, they pay a service tax included in the electricity bill (Figure 3.17). Electricity is provided by ELFEC S.A. (*Empresa de Luz y Fuerza Eléctrica Cochabamba*) that collects the service tax (*tasa de aseo*) for the Municipality of Cochabamba. The tax depends on the consumption range [15], and many inhabitants pay around 7 Bs./month. Many residents are not aware of this, because they can't read their electricity bills or they don't understand the meaning of *tasa de aseo*.



Figure 3.17: Electricity bill with tax for waste management services (*tasa de aseo*).

As presented in Figure 3.18, three quarters of the surveyed residents declare that they separate the organic waste from the residual waste (plastics and paper). Globally, around half the households reuse the organic waste and benefits directly from the waste separation; families who have a kitchen garden use them directly as a soil conditioner, which is usually the only type of fertilizer they apply. Families who own cattle (mainly sheep) use the organics as animal feed, while other families pass their organics on to families who have cattle.



Figure 3.18: Separation and use of organic waste based on the auto-declaration of the surveyed residents.

3.4.3 Use of the UDDTs

Almost no-one had its own toilet before the construction of ADRA's UDDTs, and open defecation was common. At present, only a third of the households uses their UDDT (Figure 3.19). Another third uses simple pit latrines, of which almost one half corresponds to UDDTs that were transformed into pit latrines. Open defecation is still widespread. A majority indicates they are disgusted by this practice, but at the same time many families don't have an alternative. Many complain about smells and the contamination of the water and environment caused by human excrements. Women also feel insecure when they have to go outside alone at dusk.

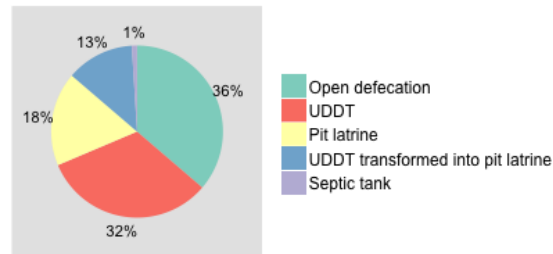


Figure 3.19: Type of toilet used based on the auto-declaration of the surveyed residents.

The percentage of UDDT users varies considerably among the OTBs, with only 13% of the households using the UDDT in the OTB Florida against 54% users in the OTB Yuraj Jallpa (Figure 3.20).

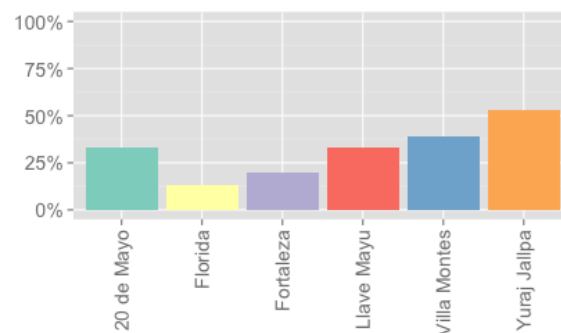


Figure 3.20: Percentage of households using the UDDTs based on the auto-declaration of the surveyed residents.

The percentage of users is probably overestimated for the three following reasons:

1. The number is based on the auto-declaration of the surveyed residents, even though some UDDTs didn't seem to be in use.
2. The survey didn't include house or property owners not living in the OTBs. Even though ADRA required the families who wanted to build a UDDT to live permanently in the OTBs, not all beneficiaries of the project respected the condition. Some owners built the UDDTs planning to sell the property at increased prices in the future (Figure 3.21).
3. Conceivably, the interviewers distorted the results to gain time during the survey. It is striking that the percentage of UDDT users is than high in the OTB Yuraj Jallpa, where external assistants carried out almost all surveys.



(a) UDDT next to an uncompleted house in the OTB 20 de Mayo.



(b) House for sale in the OTB 20 de Mayo.

Figure 3.21: Examples of house or property owners not living permanently in the OTBs.

As a consequence of an inadequate design and construction of the UDDTs, in combination with a lack of maintenance by the users, the condition of the unused toilets frequently is poor. The most common problems include:

- Many UDDTs lack buckets and jerrycans, because they are broken, used for other objectives, or were lost.
- Many UDDTs have problems with the access to the faeces chamber, that are rusty or can't be opened due to terrain movements (Figure 3.22a).
- In some toilets, the main door is broken as well.
- A part of the toilets doesn't have any aeration system, or the aeration tubes have holes (Figure 3.22b).
- Finally, some UDDTs have been irreversibly transformed into simple pit latrines (Figure 3.22c).



(a) Broken access door to the faeces chamber



(b) Broken aeration tube



(c) UDDT transformed into simple pit latrine

Figure 3.22: Frequent maintenance problems and change of design.

As presented in Figure 3.23, the majority of the households uses earth as drying material for the faeces, frequently in combination with paper (toilet paper or newspaper). The earth is usually taken directly from the site, so that it comes for free. However the drying capacity is limited and problems with smells are frequent. Households cooking with wood also use ash to avoid smells in the toilet. The use of sawdust isn't widespread, mainly because it is difficult to find in the zone and many households find it too expensive.

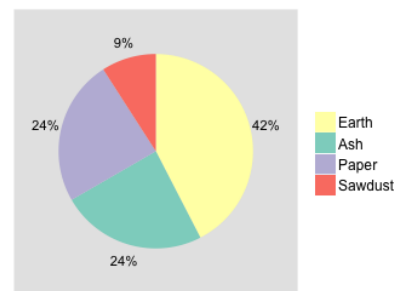


Figure 3.23: Use of drying materials based on the auto-declaration of the households currently using the UDDTs.

Independently of the number of users, almost all surveyed residents declare the faeces buckets fill in a month. When the buckets are full, the majority of the households buries the faeces, usually directly on-site (Figure 3.24). Given the dry and rocky soil, the digging work is challenging and usually the men's responsibility. The majority doesn't use the faeces as a natural soil conditioner. To avoid digging, around a third of the households dump the faeces directly into the river or into empty parcels of land, which frequently causes conflicts with the neighbours. A few families who own a vehicle also take the faeces to the city, where they deposit them in the public waste containers. Finally, a few families pay around 10 Bs. to a person of the OTB who buries the faeces for them.

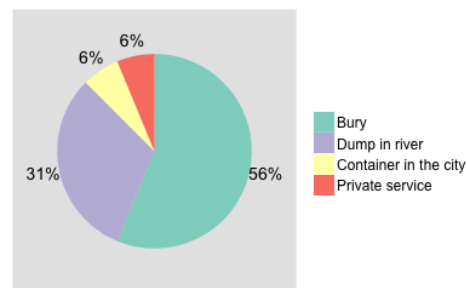


Figure 3.24: Disposal of the faeces based on the auto-declaration of the households currently using the UDDTs.

The urine jerrycans fill in one to two weeks. Half of the households dumps the urine directly onto the soil (a few of which dig holes to facilitate infiltration). The physical effort required is less than for the faeces, and any member of the household can be responsible for this duty. A few families have changed the design of the UDDT, so that the urine is infiltrated directly. This is especially the case in Yuraj Jallpa, where ADRA even provided the infiltration tubes. Those who don't want to infiltrate the urine directly in their property usually throw it into the river. A small minority also uses diluted urine as a fertilizer for the plants, but the quantities of urine produced by far exceed the

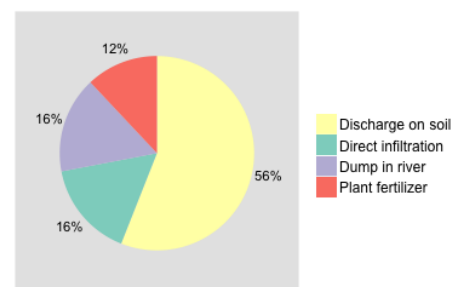


Figure 3.25: Disposal of the urine based on the auto-declaration of the households currently using the UDDTs.

need at household level.

3.5 Stakeholder analysis

Summarising the main interests, as well as the strengths and weaknesses of the key stakeholders involved in the project, this analysis is an essential step for the successful implementation of a collection service for the faeces. The present section is based on the information gathered during the interviews and surveys with the different stakeholders. We identified three main categories of stakeholders: municipal authorities (Mayor and Municipal Council, engineers in charge of water and sanitation), civil society (OTB representatives, residents) and NGOs.

3.5.1 Characteristics of the key stakeholders

In this section, we present the main characteristics of the identified stakeholders and evaluate the necessity to participate of each.

At municipal level, there are two types of stakeholders: the Municipal Government (Mayor and Council) and the engineers in charge of water and sanitation.

Municipality: Mayor and Municipal Council

The Municipal government comprises the Mayor (executive) and Council (legislative) that are elected for a period of five years. In District 4, the municipal executive authority is represented by the Mayor's office (*Alcaldía*) and the District office (*Sub-alcaldía de la Subcentral Zona Norte*), which is responsible of the coordination between the Mayor and the OTB representatives.

It is the Municipality's obligation to guarantee the access to water and sanitation services, and the implementation of a new collection service is an opportunity to meet this obligation. The Mayor and Council also have a political motivation to fulfil the demands from District 4, as this would improve the people's faith in the Municipal administration. The Mayor personally requested the composting plant to work and granted 40'000 Bs. for this purpose.

Municipality: Engineers in charge of water and sanitation

The start-up of the faeces treatment plant falls into the domain of the Department for Productive Development and Environment (*Dirección de Desarrollo Productivo y Medio Ambiente*). More precisely, sanitation is in charge of two units, the Unit for Basic Sanitation (*Unidad de Saneamiento Básico*, USB) and the Unit for Environment and Local Economic Development (*Unidad de Medio Ambiente y Desarrollo Económico Local*, MADEL). Each unit is represented by one engineer responsible for the implementation of projects in the entire Municipality.

The two engineers have assumed function recently, a consequence of frequent changes in the Municipal staff, and have limited experience in project management.

They are under pressure from the Mayor who wants the treatment plant to start up as soon as possible. They have limited capacity (technical, organizational or time) to implement a sustainable service.

Their interest in the success of the project is high and their role is important, as they are responsible for the communication with the Mayor.

Concerning civil society, there are three stakeholders: the OTBs as institutions, the OTB representatives and the residents of the project zone.

Civil society: OTBs

The OTBs are civil organizations that represent the community before the municipal administration.

Their competences in the Municipality are limited to the right of information, consultation, cooperation and control. For example, the OTBs have the right to make propositions for the development of the municipality, in particular in the PDTAs [21].

The members of the OTB meet once a month to discuss the most urgent problems. It is in these reunions that decisions affecting the entire OTB are taken. During the survey, many residents were not ready to communicate their own opinion, arguing that the questions needed to be discussed in a reunion to come to an opinion at OTB level.

The decisions taken during the OTB reunions have a binding character for the members; it can be interdictions (for example, not dumping waste into the river) or obligations (for example, the obligation to use the UDDTs, participate in community work, pay for a new construction in the OTB). The members can also define penalties for those who don't respect the decisions.



Figure 3.26: Presentation of the agenda for the monthly reunion in the OTB Yuraj Jallpa.



Figure 3.27: Preparation of a day of community work to fix the piped water network in the OTB Llave Mayu.

Civil society: OTB representatives

The institutions of the OTBs are fixed in the statutes. All have a President and a Water Committee. The commitment is voluntary and the representatives don't receive any form of remuneration for the community service.

The main role of the OTB representatives is the communication between the authorities and the residents. They also assume some responsibilities that would usually fall into the municipality's duties. For example, the water supply is organized by the Water Committees in each OTB.

The OTB representatives have a certain power of persuasion over the residents. They have a high interest in the project, as it represents an opportunity to prove their management capacity and give them social prestige. Moreover, they live in the project zone and are hence directly affected by the improvement of the local situation.

However, the majority of representatives have only limited technical and organizational capacities, so that it seems difficult that they take informed decisions.

Civil society: Residents

Only every fifth resident was born in the Municipality of Arbieta (Figure 3.27a). Many immigrated into the zone less than 10 years ago, mainly from rural parts of the Department of Cochabamba, but also from the Altiplano (rural zones of the Departments of Potosí and La Paz). A large majority of the men are construction workers (mainly masons), but there is also a considerable proportion of merchants and drivers (Figure 3.27b). More than half of the population has never been to school or has only primary school education (Figure 3.27c).

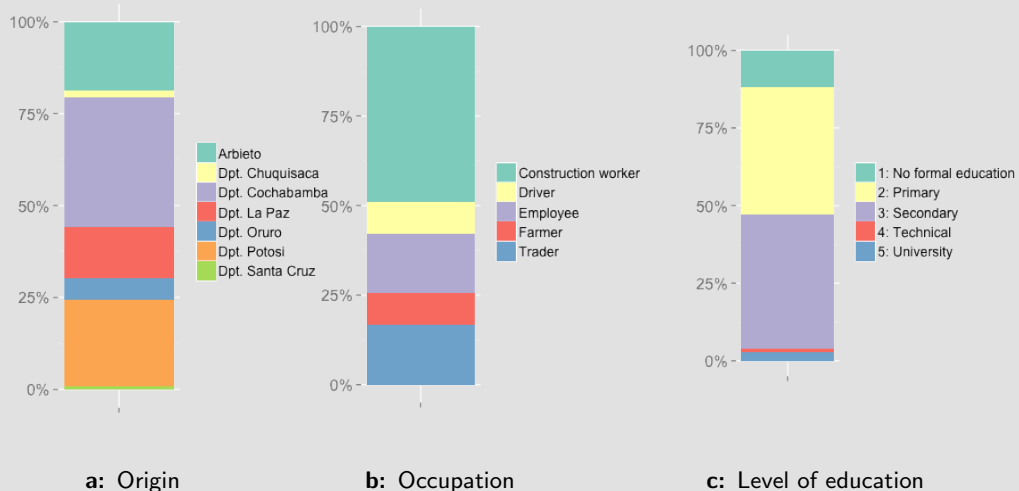


Figure 3.28: Characterization of the residents: origin, occupation and level of education.

More than two thirds work in the city of Cochabamba (Figure 3.29). They settled in District 4 for its proximity to Cochabamba, in combination with affordable land prices. Almost all own the land they live on, and a majority built their housings themselves. In average, people are present part of the day: the women are frequently housewives or own a small shop in the OTB, and the children go to school only in the morning or in the afternoon. Most are, however, not present in the zone the entire day, as almost all economic activities take place in the city.

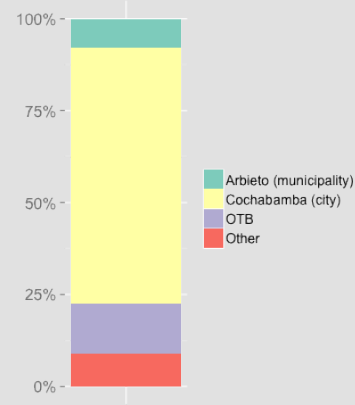


Figure 3.29: Characterization of the residents: work place.

There are no rich families living in the zone, but the majority isn't very poor either: almost all families have a mobile phone and a TV. The refrigerator is probably the best way to distinguish between richer and poorer families: in total, 60% of the families own a refrigerator.

The interest the residents have in the project is counting on a services that is in line with their necessities (health, safety, economy) and acceptance. They have a high interest that a recollection service for the faeces is implemented, as they already invested in the construction of the UDDTs without being able to use them.

At the same time, they lack a common understanding of the sanitation situation: the knowledge about the different technical and tariff options is very limited, and it seems impossible that they take informed decisions without previous education.

The last important stakeholder is the Fundación Aguatuya.

NGO: Fundación Aguatuya

In the framework of the GAM Project, the Fundación Aguatuya provides technical assistance for the Municipality of Arbieta. The project has granted funds for the development of a recollection and treatment service of the faeces.

Aguatuya's experiences lay mainly in the provision of sustainable drinking water and sewerage services. Solid waste management is a relatively new focus, and the Foundation's former UDDT projects didn't succeed at medium and long term.

The implications and interests of the stakeholders, along with their influence and resources and strengths and weaknesses are summarised in a table in Appendix C.

3.5.2 Relations between the key stakeholders

The relationships that seem essential for the success of each step of the project are summarised in the following paragraphs.

1. Development of service scenarios

For the technical support (including the development of service scenarios), there is a contract between the Municipality and the Fundación Aguatuya that formalizes the conditions of service.

It seems helpful that the Municipal engineers in charge of the project collaborate closely in the development of the project, as they are responsible of the communication with the Mayor.

2. Selection of the service scenario

Including the practice of decision-making in OTB reunions in the process is important, as it is here that the residents will decide whether they accept a service proposition or not. The process needs to be accompanied by information and training sessions enabling the residents to take informed decision.

In this step, it is crucial that the authorities understand the residents' priorities and preferences concerning the collection service, since the project's success depends largely on its use by the population.

The OTB representatives have a high interest in improving the current situation, along with the capacity to influence public opinion. Their principal role lays in the convocation and information of the OTB members. In order to ensure their support, the municipal authorities should establish contact with the OTB representatives at an early stage.

A factor that might prove helpful is the fact that some residents know the Fundación Aguatuya for their work related to the provision of drinking water. However, others mistake Aguatuya for ADRA, an NGO they don't trust much.

In this step, the conflict-ridden relationship between the OTBs (conflicts over water and boundaries) could impede the selection of the scenario most favourable for all OTBs. Another problematic factor is the prospective interest of the Municipality to select the most economic scenario, which might not be the most adapted one for the zone. The conflict with the Province of Cercado might additionally decrease the Municipality's motivation to invest money in District 4.

3. Organization of the service (recollection and treatment)

The *Unidad de Saneamiento Básico* will be responsible for the management of the new service, hiring new operating staff. This is in accordance with the residents' wish that it is the Municipality that should organize the service, since they have more trust in its organizational capacity than in the Water Committees'. Besides, the members of the Water Committees don't seem motivated to take responsibility in this project, as the residents' frustration about

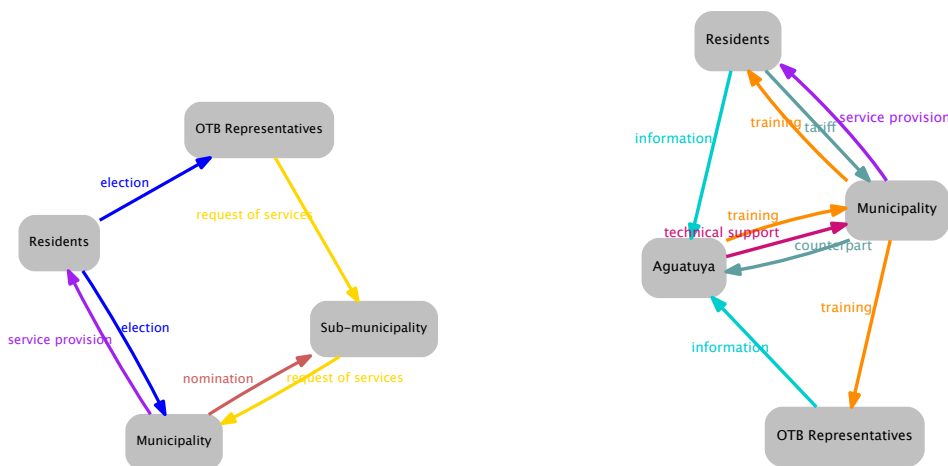
the absence of a collection service unleashed on them. In the OTB 20 de Mayo, for example, the Records Secretary *Secretario de Actas* who was responsible of the communication with ADRA is frustrated because he's being criticised by the residents, despite his effort to improve the conditions in the OTB.

4. Tariff collection

It seems pertinent that it is the operative personnel that directly collects the tariff, as the residents' trust in the financial administration of the OTB representatives is limited. The conflicts between residents and Water Committees are presented in Section 3.4.1. There are also ongoing conflicts about finances between the Presidents and residents. In Yuraj Jallpa, for instance, the Presidents lost parts of the documentation about the construction of a new sports ground, while the residents demand access to the information to know what happened with their financial contribution. There are similar situations in the other OTBs. The residents don't have any experience with services provided directly by the Municipality, so that they currently have no reason to distrust its financial management.

Finally, we can use the community feeling withing the OTBs as an instrument to exert social pressure for tariff collection. En Yuraj Jallpa, for example, the Water Committee publishes a list of all community members currently in default along with the sum they owe. It's an effective instrument, as the defaulting residents feel ashamed to have their name published.

Two different types of relations between stakeholders are summarized in Figure 3.30: Figure 3.30a presents the formal relations as defined in legislation and regulations, while the possible relations of the stakeholders related to the provision of a faeces collection service are outlined in Figure 3.30b .



(a) Usual relations between stakeholders for the provision of basic services as defined in the legislation.

(b) Proposition of relation between stakeholders for a faeces collection service.

Figure 3.30: Relations between key stakeholders.

3.6 Analysis of the enabling environment

The enabling environment is the set of conditions that can impact the potential to bring about sustainable and effective change [11]. The planning guideline CLUES identifies six interrelated elements of an enabling environment: government support, legal and regulatory framework, institutional arrangements, skills and capacity, financial arrangements and socio-cultural acceptance (Figure 3.31). The following sections evaluate each of the elements of the local environment.

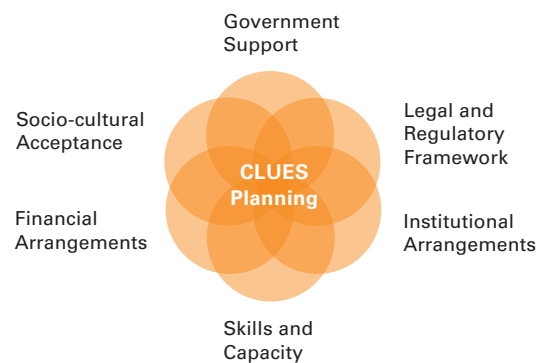


Figure 3.31: Six elements of an enabling environment [11].

3.6.1 Government support

It is important that there is explicit government support for participatory processes and that the project is in line with the government's socio-economic development policies.

As presented in Chapter 2, improving the access to sanitation services is a priority at National level.

Cornerstones of the National Plan for Basic Sanitation 2008-2015 [13]

- El acceso a los servicios de agua y saneamiento es un Derecho Humano fundamental.
- El agua y el saneamiento no son objeto de concesión ni privatización.
- El Estado es responsable, en todos sus niveles de gobierno, de la provisión de los servicios básicos a través de la prestación directa, o de empresas públicas, cooperativas, comunitarias o mixtas.
- La provisión de servicios debe responder a los criterios de universalidad, sostenibilidad, responsabilidad, accesibilidad, continuidad, calidad, eficiencia, eficacia, tarifas equitativas y cobertura necesaria con participación y control social; velando la equidad social y de género.

The assessment of the governmental support follows the critical questions defined in CLUES [11].

Critical questions regarding governmental supports from CLUES [11]

- *Is increased access to safe water and sanitation for all recognized by the government as important for socio-economic development?*
- ✓ The PSD-SB underlines the importance of water as the most important resource

for ecosystems, and hence for all related ecosystem services. The plan explicitly mentions the access to water and sanitation as a decisive component of the socio-economic development of the country [14].

- *Is there a general decentralization movement underway? Does the government promote decentralization of environmental sanitation service delivery functions, including the participation of the private sector?*

≈ As explained above, the municipalities have an important role in the sanitation sector. Service delivery through the EPSA might also be regarded as a decentralization process promoted by the government. However, the participation of profit-oriented private businesses in the water and sanitation sector is explicitly excluded [13].

- *Is there a policy which promotes affordable service provision to unserved areas?*

✓ Art. 20 CPE promulgates the access to drinking water and basic sanitation as a human right, and the government is responsible to guarantee this right. The necessity of establishing tariff structures and prices that are accessible (i.e. affordable) is also recognized [14]. The MICSA prioritizes poor regions with less service coverage.

- *Do existing policies promote community participation in activities related to environmental protection and service provision?*

✓ In the PNSB, the national government emphasizes the importance of community participation in service provision. By improving social participation, the PNSB means primarily the reinforcement of “community systems” and cooperatives and the recognition of uses and customs [13]. The PSD-SB more explicitly promotes the participation of the users, but does not detail how this participation is to be achieved [14].

In summary, most of the critical questions from CLUES are affirmed.

1. From a regulatory point of view, the access to water and sanitation for all is a priority for the Bolivian government.
2. There is a commitment to decentralization, however, with strict conditions on who is allowed to participate in the water and sanitation sector.
3. Social participation in the drinking water and sanitation sector is one of the pillars of the regulatory framework, but it is not clear how the participation of the users is to be included in the development and maintenance of sanitation services.

As mentioned in Section 2.2.2 this recorded governmental support might, however, not always be sufficient, as the National government may not be capable to implement or enforce these principles.

At Municipal level, the Mayor explicitly commissioned one of the engineers to organize the up-start of the treatment plant. His main motivation is probably the fact the the plant already exists, so that the Municipality should benefit of the investment they made in the

past. However, there's a lack of sensibilization with respect to the challenges of implementing a sustainable collection service.

As a consequence of the geographic distance to the urban centre of Arbieto (where the decision are taken) and the territorial conflict between Arbieto and Cochabamba, District 4 doesn't seem to be a geographic focus of the Municipality. Their might be a reduced willingness to invest funds into an area that might not be part of its territory in future. Moreover, expanding the access to sanitation for all isn't really a priority for the Municipality, and investments in the sector are very limited, as presented in Section 3.6.5.

Government support

- ✓ Increasing the coverage of sanitation services is a priority at National level.
- ✓ The mayor commissioned the up-start of the faeces treatment plant at soonest.
- ≈ There is a lack of awareness about the time and means required for the implementation of a sustainable service.

3.6.2 Legal and regulatory framework

The legal and regulatory framework at National level are presented in Chapter 2.

The Municipality is responsible for the provision of drinking water and basic sanitation services. They are used to coordinate their work with the OTB representatives. Moreover, the OTBs have the possibility to independently manage the drinking water supply (including operation and maintenance, as well as tariff collection and management) through Water Committees. However, the Municipality of Arbieto hasn't yet elaborated a detailed regulatory framework defining the responsibilities and conditions for the provision of sanitation services currently, there are no laws or regulations that might influence the selection of a collection and treatment system or the financing.

Legal and regulatory framework

- ✓ It is possible for local structures (OTBs) to manage basic services (which is for instance the case for the water supply).
- ≈ There are no laws or regulations influencing the type of collection and treatment service or tariff.
- ✗ Currently, there are no regulations defining waste collection tariffs (the waste collection service is free in the urban centre).
- ✗ There is an ongoing conflict about territorial limits between the Municipalities of Arbieto and Cochabamba.

3.6.3 Institutional arrangements

The relations between key stakeholders are summarised in Section 3.5.2, and more specifically in Figure 3.30. Formally, there is a specific agreement between the Municipality and the GAM Project defining the responsibilities of both. Finally, we recall that the residents pay a tax for waste management services without receiving any service as a consequence of the territorial conflict between Arbiето and Cochabamba.

Institutional arrangements	
✓	The municipality is willing and has the practice to coordinate its work with the OTB representatives.
✓	The Presidents of the OTBs assume the communication between the residents and the Municipality.
≈	The Water Committees are in charge of managing the water supply (with more or less success, depending on the OTB).
✓	The residents meet every month to take decision at OTB-level.

3.6.4 Skills and capacity

At Municipal level, the **engineers in charge of sanitation** are technically well trained, but have little experience in project management, since they were appointed only a few months ago. They are becoming more and more familiar with the legal and regulatory frameworks, but haven't acquired a detailed knowledge of the subjects yet.

The **OTB representatives** have only limited skills and capacities relative to sanitation. Many are labourers without experience in planning processes or knowledge about realistic technical options.

The majority of the **residents** has little formal education. ADRA organized workshops to explain the correct use of the UDDTs, but they didn't raise awareness about the costs of the collection and treatment of the faeces or maintenance requirements for the latrines. Most residents lack understanding about the technical, economic and environmental implications of the different sanitation options.

Aguatuya has ample experience in the provision of drinking water and the treatment of waste water, but solid waste management is a relatively novel area. The foundation constructed UDDTs in the past (see Section 5.2), but failed to provide a collection and treatment service.

Skills and capacity	
Municipality	
≈	Few staff for the implementation of projects
Community-based organisations	

<ul style="list-style-type: none"> ✗ Lack of capacities in technical decision-making and financial administration
<p>Residents</p> <ul style="list-style-type: none"> ≈ Training about the correct use of UDDTs provided by ADRA ✗ Lack of awareness about the costs of a collection service and maintenance of the latrines
<p>Aguatuya</p> <ul style="list-style-type: none"> ≈ Little experience with solid waste management

3.6.5 Financial agreements

Every five years, the Municipality publishes a Territorial Development Plan (*Plan de Desarrollo Territorial Autónomo*, PDTA) and every year an Annual Operation Plan (*Plan Operativo Anual*, POA). Under the Decentralization Law (*Ley de Descentralización*), the National Government redistributes 20% of its tax revenues among the municipalities in function of the number of inhabitants. This redistribution of national taxes is called Tax Coparticipation (*Coparticipación Tributaria*). In 2015, the amount transferred to Arbieto was around 25'000'000 Bs., or more than 1'000 Bs. per inhabitant. From this amount, the Municipality officially uses 25% for its operating costs, while the remaining 75% are reserved for investment projects. The other sources of income (own resources, resources for poverty alleviation, community contributions) are negligible in comparison [17].

The Municipal investments related to water and sanitation budgeted for the period 2015-2019 are around 400'000 Bs. per year for the entire Municipality (2'210'000 Bs. for five years). This corresponds to 20 Bs. per inhabitant per year, or less than 2% of the total Municipal investments. In comparison, the investments for the promotion of sports are almost four times higher [17]. Figure 3.32 presents the investments by topic. Resources planned for solid waste management are sparse. Clearly, the Municipality's two priorities are the provision of drinking water and the treatment of waste water. However, these investments are not distributed evenly between the years. In a first stage from 2015-2017, the Municipality invests in the construction of new drinking water system. Only in a second stage from 2018-2019, the construction of sewerage and waste water treatment plants begins.

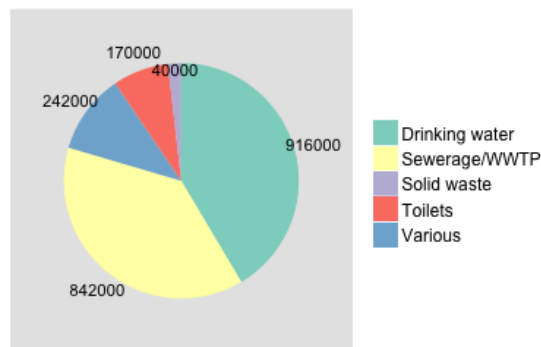


Figure 3.32: Distribution of the investments 2015-2019 in the sanitation sector by topic (based on the investments presented in the POA).

Figure 3.33 presents the investments by District. Clearly, the largest share of total funds go to District 4 (973'000 Bs. of 2'210'000 Bs., or more than 40% of all investments). With 6'900 inhabitants, District 4 is also the most populated district in the Municipality (2012 census, [17]). Overall, the investments in District 4 are proportional to the number of inhabitants, in spite of the low coverage of services in this part of the Municipality. Currently, the POA reserves 40'000 Bs. specifically for the equipment and up-start of the faeces treatment plant. These funds are guaranteed only for 2016 and there is no security that a budget will be available to maintain the service in the following years.

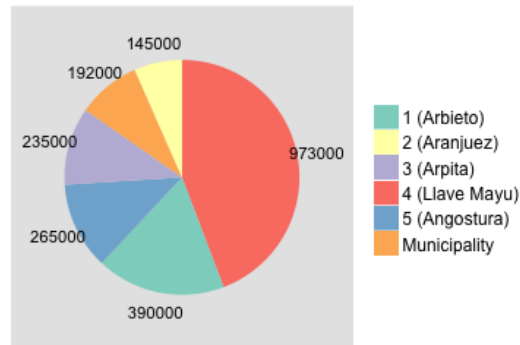


Figure 3.33: Investments 2015-2019 in the drinking water and sanitation sector by district (based on the investments presented in the PDTA).

There is no user awareness about the costs of a faeces collection and treatment services, and ADRA never mentioned any tariff. When ADRA organized two collection tours, the users didn't have to pay anything for the service. As a consequence, the vast majority believes that the service was meant to be for free. Even so, many residents indicate they would be willing to pay for a reliable service (see Section 4.3), but the amounts they suggest are not sufficient to cover all costs.

Finally, it is important to recall that the residents already pay a waste management tax in their electricity bills, that currently benefits the Municipality of Cochabamba (see Section 3.4.2).

Financial agreements

- ✗ Limited capacity and willingness of the Municipality to invest funds into the implementation of a faeces collection and treatment service (40'000 Bs. for the up-start of the plant).
- ✗ Municipal funds only guaranteed for 2016.
- ✗ Lack of user awareness about the costs of a collection and treatment service (the collection was initially for free).
- ✗ The residents already pay a waste tax, without receiving any service.
- ≈ The majority of the households are willing to pay for a service, but the amounts are not sufficient to cover the costs.

3.6.6 Socio-cultural acceptance

The initial demand for the construction of toilets was addressed by the OTB representatives, but it is ADRA who decided they would implement UDDTs. From its former UDDT projects, ADRA already realised that the acceptance of the toilets would be a key factor and decided to give major importance to the sensitisation of the users [23].

In the past, ADRA had already successfully executed a drinking water project in the zone, so that most OTB representatives agreed to promote the selected technology. However, the acceptance of the UDDTs was low from the very beginning, and some families only constructed the toilets under the pressure from ADRA and the OTB representatives. Already during the construction, many inhabitants complained about the design of the toilets, for instance about the size and the steepness of the stairs.

As a consequence, many families stopped using the toilets without having access to an other toilet when they realised no collection service would come. Apparently, they preferred defecating in the open rather than handling the faeces themselves (see Section 4.1 for a more detailed analysis). Other consequences are the lack of maintenance of the toilets or the transformation of UDDTs into simple pit latrines, which was the preferred technology from the beginning.

With this past history, the OTB representatives are less willing to promote a new faeces collection service. The majority of the representatives, just as the residents, would prefer constructing pit latrines or ideally sewerage rather than UDDTs. Some of the representatives and residents are, however, still ready to use and promote the UDDTs as a temporary solution until a different technology is implemented.

Finally, it is important to recall the conflicts between and within the communities (see Section 3.4.1), further impeding the implementation of a new service for all OTBs.

Socio-cultural acceptance	
✓	Initial demand for the construction of toilets from the community
✓	Willingness of the OTB representatives to promote the technology selected by ADRA
✓	Success of ADRA's drinking water project (at short term) helped in building the resident's trust
≈	Tensions in the communities (between residents and Water Committees, between immigrants from the Altiplano and the Department of Cochabamba)
✗	Acceptance of the UDDTs limited from the beginning
✗	Lack of a collection service during more than a year further deteriorated the situation
✗	Lack of maintenance of the toilets
✗	Distrust in the work of NGOs as a consequence of the work of ADRA

3.6.7 Global evaluation of the enabling environment

Overall, the situation seemed favourable at the moment of construction of the UDDTs, with a demand for the construction of toilets coming from the community and support from the OTB representatives for the selected technology. As a consequence of ADRA's poor planning and the lack of active participation of the population during the process, the situation is more difficult now. Especially the limited funds and the low acceptance of the UDDTs are challenges for the implementation of a new faeces collection and treatment system.

At the same time, there is an explicit demand from the Mayor for the up-start of the treatment plant. Funds are limited, but reserved for the project. Moreover, the deterioration of the UDDTs is still reversible in many case.

Even though not all elements are favourable now, it might be the last opportunity to implement a collection service and start the treatment.

User perception of the UDDTs and the service options

Before drafting out possible service chains, it is important to summarise all factors that might influence the service options.

The key question we must answer to understand the perception of the residents towards the UDDTs and their service preferences are the following:

1. What were the motives to build the UDDTs and the factors that influence the current use?
2. What were the reasons to stop using the UDDTs?
3. What are the factors that influence the preferred type of collection service and the tariff system?
4. What are the priorities of the population with respect to drinking water and basic sanitation?

The analysis is based on the household surveys. In Section 3.3, we presented the data acquisition strategy. The questionnaires can be found in Appendix A and the data treatment and statistical methods (boxplot, Kruskal-Wallis test of significance, Pearson correlation) are presented in Appendix D.

Many questions don't include only two possible answers (yes or no), but offer answers on a scale from 1 to 5. The goal of this type of questions is to understand the perception of the situation and the factors influencing the current use in more depth. The way the questions are formulated is inspired by the RANAS approach (see Appendix A for a short introduction).

4.1 Factors influencing the current use of the UDDTs

Households without UDDTs

Almost all residents that already lived in the OTBs when ADRA implemented its toilet project built a UDDT. The 10 families we interviewed that don't have a UDDT mentioned the following reasons:

- They didn't live in the zone during the construction.
- They didn't want a UDDT because they already had a pit latrine.
- ADRA gave them the materials, but, as a consequence of bad experiences of the neighbours, they never started the construction works.
- ADRA promised to provide them with the construction materials, but left the project before handing them out.
- ADRA refused providing the materials, pretending the family didn't live in the zone permanently.

With the exception of the families that already had pit latrines, all surveyed practice open defecation. The interest in the construction of new UDDTs seems very low, since there is currently no faeces collection service. Some families have already started digging pits, other plan to build pit latrines in the future.

The vast majority of families permanently living in the OTBs own UDDTs. It is important to understand why they initially accepted ADRA's offer. Figure 4.1 presents the different types of motivations for building the UDDTs. A quarter of the population decided to build a UDDT to own their own toilet (no matter which type) and stop open defecation. Another quarter indicates they don't remember why they initially wanted a toilet. Every fifth mentions ADRA's good publicity: the drinking water provision worked (at least at short term), which helped in building confidence in ADRA's work. Moreover, ADRA actively promoted the selected technology that doesn't use water and produces compost, promising the collection system would work. For some, the only reason to build a UDDT was that they didn't have to pay anything for it. Every tenth surveyed resident felt under pressure from the OTB leaders, as the decision to build UDDTs had been taken at OTB level. Finally, a minority decided to build a UDDT to protect environment and health.

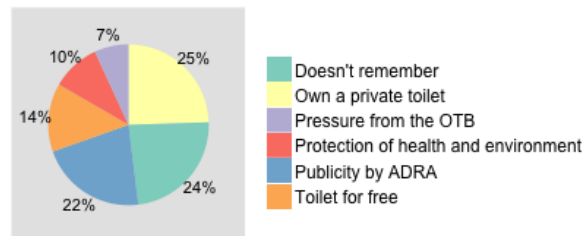


Figure 4.1: Motive for building a UDDT, based on the auto-declaration of the surveyed residents.

The motives can be divided into two types: intrinsic (own a toilet, protect environment and health) or extrinsic (toilet for free, publicity by ADRA, pressure from the OTB), which allows us to compare the influence of the motive on the current use of the UDDTs. Figure 4.2 shows that the current UDDT use is much higher among households that had an intrinsic motive to built the toilet: almost half of these households are still using the UDDTs, while it is less than 20% among those whose initial motive was extrinsic. This different is statistically significant with $p < 0.005$ (Kruskal-Wallis test). None of the households that felt under pressure from the OTB is currently using the UDDT. It is evidence that pressuring the population works only at short term: for a sanitation system to work at longer term, we need a real demand from the population.

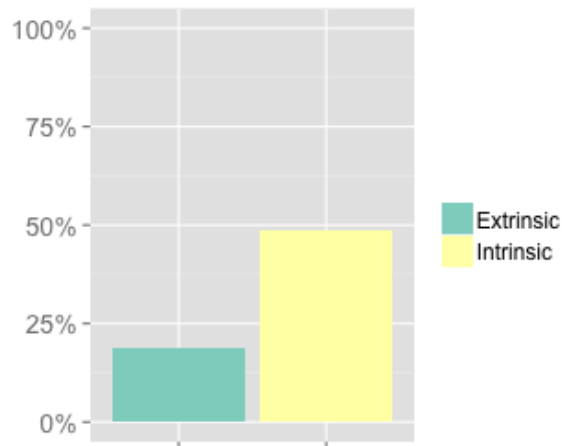


Figure 4.2: Current use of the UDDTs by type of initial motive: intrinsic (own a toilet, protect environment and health) or extrinsic (toilet for free, publicity by ADRA, pressure from the OTB).

It is interesting to compare which are the characteristic distinguishing the households currently using the toilets and those who aren't using them. We only present the factors for which the differences are statistically different ($p < 0.05$, Kruskal-Wallis test).

We can do two different comparisons:

1. Households using toilets (UDDT or pit latrine) and households practising open defecation
2. Households using UDDTs and households not using them (pit latrine or open defecation)

The first comparison helps us understand which are the key factors motivating some families to use toilets rather than practising open defecation, while the second one gives us more specific reasons for using UDDTs.

As presented in Figure 4.3, three characteristics are statistically different between the households using a toilet (UDDT or pit latrine) and those practising open defecation. First, the acceptance of open defecation is lower among those using a toilet. Apparently, an important motive to use a toilet is stopping defecating in the open. Second, the level of education is higher. In combination with the low acceptance of open defecation, we could imagine that the households using a toilet have a better knowledge of the related risks. Third, the households using a toilet are more satisfied with the current toilet situation.

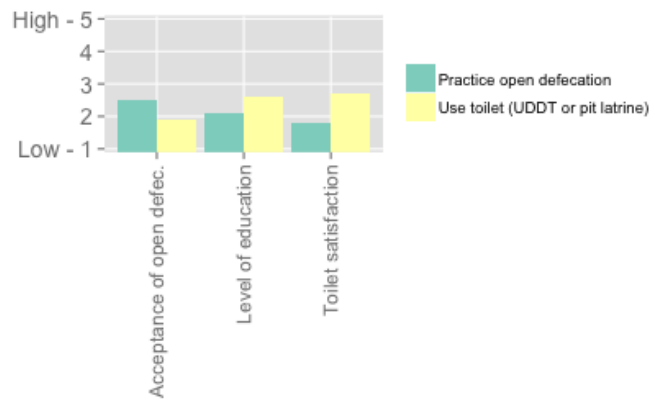


Figure 4.3: Differences between households using a toilet (UDDT or pit latrine) and households practising open defecation ($p < 0.05$, Kruskal-Wallis test). Scale from 1 to 5.

Figure 4.4 presents the differences between the households using UDDTs and those using pit latrines or practising open defecation. As before, the acceptance of open defecation is lower, which is linked to a higher feeling of disgust towards this practice. The level of education is higher, which might again be interpreted as a better knowledge of the problems caused by open defecation. It is interesting to observe that the households that are currently using the UDDTs experience less problems with smells. It is not possible to determine the reason definitely; possibly, the households that experience problems with smells stopped using them. Finally, smaller families have a higher probability to use the toilet, as it is easier to control the correct use of the toilet when there are fewer users. Moreover, the faeces buckets and urine jerrycans fill more slowly.

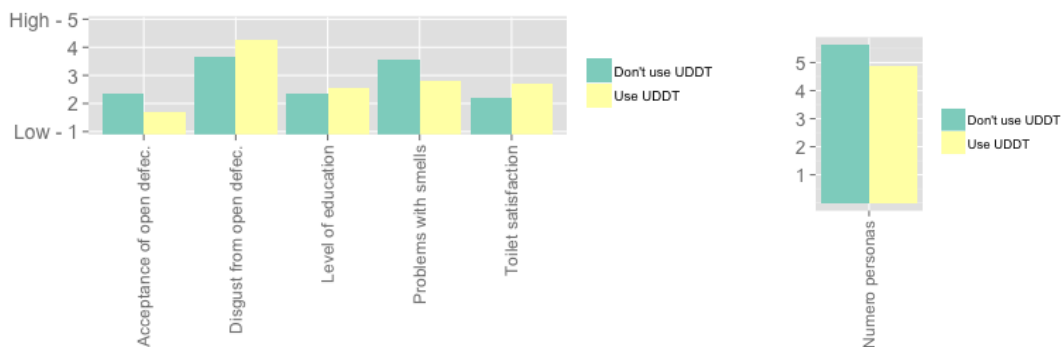


Figure 4.4: Differences between households using UDDTs and households using simple pit latrines or practising open defecation ($p < 0.05$, Kruskal-Wallis test). Scale from 1 to 5 (left) resp. number of people (right).

4.2 Reasons for stopping the use of the UDDTs

First, we can directly analyse the reasons the residents mention when asked about why they stopped using the UDDTs. Two thirds indicate the main reason was the absence of a collection service for the faeces. As a consequence, many families gave up their UDDTs when the promised service stopped after a month. For a fifth of the households, the smell was the main reason to stop using the UDDT. Others think that using the UDDT correctly is too difficult, especially for small children. All six families that rent their housing can't use the UDDTs because the owners won't allow it. It seems they want to avoid the tenants burying the faeces on the land parcel. Finally, some families prefer using the structure as a deposit or even as a kitchen, because they find those more valuable than a toilet.

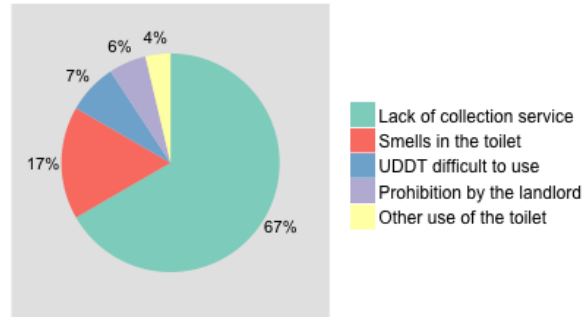


Figure 4.5: Reasons for ceasing the use of the UDDTs based on the auto-declaration of the surveyed.

We can also evaluate during how much time the families used the UDDTs. Figure 4.6 presents the percentage of users at five moments: at the end of construction work (time 0), at the end of ADRA's collection service (two weeks), after half a year, one year, and current use. We can see that not all families finished the constructions. There is an important decrease when the surveyed realised no collection service would come anymore. During the next six months, the decrease continues, as the problems with smells and flies begin, and family are not ready to eliminate the faeces themselves. After this strong decrease, the percentage of users stabilizes. Now, the slight decrease is mainly due to households transforming their UDDTs into pit latrines.

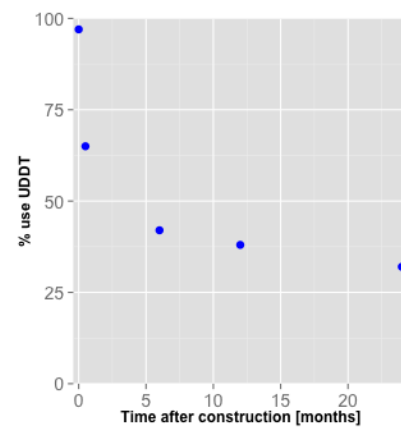


Figure 4.6: Change in the percentage of UDDT users over time.

As mentioned before, the main reason why the residents don't use the toilets is the absence of a collection service, which implicates they have to handle the faeces and urine themselves. The elimination of the faeces is a problem for most households, as they feel very disgusted by the direct contact (Figure 4.7). Handling the faeces is also an important physical effort, as many bury them in the dry and rocky soil. It is interesting that even though the median values are similar for the level of disgust and the physical effort, the distribution of the answers is much larger for the level of disgust. Probably, the condition of the faeces varies a lot from household to household; the households that have a low level of disgust indicate that the faeces are dry during the handling and hence don't smell. The urine is also a source of disgust, but to a lower degree than the faeces. Moreover, the physical effort of the elimination is reduced, since the vast majority doesn't dig holes as for the faeces. The distribution of the level of disgust is narrower than for the faeces. We could assume that there are less differences between the surveyed because the smell doesn't depend on the correct use of the toilet, as it is the case for the faeces.

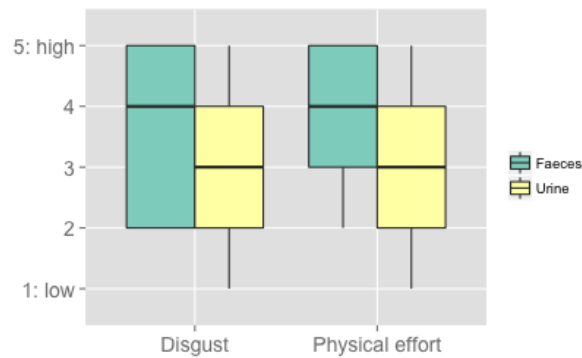


Figure 4.7: Disgust and physical effort linked to the handling of the faeces and urine, on a scale from 1 (low) to 5 (high).

4.3 Opinion about the type of service and tariff system

Two types of service are possible: a service on demand that can be called when the faeces buckets (and possibly the urine jerrycans) are full, or a service that comes at a given frequency. As presented in Figure 4.8, the preference of the surveyed residents is unambiguous: more than 75% of the population thinks a regular service would be best. The main reason is that they don't trust the service on demand would really work. However, many insist that the regular service would require a schedule stating the exact day and time the collectors come, since many families are at home only part of the day. The frequencies they mention lay between two times per week and once a month. For the majority, a frequency of twice a month would be adequate, which is just what ADRA promised.

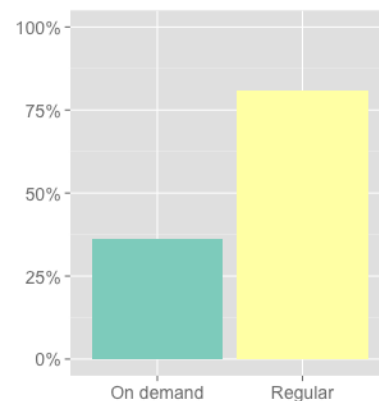


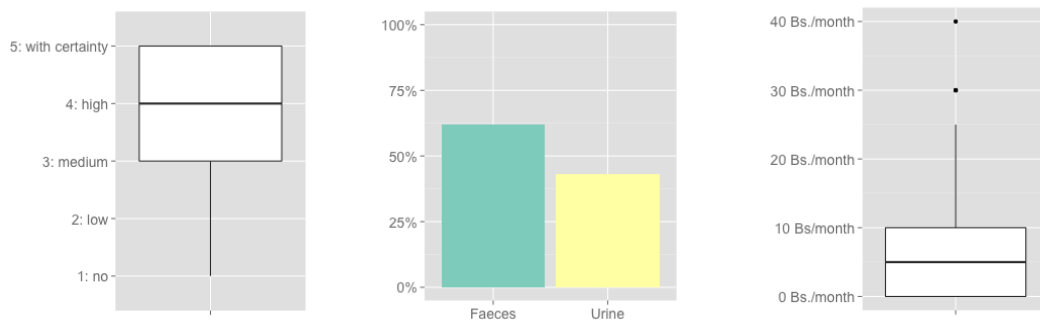
Figure 4.8: Preferred type of service: on demand or regular (possibility to chose both options).

The majority of the surveyed residents have a high willingness to use the service or would definitely use the service (Figure 4.9a). There are four factors that have a significant correlation with the willingness to use the service:

- + **Use of the UDDT:** Pearson correlation **+0.21**. The households currently using the

UDDTs have a higher willingness to use a collection service.

- + **Level of education:** Pearson correlation **+0.21**. The surveyed with a higher education level also have a higher willingness to use a collection service. This result might be linked to the higher proportion of better educated people using the UDDTs (see Section 4.1).
- **Smells in the toilet:** Pearson correlation **-0.37**. The households that have or had smells in the toilet have a lower willingness to use the collection service.¹
- **Flies in the toilet:** Pearson correlation **-0.28**. The same observation made for the smells are also valid for the flies in the toilet.



(a) Willingness to use a collection service for the faeces and urine, on a scale from 1 (low) to 5 (high).

(b) Percentage of surveyed residents willing to pay for a collection service for the faeces and for the urine.

(c) Maximum monthly tariff that the surveyed residents are ready to pay for a collection service.

Figure 4.9: Willingness to use and to pay for a collection service and maximum tariff.

Figure 4.9b shows that more people are ready to pay for a collection of the faeces than for the urine. This result is linked to the previous section: people find it more disgusting and more physically challenging to eliminate the faeces than the urine (Figure 4.7). It is important, though, to note that most survey stress they'd only pay for a reliable service and stop paying if the service doesn't meet this condition.

The definition of a maximum tariff is more sensitive, and roughly a third of the surveyed refuses to answer the question, mainly because it should be addressed in an OTB reunion. As shown in Figure 4.9c, the tariffs mentioned vary by one order of magnitude. The median tariff is low, around 5 Bs./month, but there is one family that would be ready to pay up to 40 Bs./month for someone to collect their faeces. Three quarters of the population would pay less than 10 Bs./mes. Similarly to the willingness to pay, we can analyse the factors that influence the maximum tariffs the households are ready to pay.

¹We could also have imagined a positive correlation, since a frequent service would help reducing the smells. However, the surveyed apparently didn't make this link, so that a deeper sensitisation might be helpful.

There are four factors that have a significant correlation with the maximum tariff:

- + **Use of the UDDT:** Pearson correlation **+0.36**. The households that are currently using their UDDT are ready to pay more for a collection service.
- + **Level of education:** Pearson correlation **+0.38**. The households with a higher level of education are ready to pay more for a collection service.
- + **Possession of a fridge:** Pearson correlation **+0.28**. The households with a higher living standard are ready to pay more for a collection service.
- + **Willingness to pay for a collection service:** Pearson correlation **+0.37**. The households that have a high willingness to use a collection service are ready to pay more for a collection service.

It is interesting to note that the tariff does not depend on the collection frequency: there are households that want the service to come twice a week that'd pay much less than those who'd also accept the service to come only once a month.

Finally, we can relate the tariff for a collection service with the spending capacity. Many families that use a toilet (UDDT or pit latrine) use toilet paper. For a family using two rolls a week for a unit cost of 1.50 Bs., this sums up to a monthly cost of 12 Bs. The price for a 2L bottle of a popular softdrink (for instance Coca Cola) is around 10 Bs., and many families regularly buy softdrinks. The difficulty when establishing a tariff probably isn't primarily the spending capacity, but the motivation of the users to pay for this type of service, leading us to the conclusion that the sensitization of the population and adequate communication strategy are key factors.

4.4 Perception of the current situation and establishment of priorities

It is important to evaluate if the operation of the UDDTs is a priority for the residents, or if there are more urgent problems. We can also analyse whether the prioritisation is linked to the level of satisfaction with the services.

Figure 4.10 presents the level of satisfaction with the three topics. In average, the residents are more satisfied with the water provision (2.7/5) than with the toilets (2.4/5) and the solid waste management (1.8/5). However, these average values don't provide any information about the distribution of the answers. Figure 4.11a presents the results as box-plots. While the distribution of answers is narrow for the waste management and the toilets, there is a much wider distribution for the water provision. Figure 4.11b shows the results for the water provision by OTB. We can easily distinguish the three groups already determined earlier (see Section 3.4.1). In the OTBs Villa Montes and Yuraj Jallpa, where the water

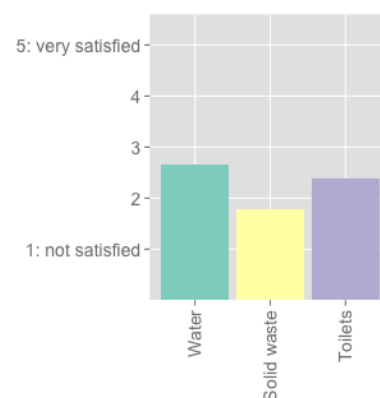
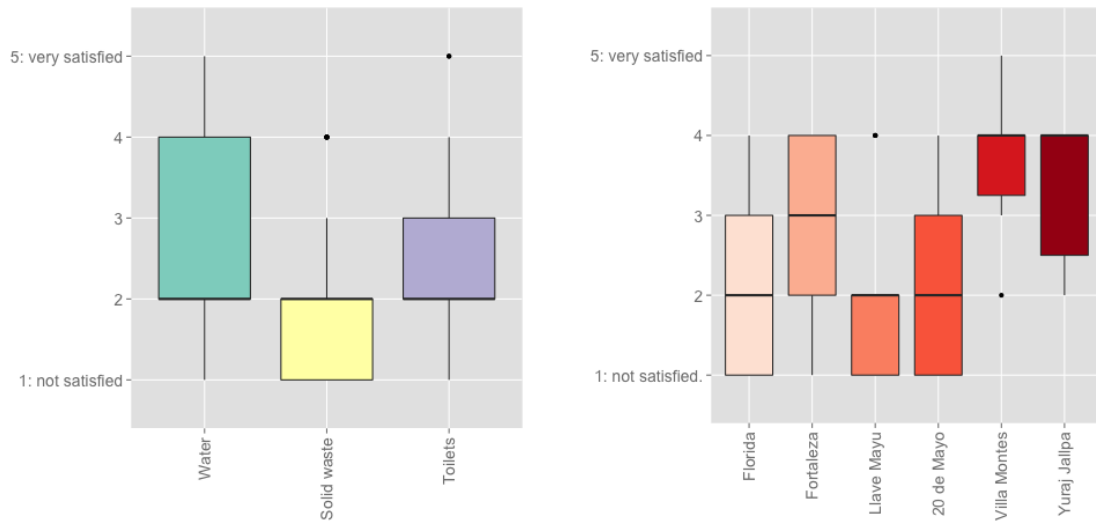


Figure 4.10: Average satisfaction with the current situation: water provision, solid waste management and toilets, scale from 1 to 5.

provision is constant, in median the residents are satisfied with the situation. In the OTB Fortaleza, where there is water every day, the residents are relatively satisfied. On the other hand, the vast majority is unhappy with the current water provision in the OTBs Llave Mayu, 20 de Mayo and Florida.



(a) Overall results: water provision, solid waste management, toilets.

(b) Results by OTB: water provision.

Figure 4.11: Satisfaction with current situation: water provision, solid waste management and toilets, on a scale from 1 (low) to 5 (high) (boxplot).

In view of these results, we could imagine that the priority of the residents is the improvement of the solid waste management or the toilets, at least in the OTBs where the population is relatively satisfied with the water provision. It is surprising that, independently of the OTB, water provision is the priority, as presented in Figure 4.12. The reason lays in the importance of water provision for the residents. While they can find solutions at household level when there is no waste collection (burn it, dump it) or when there's no collection of the faeces (bury them, build pit latrines, or defecate in the open), they are dependent on the constancy of the water provision. This credo of "water first" is important when developing service scenarios for the faeces collection, since the residents seem less ready to discuss the UDDTs before the water crisis is not resolved. Once again, an adequate communication strategy is key: while major investments are necessary to resolve the water problem, a faeces collection service can be implemented comparatively easily, paying a small monthly fee.

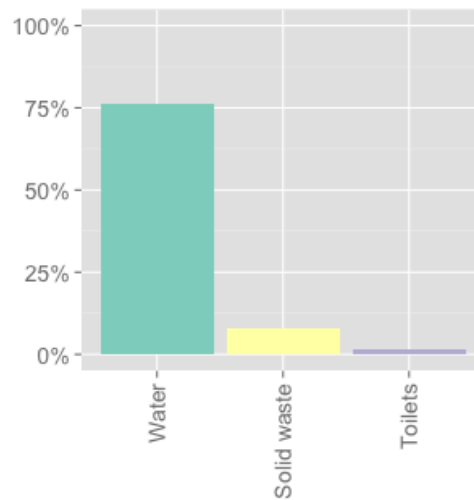


Figure 4.12: Priority: water provision, solid waste management or toilets.

Lessons learnt from other projects

In this chapter, we present the parallels between the case of Arbieto and other projects that could serve as models, or, on the contrary, allow us to avoid committing the same errors:

- Composting plant in Tiquipaya
- UDDT projects implemented by the Fundación Aguatuya in Cochabamba
- UDDT project implemented by the Fundación Sumaj Huasi in El Alto

5.1 Composting plant in Tiquipaya

The visit was accompanied by Denis Sanchez, who is in charge of the composting plant in Tiquipaya.

The Municipality of Tiquipaya, situated directly to the west of the Municipality of Cochabamba, has a population of around 54'000 inhabitants (INE, 2012) and is part of the city's agglomeration. Solid waste management is under the responsibility of the *Unidad de Gestión Integral de Residuos Sólidos* (GIRS, Unit for the Integral Management of Solid Waste). As in Arbieto, there is no sanitary landfill and the main motivation to build the composting plant in 2006 was the reduction of the quantities of solid waste needed to be disposed off. The plant was modified and modernized with the help of the *Diputación de Barcelona* (Province of Barcelona) who invested more than 440'000 Bs. in equipment in 2015.

The plant has a capacity of up to 8 tons of organic waste a day, using thermo-composting with forced aeration (Figure 5.1a). They also have an area for lombriculture, but the goal of this type of treatment is mainly educational (Figure 5.1b). In total, there are nine employees working in the plant, four of which part-time. The composting plant currently treats around 3.5 tons of organics per day, that provide principally from the Municipality and the markets. Since the beginning of 2016, there is also a door-to-door collection of the organic waste in one of the Municipality's district. This service has been accompanied by an education campaign explaining the correct separation of the waste. The acceptance of the service is

relatively good, even though behaviour change is a large process and there are frequently plastics and other inappropriate materials in the collected organic waste.



(a) Thermo-composting with forced aeration.



(b) Lombriculture.

Figure 5.1: Composting technologies in the plant of Tiquipaya

Annual costs are around 150'000 Bs. Currently, the *Diputación de Barcelona* covers a part of the costs, but this support will soon come to an end. The Municipality is looking for an other source of foreign income, as they are not willing to cover all costs themselves. The plant generates only 10'000 Bs. of yearly income from the compost sales (average price of 120 Bs./m³), as most of the compost is reused directly by the Municipality. Apparently, the demand for compost is high in the region, as the local farmers know about its quality as a soil conditioner. The residents don't pay for the door-to-door collection of their organics, and Denis Sanchez doesn't believe the introduction of a tariff to be a realistic option at the current stage. As a consequence of a poor coordination with ELFEC, the inhabitants do not pay any tax for the waste collection service as part of their electricity bill either.

There is a project for a sanitary landfill shared by seven municipalities that form the metropolitan region Kanata (*Región Metropolitana de Kanata*): Sacaba, Cercado, Tiquipaya, Colcapirhua, Quillacollo, Vinto and Sipe Sipe. The municipalities will cover the costs proportionally to their waste generation, so that Tiquipaya's interest in reducing its organic waste persists. However, the problem of financing the composting plant continues, and there is a lack of political will to implement a tariff system. Added to which there is a poor maintenance of the equipment. Currently, the shredder is out of service, thus preventing the treatment of most waste coming from the public parks and green areas (Figure 5.2).



Figure 5.2: Accumulation of organic matter after the shredder broke down.

Lessons learnt for a collection service in Arbieto's District 4

- ✓ The Municipality has a strong interest in reducing the quantity of solid waste they have to dispose off in a sanitary landfill.
- ≈ It is indispensable to train the population in the correct separation of waste, but even so, the time required for behavioural changes can be long.
- ✗ It is challenging to get municipal funds for the operation of the composting plant and to implement a tariff system for the collection service.
- ✗ Good maintenance of the equipment is key for the treatment plant is to operate at medium and long term.

5.2 UDDT projects implemented by the Fundación Aguatuya in Cochabamba

The visits in the OTBs Higuera and 22 de Febrero were accompanied by Antonio Becerra and Gustavo Heredia from the Fundación Aguatuya.

The OTB Higuera, where the Fundación Aguatuya executed a UDDT project in 2010, is located in District 9 of the Municipality of Cochabamba, approximately 13 km from the city center. Most of Higuera's inhabitants live from agriculture.

Following the resident's request, Aguatuya initially offered two toilet technologies: UDDT or flush toilet. Each family could select its preferred option; both included a shower and a washbasin (Figure 5.3). 30% of the families opted for the dry toilets, most of them because they liked the idea of producing their own soil conditioner, but some also out of curiosity. The families had to pay for the workforce (mason) and provide local construction materials. With financing from UNO Habitat and the Municipality of Cochabamba, the Fundación Aguatuya provided the materials corresponding to the selected technologies (e.g. toilet bowls, washbasins, etc.). The composting of the faeces was supposed to be organized at OTB level, while the urine was to be used at household level.



Figure 5.3: Design of the bathrooms in the OTB Higuera: UDDT (back) and shower (front), foto taken by the Fundación Aguatuya.

Currently, none of the toilets work as a UDDT: only a short while ago, the last family changed the design so that its toilet works as a pit latrine. The organization of the communal composting never worked, and most families forgot how the urine can be used as a fertilizer. The OTB recently drilled a new well, and with the water supply now being constant and water prices going down, the UDDTs lost its main advantage over the flush

toilet. Nonetheless, the families seem to be happy with the current design of their toilets.

The OTB 22 de Febrero is located in the south of the city of Cochabamba, at around 18 km of the city centre. The context is very similar to Arbieta's District 4. The area is located on a hill and poorly accessible. The majority of the families are migrants from rural zones of Cochabamba and other departments of Bolivia. Many men work in the construction sector, frequently as masons. There is no piped water network, and the residents depend on water from water trucks.

Aguatuya agreed to finance the materials (toilet bowl, ventilation, buckets and jerrycans) for 40 UDDTs, but the demand was even lower. Finally, only around 10 toilets were built in 2010 (Figure 5.4). Aguatuya's idea was to help forming a micro-company responsible for the collection and treatment of the faeces in the city. Due to the distance and the difficult access, however, the company never came to the project zone. The company rented an area for the composting, but since there were only few UDDTs, the business was not profitable. Currently, no family uses its UDDT in the OTB 22 de Febrero and, just as in Arbieta, they don't maintain the toilets correctly. The families we met all assert they stopped using the UDDTs for the lack of a collection service and would start using them again if there was a service. As there is no piped water in the zone, no-one changed the design of the UDDTs into flush toilets. They still like the technology of the dry toilet, as it allows them to save water, which is very expensive in 22 de Febrero (35 Bs./m³, similar to Arbieta).



Figure 5.4: Design of the UDDTs in the OTB 22 de Febrero.

Lessons learnt for a collection service in Arbieta's District 4

- ✓ The residents are still in favour of UDDTs when there is no reliable and affordable water supply, because the technology doesn't need water.
- ≈ The residents only use the UDDTs if there's a collection service.
- ✗ Organizing the composting at OTB level doesn't seem to work at medium and long term, as the initial motivation of the residents in charge of the treatment decreases rapidly.
- ✗ Implementing a collection service that is financially sustainable is a challenge and, due to the high fixed costs, only is profitable if there is a sufficient number of users.
- ✗ The residents accept the technology of a dry toilet only as a temporary solution until they can implement a flush toilet.

5.3 UDDT project implemented by the Fundación Sumaj Huasi in El Alto

The visit was accompanied by Carlos Suntura, project coordinator for the Fundación Sumaj Huasi.

Sumaj Huasi launched a first UDDT pilot project in 2006 in El Alto's District 7. Initially, they focussed on the most precarious zones. The demand was, however, very low and the project a failure. They realized that there was a much higher demand in more urbanized zones (see Figure 5.5), mainly because of the lack of spots that the residents could use for open defecation. Finally, the success of the UDDTs in these urbanized zones helped in creating demand in the poorer parts of the District.



Figure 5.5: Sumaj Huasi's working zone: peri-urban zone in El Alto (District 7).

Since then, Sumaj Huasi has built 1'200 UDDTs in El Alto's Districts 7 and 9. All toilets have a shower, a washbasin and a small household garden where the greywater is reused after passing through a grease trap. Sumaj Huasi financed the toilet bowl and the ventilation and offered technical assistance for the construction. The interiors of the toilets depends on the preferences and financial capacity of the families, but many were willing to invest time and money for the toilets to look attractive (Figure 5.6). The families we spoke with were all very satisfied with the UDDTs and the collection service.



Figure 5.6: Interior of one of Sumaj Huasi's UDDTs.

From the 1'200 families that own a UDDT, currently 600 use the collection service for the faeces and urine. The service comes once a week and the families are required to use paper bags in the buckets to reduce the time needed to clean them. In order to reduce smells in the toilet, Sumaj Huasi promoted sawdust as a drying material. The prices for sawdust have, however, substantially risen as a consequence of the increased demand. They are now similar to the prices in Arbieta (5 Bs. per month) when the residents could get the material for free in the beginning.

The users of the collection service pay 10 Bs./month independently of how many times a month they use the service and independent of the zone they live in. In contrast, the real transport costs per user are around 3 times higher. Implementing a tariff was a long process,

as the service was initially for free. Many residents only agreed to pay for the service because they trusted Sumaj Huasi who had provided a reliable and regular service for years before asking for a contribution from the users. The current tariff is a compromise between the tariff that Sumaj Huasi initially wanted (15 Bs./month) and what the residents agreed on during OTB reunions.

The micro-enterprise responsible for the collection and treatment has five employees. The treatment of the faeces uses lombricomposting without adding any other materials with a treatment time of around a year. The urine ferments during three months (Figure 5.7a). Initially, the demand for the compost and the fermented urine was so low that Sumaj Huasi had to give it away for free during the first years of the project. It is only as a result of the good experiences the local farmers made during this period that they can now sell it for a price of 60 Bs./45 kg. Figure 5.7b presents a lettuce production located at 500 m of the treatment plant, using compost sold by Sumaj Huasi.



(a) 5000 L storing tanks for the urine in Sumaj Huasi's treatment plant.



(b) Use of compost in a lettuce production in El Alto's District 12.

Figure 5.7: Urine treatment and use of the compost in Sumaj Huasi's UDDT project.

Lessons learnt for a collection service in Arbieto's District 4

- ✓ It is advisable to start with a service in areas that are more concentrated and better organized. From there, the service can be extended to more precarious zones.
- ≈ The implementation of tariffs for the collection service and for the compost sales is a long process and only works once the users have trust in the product.
- ✗ Covering the costs only through user tariffs doesn't seem realistic.
- ✗ Even though it is reliable and subsidized, only half the population currently uses the collection service.

Service chain scenarios

Based on the results from the survey, where we identified the absence of a solid waste collection service, we developed two main service scenarios:

- 1 **Collection of the faeces**
- 2 **Collection of all solid waste¹**

Besides the improvement of environmental conditions, there are practical reasons why it might be advisable to include the collection of all solid waste:

- It is politically difficult to provide a service that only serves part of the population, as it is the case of a faeces collection service
- The fixed costs of the service can be distributed among more users, so that the costs per user are lower
- The co-composting of the faeces and the organic waste produces better quality compost

At this stage of the project, the collection of the urine is not included for the following reasons:

- The **quantity** of urine produced requiring a high collection frequency, thus considerably adding to the costs
- The **investment** required for buying storage tanks for the urine (or another type of treatment)
- The low **willingness to pay** for this type of service as a consequence of a lower level of disgust and less physical effort required for the elimination of the urine

¹In this report, the term solid waste includes organic waste, recyclables (plastics, glass, paper, metal), not usable residues, as well as the faeces.

Within the two main scenarios, we can imagine two transport options:

- a **Door-to-door** collection
- b Collection in **collection points**

On one hand, the service with collection points doesn't only offer more flexibility in the organization of the collection (no precise schedule required), but also has the advantage for the users that don't have to be at home for the collection. On the other hand, the motivation of the users to cross the OTB with their faeces buckets is probably very limited. Overall, the door-to-door collection seems the more convenient option for the users. Moreover, it offers the possibility of a direct contact between users and service providers. This contact allows for a better justification why the users have to pay a tariff for the service. It also allows the implementation of a tariff collection system and a direct feedback on user satisfaction.

The sanitation system for scenario 1a (named as in the classification above) is presented in Figure 6.1. The other tree systems (scenarios 1b, 2a and 2b) can be found in Appendix E. These four scenarios are analysed in more detail in the following sections. A summary of all alternatives of each aspect of the service chain and organizational models of the scenarios can be found in Appendix F and Appendix G.

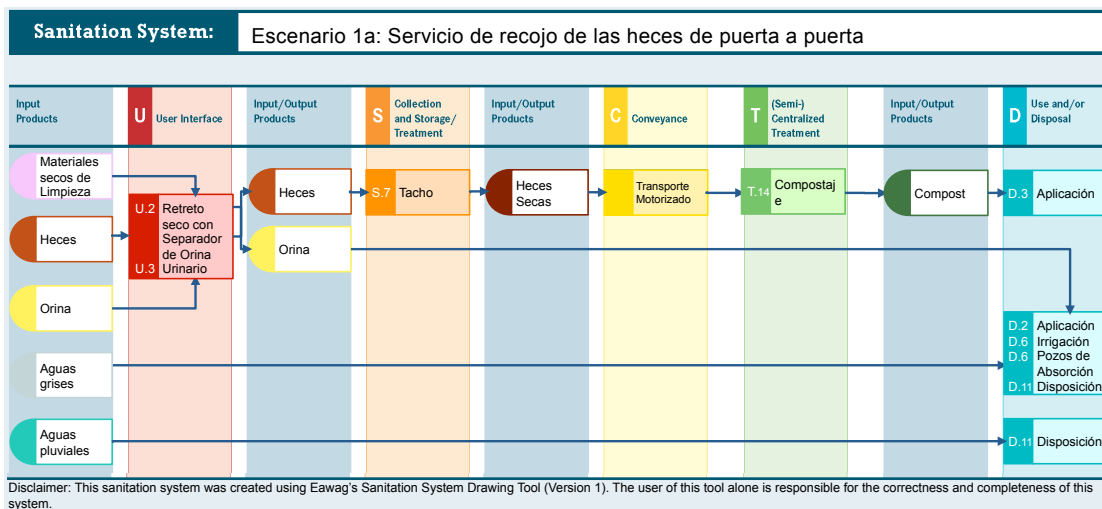


Figure 6.1: Sanitation system for scenario 1a (door-to-door collection of the faeces).

6.1 Working hypotheses

In this section, we present the hypotheses related to the transport, treatment and sales data that form the base of the costs calculations for each of the service scenarios.

The calculations correspond to the real costs of the service, including the amortization of the equipment, the vehicle and the treatment plant. Some of the costs are fixed (F), while others depend on the number of users of the service and are hence variable (V). **The calculations don't include costs related to the launch of the service.**

Costs not included: launch of the service

- Initial equipment of the treatment plant (water and electricity connection, acquisition of additional buckets)
- Reparation of toilets, implementation of direct infiltration of the urine, change of the design of the toilets in the OTB Yuraj Jallpa^a (see Section 3.2)
- Coordination with the OTBs to choose the most adequate service option
- Sensitization of the users about the service and the tariff system
- External support for the upstart of the lombricomposting

^aCurrently, some families use the toilets with buckets, but they lack a door for an easy access to the faeces chamber.

The **baseline data** includes the number of residents and UDDTs, the production of solid waste (including faeces) and the salary data.

Baseline data

- The number of residents is based on the number of members of each OTB, multiplied with the average number of members per family (5.4, result from the survey). This number is most probably overestimated, as not all members of the OTBs live permanently in the zone (see Section 3.4.3).
- The number of UDDTs corresponds to the number for which ADRA provided the materials. However, not all families actually finished the construction (Section 3.4.3).
- The quantity and composition of the solid waste is based on a study for the urban center of Arbiesto. We could imagine that the waste production is lower in District 4, as many residents aren't at home during the day.
- The salaries correspond to the minimum salary in Bolivia (2016). They include a (compulsory) bonus called *aguinaldo* and the social security contributions (*aportes sociales patronales*^a). We assume that the operators are employed only for the working time for which they are actually required. If the Municipality prefers employing them full-time, they would have to take on other public tasks.

^aIncludes AFP Riesgo Profesional, Aporte Vivienda, Fondo Solidario, Caja Nacional

Transport costs depend principally on the transport and collection distances. They are composed of vehicle and personal costs. In Scenario a (door-to-door collection), the vehicle only passes the roads that are in a good state. The collection is organized in five tours (joint tours for 20 de Mayo/Florida and Cristal Mayu/Fortaleza). In Scenario b, the number of collection points was chosen in order to ensure that each family is located at less than 200 m from the nearest point. Based on this criterion, we need 20 collection points that can be emptied in 14 tours. The maps of the five collection tours can be found in Appendix H and

the localization of the collection points in Appendix I.

Transport costs
<p>Vehicle costs</p> <ul style="list-style-type: none"> F Amortization, maintenance and vehicle insurance V Consumables (gasoline, motor oil, tyres) depending on the transport distance <p>Personal costs</p> <ul style="list-style-type: none"> V Working hours for the transport, depending on the transport distance V Working hours for the collection, cleaning of the faeces buckets and administration (tariff collection), depending on the number of users V Costs for working clothes and protection gear depending on the number of employees <p>To this, we have to add the costs for the water required to clean the buckets.</p>

The **treatment costs** include costs related to the treatment plant and to the employees.

Treatment costs
<p>Costs related to the treatment plant</p> <ul style="list-style-type: none"> F Amortization and maintenance of the plant F Electricity <p>Costs related to the employees</p> <ul style="list-style-type: none"> V Working hours for the treatment depending on the quantity of waste (faeces, organics) treated and the composting time V Costs for working clothes, protection gear and tools depending on the number of employees <p>To this, we have to add the cost for the water required to humidify the compost.</p>

The current **composting pits** aren't sufficient to treat the faeces and the organic waste, so that the construction of additional pits is necessary. The construction costs are transformed into amortization costs.

Amortization costs for the composting pits
<ul style="list-style-type: none"> V Amortization of the additional composting pits depending on the number of users and the treatment time

The service can generate **revenues** from the compost sales and, depending on the scenario, the sales of recyclables. We suppose that all compost produced can be sold, but only part of the recyclables meets the quality requirements for the sale.

Revenues from the sales of compost and recyclables

- ✓ Revenues from the sales of compost depending on the quantities of faeces and organics, as well as the market prices
- ✓ Revenues from the sales of recyclables, depending on the quantity of recyclables and the market prices
- ✓ Administration costs for the sales^a

^aThe costs for the separation of the recyclables are not included, as we suppose that this is done directly in the households. However, we include time during the collection tour to verify the correct separation of the recyclables.

The collection frequency isn't part of the working hypotheses, because the goal is to adapt the frequency in case the vehicle capacity is insufficient during the collection. All minor hypotheses and the exact values of the parameters used are listed in Appendix J.

6.2 Cost calculations

Based on the hypotheses presented above, the costs for each scenario are calculated, which can be done per household (Figure 6.2) or per volume of treated material (Figure 6.3). The calculated costs correspond to a service that comes once a week and are presented in function of the percentage of users of the service:

- Scenario 1: total of **458 households** (number of households owning a UDDT)
- Scenario 2: total of **864 households** (total number of households living in the zone)

The costs are lower if all solid waste is collected (scenario 2) for the two following reasons:

- A larger number of potential users, dividing the fixed costs among more households
- Revenues from the sales of recyclables

We also note that the scenarios with collection points only are worthwhile for a large number of users. For instance, scenario 2b (collection of faeces and solid waste in collection points) is more cost-effective than scenario 2a, since the number of potential users is large. This is not the case for scenario 1b (collection of the faeces in collection points) that remains more expensive than scenario 1a (door-to-door collection of the faeces), because the number of clients is limited.

For a large number of users, scenario 2b (collection points) is most cost-effective, as the fixed costs are divided between all users. If more than 80% of the households can be convinced to use the service, it could be financially auto-sustainable.

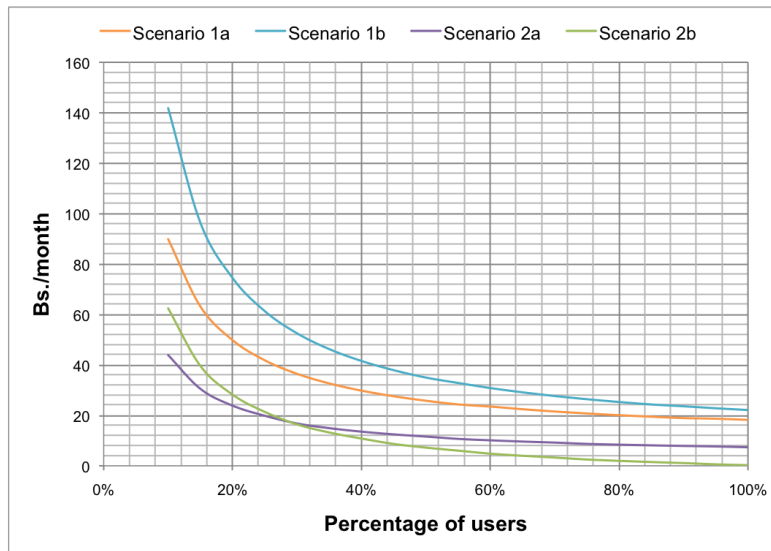


Figure 6.2: Costs per household for four service scenarios as a function of the percentage of user for a collection frequency of once a week. 1a: Door-to-door collection of the faeces. 1b: Collection of the faeces in collection points. 2a: Door-to-door collection of the faeces and solid waste. 2b: Collection of the faeces and solid waste in collection points.

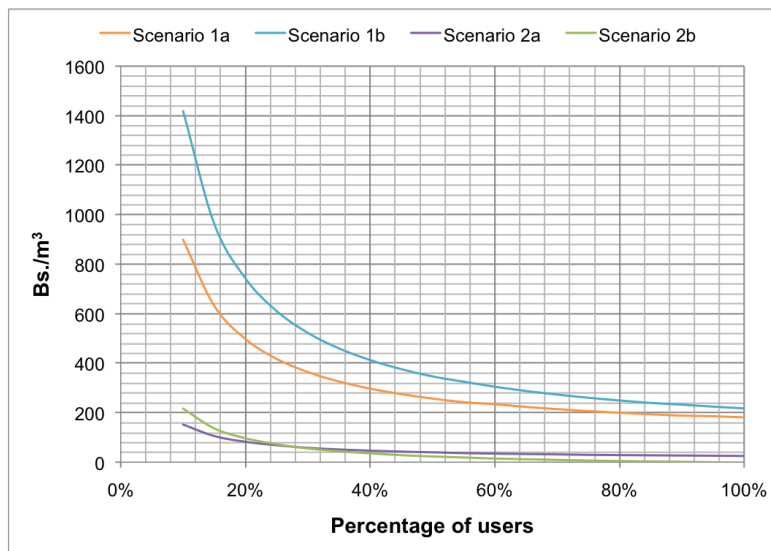


Figure 6.3: Costs per treated volume (faeces and organics) for four service scenarios as a function of the percentage of user for a collection frequency of once a week. 1a: Door-to-door collection of the faeces. 1b: Collection of the faeces in collection points. 2a: Door-to-door collection of the faeces and solid waste. 2b: Collection of the faeces and solid waste in collection points.

However, we haven't checked yet whether the capacities of the vehicle and the treatment plant are sufficient. It is, for instance, possible that the surface of the plant isn't sufficient for co-composting the faeces and solid waste, or that the transport volume of the vehicle is smaller than the quantity of waste produced.

6.3 Verification of the capacity

For the collection service, ADRA bought a van with a transport capacity of around 2.5 m³. Figure 6.4 presents the average filling of the vehicle for each scenario for a collection frequency of once a week. This average filling doesn't take into account that the number of clients served depends on the tour (that is: for some tours there are more users than for others). This problem can, however, be solved by optimizing the tours to ensure that the number of users is similar for each. Clearly, the vehicle capacity is insufficient for the combined collection of faeces and solid waste (scenario 2). We can reduce the average filling by increasing the collection frequency.

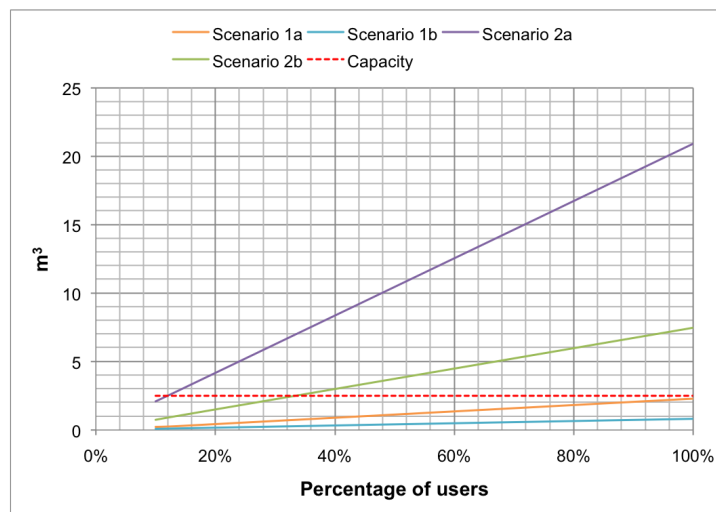


Figure 6.4: Average filling of the vehicle as a function of the percentage of user for a collection frequency of once a week. 1a: Door-to-door collection of the faeces. 1b: Collection of the faeces in collection points. 2a: Door-to-door collection of the faeces and solid waste. 2b: Collection of the faeces and solid waste in collection points.

Figure 6.5 presents the results for a service that comes twice a week in the case of scenario 2 (collection of faeces and solid waste). The capacity is still insufficient in the case of a door-to-door collection (2a). In contrast, the service could reach up to 80% of the households for the scenario with collection points (2b). Figure 6.6 presents the new monthly costs per household. We can see that scenario 2a loses its economic advantage even though the capacity still isn't sufficient. Scenario 2b remains the most economically most favourable option.

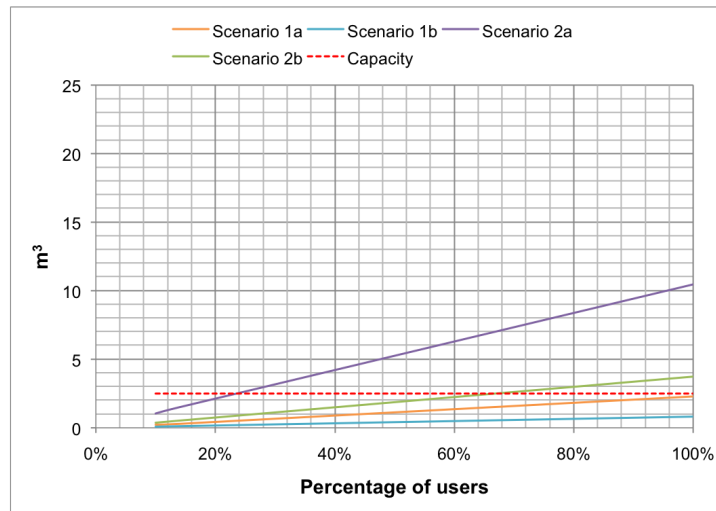


Figure 6.5: Average filling of the vehicle as a function of the percentage of user for a collection frequency of once a week (scenario 1) respectively twice a week (scenario 2). 1a: Door-to-door collection of the faeces. 1b: Collection of the faeces in collection points. 2a: Door-to-door collection of the faeces and solid waste. 2b: Collection of the faeces and solid waste in collection points.

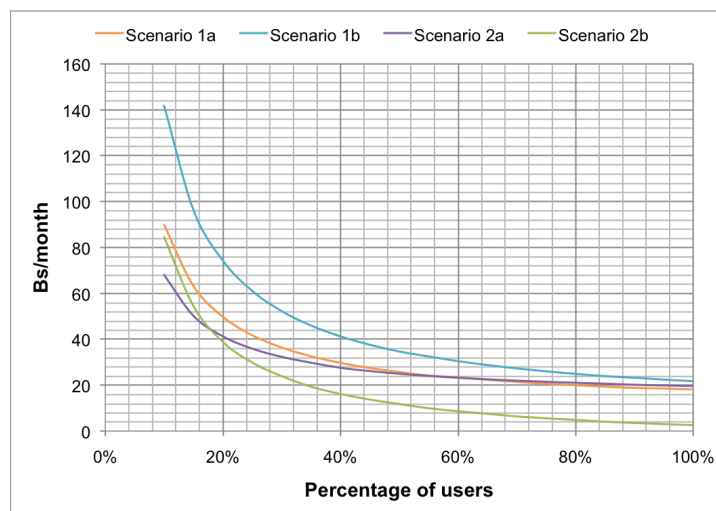


Figure 6.6: Costs per household for four service scenarios as a function of the percentage of user for a collection frequency of once a week. 1a: Door-to-door collection of the faeces. 1b: Collection of the faeces in collection points. 2a: Door-to-door collection of the faeces and solid waste. 2b: Collection of the faeces and solid waste in collection points.

All scenarios include the construction of new composting pits, as the current capacity of the plant is insufficient. It is necessary to check whether the available surface is sufficient for their construction. Currently, roughly a quarter of the total surface is constructed. If we use half the plant's surface for new pits, a quarter remains for all other activities (cleaning the buckets, sieving and storage of the compost, etc.). In Figure 6.7, we compare the additional required surface and the available surface. The plant capacity is clearly not sufficient for co-composting the faeces and the organic waste (scenario 2). **With the current plant, it is not possible to treat the organic waste.**

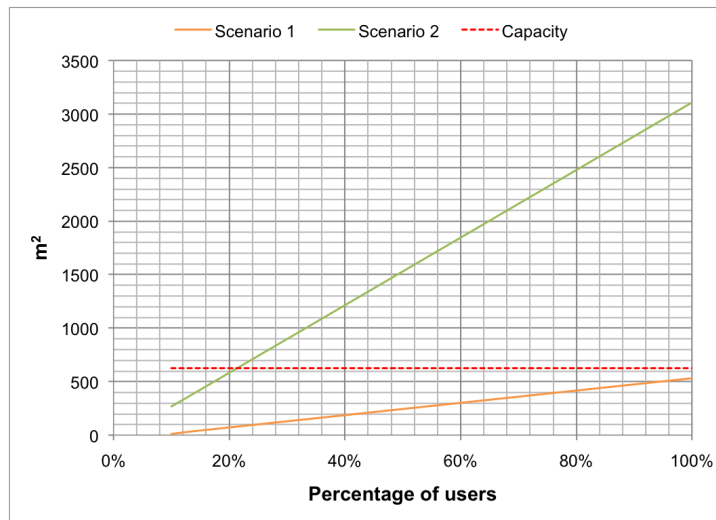


Figure 6.7: Comparison of the required surface for the construction of new composting pits and the available surface. 1: Collection of the faeces. 2: Collection of the faeces and solid waste.

The main advantages and limits of each of the service scenarios are summarized in Figure 6.8.

	Door to door	Collection points
Faeces	<ul style="list-style-type: none"> ✓ Convenient service ✗ Reduced number of clients 	<ul style="list-style-type: none"> ✓ Simple organisation ✗ Reduced number of clients ✗ High fixed costs ✗ Limited acceptance of the clients
Faeces and solid waste	<ul style="list-style-type: none"> ✓ Serves all residents ✓ Convenient service ✗ Insufficient plant capacity ✗ Insufficient vehicle capacity 	<ul style="list-style-type: none"> ✓ Serves all residents ✓ Simple organisation ✓ Cost-effective service ✗ Insufficient plant capacity ✗ Limited acceptance of the clients

Figure 6.8: Summary of the main advantages and limitations of the four service scenarios.

Conclusion

Given the insufficient vehicle capacity and the limited surface of the treatment plant, only the faeces can be treated (scenario 1). Scenario 1a (door-to-door collection) is not only more convenient for the clients, but also more cost-effective since the high fixed costs are divided among few users in scenario 1b (collection points). **In conclusion, a door-to-door collection of the faeces is the only option that seems realistic.**

6.4 Tariff system

The Municipality should cover at least a part of the costs, as providing sanitation services falls under its responsibility and it receives national funding to fulfil its obligations. However, the users also have to pay a tariff for the service. In the following calculations, we will assume a single tariff per household. Figure 6.9 presents the total annual costs for the Municipality as a function of the number of users and the tariff they pay for a door-to-door collection of the faeces.

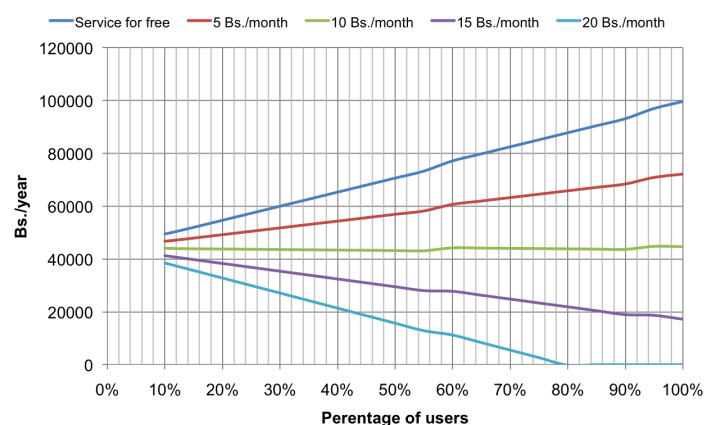
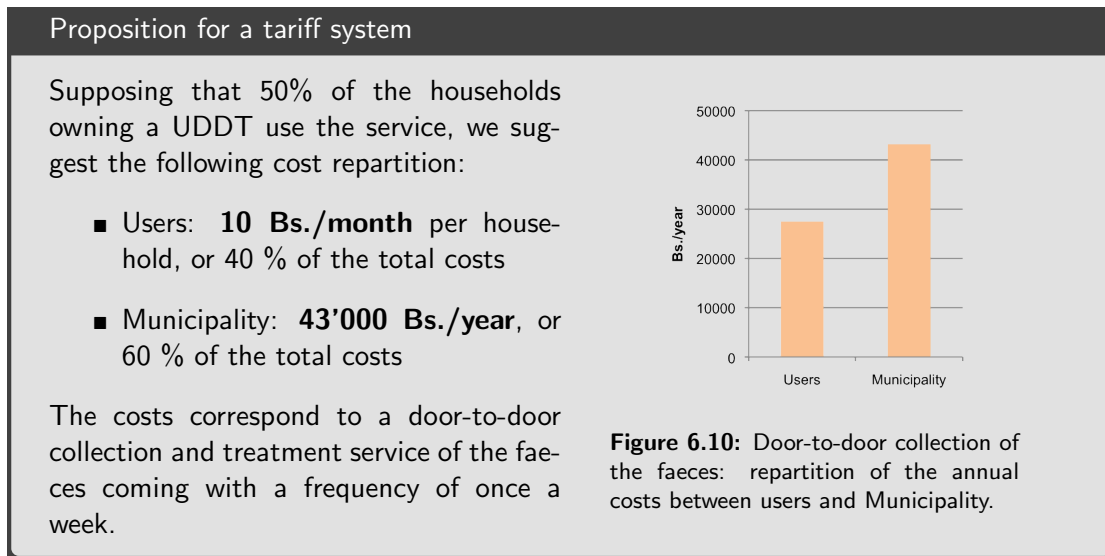


Figure 6.9: Door-to-door collection of the faeces: total annual costs for the Municipality as a function of the number of users and the tariff they pay.

With a tariff below 10 Bs./month, the total annual costs for the Municipality increase with every additional user. With a tariff above 10 Bs./month, the costs decrease with every additional user. The Municipal subsidies are independent of the number of users for a tariff of 10 Bs./month, so that it seems a good compromise between two factors:

- Willingness to pay of the residents (median of only around 5 Bs./month, see Figure 4.9c)
- Planning security for the Municipality

As mentioned in Section 4.3, 60% of the residents have a high willingness to use a collection service or would use it with certainty. Taking into account that a part of the population doesn't live permanently in the zone, it seems realistic to count on 50% of the residents. This estimation is also in accordance with Sumaj Huasi's experience in El Alto.



6.5 Sensitivity analysis

The sensitivity analysis allows us to determine the impact of the variation of distinct parameters on the end results. The analysis was performed only for scenario 1a (door-to-door collection of the faeces), as the other scenarios are not feasible.

First, it is interesting to compare the costs for each step of the service (Figure 6.11a)² or per type of cost (Figure 6.11b) in order to determine the important parameters.

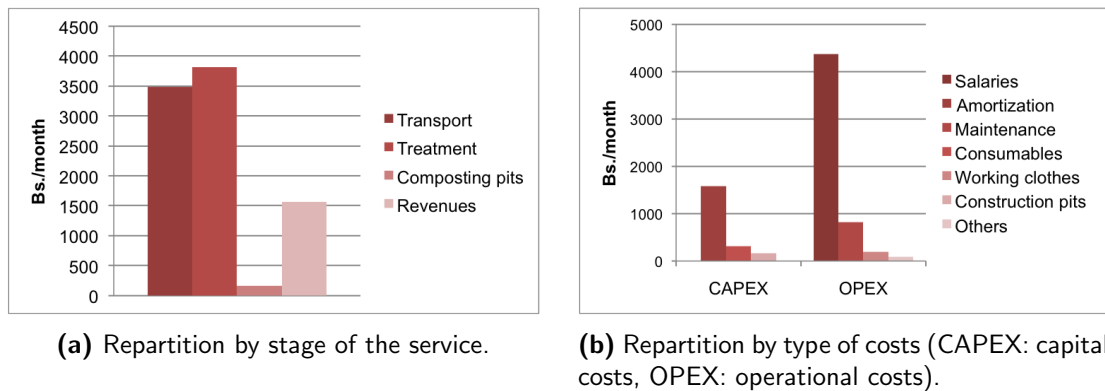


Figure 6.11: Repartición de los costos de un servicio de recojo de las heces de puerta a puerta para un porcentaje de usuarios de 50 %.

The operational costs (OPEX) include salary costs and maintenance, while the amortization costs are part of the capital costs (CAPEX). The annual amortization costs correspond to the initial value of the vehicle respectively the plant divided through its lifespan. It hence corresponds to the capital required to replace them at the end of their lifespan. We can see that for 50% users, the transport and treatment costs are approximately equal. The

²The construction costs of the composting pits are theoretically also part of the treatment. Contrarily to all other treatment costs, however, the construction of the pits requires an initial investment, so that we decided to present them separately.

revenues from the compost sales cover a fifth of the total costs. Almost 60% of the total costs are salary costs, mainly for the treatment. The second important type of costs are the amortization costs (mainly of the vehicle) contributing to a fifth of the total costs.

As salaries represent an important share of the total costs, it is important to analyse the corresponding parameters in more detail. The salary costs depend on the following parameters:

- Hourly salary
- Transport time (transport distance, average vehicle velocity)
- Collection and administration time (number of users)
- Treatment time (working time per faeces volume, composting time)
- Quantity of treated faeces (number of users, filling time of the faeces buckets)

The hourly salary is a fixed parameter, as it is directly defined by the Bolivian legislation. The transport distance was calculated in a Geographic Information System (GIS), so that it doesn't vary either for the analysed scenario. The average velocity neither has a high uncertainty, as it is based on field experience. The parameters we can't predict with exactitude are the number of users, the unitary working times, the composting time and the filling time of the faeces buckets. We can analyse the effects individually to evaluate the importance of each of these factors, or the combined effect to obtain the lower and upper limits of the costs. Table 6.1 presents the parameter intervals we tested.

Table 6.1: Parameter intervals for the sensitivity analysis.

Parameter	Unit	Current value	Min. value	Max. value
Percentage of users	%	50	40	60
Unitary working time	time/action	100 %	75 %	125 %
Bucket filling time	month	1	0.5	1.5
Composting time	month	6	3	9

The influence of each parameter on the costs per household and the combined influenced are presented in Figure 6.12. The composting time has a high influence on the tariff, as the evaluated interval is large. ADRA planned on composting the faeces during only 3 months, while the treatment time is around 9 to 12 months in Sumaj Huasi's project. Considering the favourable climate of Cochabamba, the proposed composting time of 6 months probably already includes a safety margin. We can see that the bucket filling time also has a strong influence on the cost per household. There's a larger uncertainty on this parameter, as it is mainly based on the auto-declaration of the residents. However, a filling time of 2 weeks seems very short compared to Sumaj Huasi's experience in El Alto. The percentage of users is likely to vary over time. The final percentage will depend on the tariff and the reliability of the service. Finally, it is difficult to know whether the unitary working time are over- or underestimated, as they depend on the employees and, in particular, on their work experience. In conclusion, there is an uncertainty in the proposed costs, but the combined

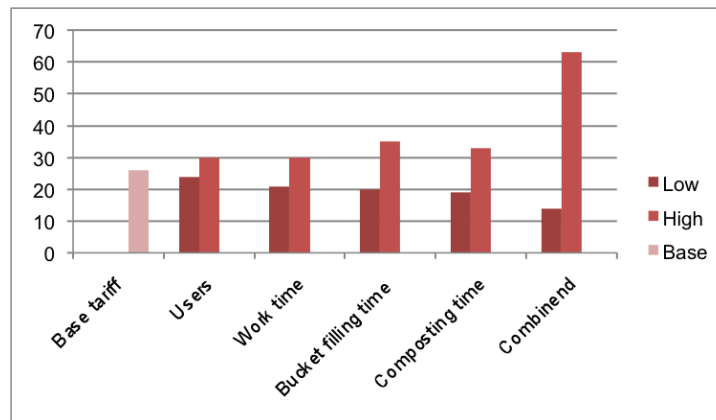


Figure 6.12: Sensitivity analysis varying the following parameters: users percentage (40% to 60% of the total population); unitary working time (75% to 125% of estimated values); filling time of the faeces buckets (0.5 to 1.5 months); composting time (3 to 9 months).

effect of the parameters is definitely overestimated, as it represents a combination of the worst cases.

Description of the selected service.

- **Type of service:** Collection of the faeces, cleaning of the buckets and treatment in the composting plant
- **Frequency:** 1/week
- **Number of employees:** 2
- **Working conditions:** full-time^a
- **Organization of the work:** collection in the morning, composting in the afternoon
- **Parts of the OTBs deserved:** streets in good condition
- **Task of the users:** deposit the buckets in front of the housing or in a street where the vehicle passes
- **User tariff:** 10 Bs./month per household
- **Tariff collection:** 1/month by the collectors
- **Cost for the Municipality:** 43'000 Bs./year

^aFor 50% of users, we need exactly 2 employees.

Comment about the CAPEX/OPEX

The presented costs correspond to the real costs of the service, which means that they include the CAPEX (capital costs). We could also do the calculation based only on the OPEX (operational costs), which would allow the service to operate at short

term (that is: until something needs to be replaced).

Supposing that 50% of the population uses the service, the following repartition of the costs seems adequate:

- Users: **10 Bs./month** per household, or 60 % of the total costs
- Municipality: **18'500 Bs./year**, or 40 % of the total costs

The costs correspond to the OPEX of a faeces collection and treatment service coming once a week.

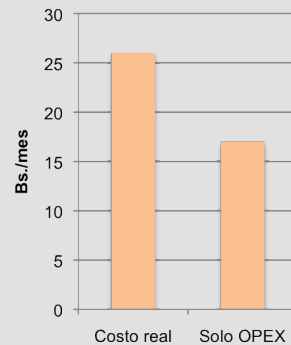


Figure 6.13: Door-to-door collection and treatment of the faeces: comparison of the real cost per household and OPEX only.

Recommendations

None of the service scenarios presented in the previous Chapter questioned the adequateness of a sanitation system based on UDDTs in the zone nor the central treatment in the composting plant in Llave Mayu. For the future, three options are possible:

- Start-up of the central treatment plant with the implementation of the collection service presented in Section 6.3
- Composting centre in each OTB
- Support for the construction of pit latrines

The main advantages and drawbacks of each option are summarized in the following sections.

7.1 Option 1: Start-up of the centralized treatment plant

The first option is to work out the details of the door-to-door collection of the faeces with a centralized treatment in the plant in Llave Mayu. As mentioned in the previous chapter, the current plant is underdimensioned, as the capacity is sufficient for only 50 households. The construction of new composting pits is necessary, which might require a considerable amount of time.

It seems convenient to start the service as soon as possible with only a part of the population. This strategy has three main advantages:

- Given the small quantities of faeces to be treated in the beginning, the processes can easily be adapted and optimized
- The hypotheses about the quantity of faeces produced, the percentage of users and the treatment time can be checked, allowing an adjustment of the number of new composting pits
- Providing a reliable and regular service is good publicity for the expansion of the service to other OTBs

As most costs are fixed,¹ the costs per households are almost identical independently in which OTB the service is started. Considering the workload, one employee is sufficient for the transport and treatment of the faeces of 50 families. However, it might be appropriate to start working with two employees from the beginning as a part of a training programme. As presented in Figure 7.1, the monthly costs per household (at the full capacity of the plant) is around 95 Bs./month with one employee or 145 Bs./month for two employees.

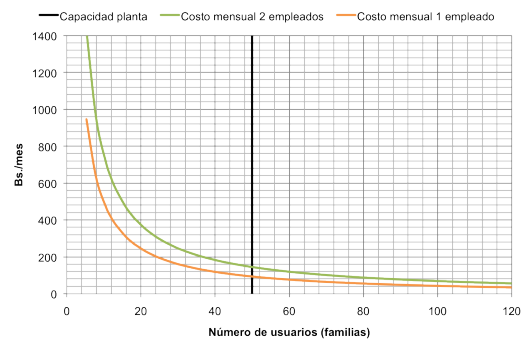


Figure 7.1: Monthly costs per households during the start-up of the treatment plant (with one or two employees).

A realistic work hypothesis is that 50% of the population that have a UDDT will use the collection service (see Section 6.4). It seems most convenient to start in the OTBs for which 50% of the population is closest to the capacity of the plant; ideally, the collection service starts in the OTBs 20 de Mayo and Florida.

With the construction of new composting pit the number of OTBs attended can gradually be increased. In this way, the quantity of faeces to be treated increases little by little, allowing the process to follow easily. As the number of users increases, the costs per user decrease, until reaching the final costs of 26 Bs./month (see Section 6.2). The Municipality would have to cover the difference between the real costs and the user tariff. The total costs for the Municipality depend on the period of time necessary between the start-up of the plant until it works at full capacity.

Currently, the majority of the population uses earth as a drying material for the faeces. This causes the following problems:

- smells due to liquids in the faeces buckets
- increased weight of the buckets
- difficulties for the composting process

The use of sawdust could solve all these problems, but the residents find it difficult to get access to it. For this reason, it could prove helpful to tie the faeces collection service to a provision service for sawdust. Based on the information gathered during the survey, this would increase the monthly costs by around 5 Bs.

We also suggest to replace the current buckets with a volume of 100 L by smaller buckets with an outlet for liquids that could otherwise accumulate in the bucket. The reduced size is particularly important for the households that don't live directly at a street where the vehicle passes, while the exit for the liquids reduces smells in case of urine entering the bucket. The price for new buckets isn't included in the cost calculations.

¹It is only the transport and collection distances that vary as a function of the number of service users.

Combining these three strategies should increase the residents' acceptance of a sanitation system based on UDDTs. The concrete implementation of such a system remains however challenging, as a validation is required in each OTB, but the final service and tariffs should be similar in the entire zone.

Advantages and drawbacks of a centralized treatment in Llave Mayu

- ✓ The treatment plant already exists, so that it isn't necessary to find a new location for the treatment
- ✓ The management and administration of the service are easier, as they are centralized
- ✓ More control over the quality of the treatment
- ✗ A single solution for OTBs with distinct contexts and conflicts between each other
- ✗ The transport to and from the OTBs is costly, as the plant is located far from most housings

7.2 Option 2: Composting centre in each OTB

There are conflicts between the OTBs and the motivation to work together is limited. The main reason to abide by the idea of treating the faeces centrally in Llave Mayu was that the plant already existed. However, the plant is underdimensioned, so that the construction of new composting pits is necessary. Instead of upscaling the treatment plant, new composting centres could be built in each of the OTB.

The majority of the service costs are salaries. Assuming that operating staff can be employed part-time in each OTB, the costs per user don't change much. An initial investment for the construction of the centres is required, but for simple structures made of wire mesh (of the same type as presented in Figure 7.3), the total costs wouldn't increase significantly. In turn, the main part of the transport costs could be saved.² An approximative calculation based on scenario 1b³ results in monthly costs of **25 Bs./household**, which is slightly less than the costs of Option 1.

However, the willingness to pay for this type of service is probably lower than for a door-to-door collection. Organizing the treatment is another issue; learning from Aguatuya's experience in Higuerani, where the communal composting failed, it is important that the composting centres are managed and administered by the Municipality.

²Most OTBs are relatively compact and we can assume that the residents take the buckets directly to the centres. The vehicle could be used in the OTB Llave Mayu, where the houses are more spaced.

³Option 2 is a special case of the collection of the faeces in collection points with the following parameters: 7 collection points with adapted construction costs, no costs linked to transport, working clothes and tools for 7 employees.

Advantages and drawbacks of composting centres in each OTB

- ✓ Opportunity to implement participative processes in each of the OTBs
- ✓ Development of solutions adapted to the distinct contexts
- ✓ Source of income directly in the OTBs
- ✗ Need of a suitable location in each OTB
- ✗ Number of stakeholders (operators) increases, making the organization of the service more complex
- ✗ Impossibility of providing a door-to-door service; it is not clear if the users are willing to bring their buckets to a centre

The composting centres could also be combined with a separate collection of all solid waste, which could then be collected by the Municipality (a waste collection truck is available). It is probable that the Municipality has a high interest in this type of waste transfer centres, as they recently started an education campaign in the schools, teaching the correct separation of solid waste (see Figure 7.2). There is also an important point of collaboration directly with the school. Especially the director of the school in Llave Mayu expressed his interest in being part of the process. If there is an interest in the OTBs, they could also organize to sell the recyclables themselves to generate revenues.



Figure 7.2: Separated solid waste collection in front of the school in Llave Mayu.

These treatment and transfer centres would be similar to a solution promoted by the project *Ecovecindarios* of the NGO Swisscontact. *Ecovecindarios* are meeting spaces between the environmental management at community-level and public environmental management. The project particularly promotes the implementation of *Puntos Verdes*, collection centres where the residents can deposit their separated solid waste in places where a door-to-door collection cannot be organized. Swisscontact's experience is that these collection points work well when the residents don't have to travel more than 300 m. One important aspect of the *Ecovecindarios* project are the *Ecorecolectores*, an organized sector of people offering a



Figure 7.3: Green point (textitpunto verde) by the NGO Swisscontact in the OTB Sivingani (Cochabamba). Source of the picture: Swisscontact Cochabamba.

door-to-door collection of recyclables that they later sell in the collection centres.

7.3 Option 3: Support for the construction of pit latrines

The construction of UDDTs was never a demand from the population and a large majority would have preferred pit latrines or, ideally, sewerage. Many that are ready to use the UDDTs insist that it is only a temporary solution, until a different system will be implemented. During the survey, many residents asked for support for the construction of pit latrines, for instance through subsidized cement. It is not only the residents that prefer pit latrines, but also the head of the USB that suggested that the Municipality invests in a tank truck and offers a pit emptying service instead of a faeces collection service.

An increasing part of the residents use pit latrines. The large majority built permeable pit latrines (see Figure 7.4). As the soil is very dry most of the year, the pits fill up only slowly. There are households who haven't had to empty the pits since the construction more than five years ago. Those who built impermeable pits have to empty them every two years in average. This service costs 300 Bs⁴, or around 12.50 Bs./ month, which is much cheaper than the real price for the collection and treatment of the faeces. The real cost for pit latrines with flush water is much higher, as the price does not include the additional costs for the water.



Figure 7.4: Construction of a permeable pit latrine in the OTB Florida.

The main advantage of the UDDTs is that they don't use water. It seems, however, probable that many families will change the design once the water provision has improved. This is what also happened in the OTB Higuera, where the Fundación Aguatuya built UDDTs: all were converted into pit latrines once the water provision was constant.

It seems that there are no environmental problems caused by the pit latrines in the zone, as to date there are only few of them. Moreover, the groundwater table is deep, and the risk of contamination is low. But if this is the technology that is to be used by a majority in the future, it is important that the pits are impermeable. For this, technical support and ideally subsidized materials from the Municipality are needed. Assuming that the faecal sludge is treated, supporting the construction of pit latrines and ensuring they are correctly built and maintained might even be the most environment-friendly solution.

⁴The service provider states that this price includes the disposal in centres authorised by Cochabamba's Drinking Water and Sewerage Service (Servicio Municipal de Agua Potable y Alcantarillado de Cochabamba, SEMAPA), see www.servimasterbolivia.com.

Advantages and drawbacks of the support for the construction of pit latrines

- ✓ High demand from the residents and interest of the Municipality
- ✓ It is the solution that will be implemented at medium term and it is an opportunity to ensure that the pit latrines will be well built
- ≈ It is only an environmental-friendly solution if the faecal sludge is treated
- ✗ Completely decentralized system (lack of control)

Ideally, Options 2 and 3 could be combined, so that each OTB can decide if they want to continue with the UDDTs with composting centres in the OTB, or if they prefer building simple pit latrines.

Conclusions

After listing the main lines of further investigation necessary in the case of Arbiето, this last chapter aims at putting the case of Arbiето in a more general context. The adequateness of UDDTs in periurban zones in Bolivia is assessed and the main factors of success are given. Finally, the applicability of a participatory planning framework like CLUES in the presence of distinct communities is evaluated.

8.1 Follow-up of the report

The present report offers a comprehensive analysis of the perception towards their toilets of households owning a UDDT. It could be insightful to do a more detailed analysis about the reasons why some households that lived in the project area during the construction of the UDDTs decided not to build such a toilet.

The presented cost calculations for the four main service scenarios are precise enough to compare the scenarios. If the decision-makers decide to actually implement the recommended scenario (door-to-door collection of the faeces), more detailed calculations are required, particularly with respect to the start-up of the plant (equipment of the plant, further training of the users) as the proposed costs include only the operation of the service.

We realized that the capacity of the plant is insufficient for the treatment of the faeces from all UDDTs and that the plant needs to be upscaled. This led to the conclusion that it might be more advantageous to quit the idea of a centralized treatment in the composting plant in Llave Mayu. Two alternatives (composting centres at OTB level, support for the construction of pit latrines) have been developed, with very rough cost estimates. If one of the alternatives were considered conceivable, it would be important to calculate more detailed costs for both options in order to take an informed decision.

Finally, the fact that the capacity of the treatment plant is not sufficient might be an incentive to re-think the situation from the beginning. The motivation to support the construction of pit latrines is proposed as the lesser of two evils. It would be interesting to evaluate whether

there is a more advisable solution for the zone. For instance, condominial pit latrines (one tank for various households) might be a solution where conventional sewerage is technically and economically not feasible. Such a semi-decentralized system would ensure a quality control that is not possible in the case of individual pit latrines.

8.2 Implementation of UDDTs in periurban zones in Bolivia

The case of District 4 in Arbieta is not an isolated phenomenon. There are numerous examples of NGOs building single-vault UDDTs in periurban zones in Bolivia and leaving the projects without organizing a faeces and urine collection service. While such infrastructure projects may be an important financial investment for the donors, the real challenge in any UDDT project is the provision of a reliable, sustainable and affordable service.

From a technical and organizational point of view, a UDDT-based sanitation system is not adapted to all types of contexts. For the collection service to be practicable, the project area needs to be easily accessible (topography, condition of the streets), the dwellings reasonably well organized, and the population density intermediate. It is also necessary that a conveniently located area for the treatment of the urine and faeces is available for the project, and there should be a local demand for the products (compost, urine), for instance from local farmers or from the municipality. These conditions are not met in District 4 of Arbieta.

It is also important that the design of the UDDT anticipates the type of collection service. For instance, the opening to the faeces chambers should allow the collector to access the bucket without entering the housing, if a door-to-door collection is planned. The type and volume of the faeces buckets and urine jerrycans should also be selected according to the planned type of transport and collection frequency. The design choices made by ADRA did not consider the collection, as the openings are located inside the housing and the faeces buckets are not adapted for the transport.

From a social point of view, it is essential that there is an initial demand from the population. Our results show clearly that the initial motive for the construction of the UDDTs is a decisive factor for the use of the toilet in the medium and long term. Starting in areas where the demand for UDDTs is high and provide a reliable collection service also helps creating demand in other areas. An effective way to filter households that do not have an intrinsic motive for building the UDDTs and increase the owner's motivation to actually use the toilet is to ask for a financial counterpart for the construction. In the case of Arbieta, many households built the UDDTs only because they got them for free.

It is also important to integrate the users' preferences; especially in the design of the toilet small changes can substantially influence the user satisfaction. For instance, many households in District 4 complain about the UDDTs' small size or the steep access, which could easily have been adapted.

UDDTs are a relatively new concept for many users, and a training before the construction is not sufficient. It is important to continue the effort during even after the implementation of the infrastructure [20].

From a financial point of view, it seems illusory to implement a system that is auto-sustainable at short term. The UDDT-based systems in Bolivia that currently operate relatively successfully receive permanent financial support. Concerning financing, political work is needed. Conventional sewerage-based systems are often subsidized by the government. However, the willingness to invest equally in decentralized sanitation systems is usually low. This is particularly problematic, when the users of UDDT-based systems pay more for a service they find less attractive than sewerage.

The numerous challenges do not mean that UDDTs are generally not adapted to the context of periurban zones in Bolivia. In particular, UDDTs seem advisable in contexts where the water supply is limited or expensive, or where the cost for sewerage is prohibitive or the terrain unfavourable. However, it is important to keep in mind that many users will see the UDDTs as a temporary solution, which they will only use until the water problem is re-solved and a more “high-tech” solution can be implemented.

Finally, an NGO intending to implement a sanitation system based on UDDTs should be aware that this consists a long-term commitment, requiring a phase of adaptation and improvement of the service that can require up to several years. It is also important to realise that a poorly planned sanitation project may actually be more harmful than doing nothing, since the failure of the project can lower the trust in the work of NGOs and the motivation to invest time, effort and money into the implementation of an alternative solution

8.3 Application of CLUES in periurban zones in Bolivia

From a regulatory point of view, Bolivia seems an ideal context for the implementation of a participative planning approach like CLUES, as the participation of rural or urban communities in projects affecting them is explicitly stated in the Law.

The following considerations are based on the observations made in District 4 of Arbiesto. They do not claim to universally apply to all periurban zones in the country, even though the main implications should be similar.

- ✓ The OTBs have a well-defined structure and their role and responsibility in the municipality is clearly laid down.
- ✓ The OTB representatives are elected, which gives them legitimacy in the community.
- ✓ There is a strong community feeling even in zones with a high proportion of immigrants.
- ✓ The communities are used to take decisions concerning projects at OTB level together, as well as financing them and contributing with workforce.
- ✗ There are frequent conflicts between residents and representatives within the OTBs.
- ✗ The representatives have short mandate periods (usually a year) compared to the time frame of a participatory planning process.
- ✗ Gender equality is not guaranteed, as many discussions are dominated by men.

- ✗ Formal education is often low in Bolivia, and it seems difficult that the residents take informed decision without prior empowerment and training.

In the context of the UDDTs in District 4 of Arbieta, the direct application of the CLUES framework is not possible, as the project affects seven communities with distinct contexts. Moreover, funds are already extremely limited and there is pressure from the residents as well as from the mayor for a rapid start-up of the treatment plant. It seems challenging to justify the increased cost and time of a participatory process without funds coming from outside.

Abbreviations

AAPS	Autoridad de Fiscalización y Control Social de Agua Potable y Saneamiento Básico
ACI	Alianza Cooperativa Internacional
ADRA	Agencia Adventista para el Desarrollo y Recursos Asistenciales
AECID	Agencia Española de Cooperación
AIOC	Autonomía indígena originario campesina
CLUES	Community-Led Urban Environmental Sanitation Planning
CPE	Constitución Política del Estado (febrero 2009)
CTRL	Comisión Técnica de Registros y Licencias
COSUDE	Cooperación Suiza
DESCOM	Desarrollo Comunitario
DS	Decreto Supremo
Eawag	Instituto Federal Suizo de Ciencia y Tecnología Acuáticas
EMA	Empresa Municipal de Agua
EMAGUA	Entidad Ejecutora de Medio Ambiente y Agua
EPSA	Entidades Operadoras de Agua Potable y Alcantarillado Sanitario
GAM	Gestión Ambiental Municipal
IARIS	Identificador de Áreas de Inversión en Saneamiento Básico
INE	Instituto Nacional de Estadística
MDG	Millennium Development Goal
MICSA	Mecanismo de Inversión para Coberturas en el Sector de Agua Potable y Saneamiento
MMAyA	Ministerio de Medio Ambiente y Agua
NGO	Non-Governmental Organization
OTB	Organización Territorial de Base
PND	Plan Nacional de Desarrollo
PNSB	Plan Nacional de Saneamiento Básico

Chapter 8

Conclusions

POA	Plan Operativo Anual
PDTA	Plan de Desarrollo Territorial Autónomo Arbieta
PTAR	Planta de Tratamiento de Aguas Residuales
PSD-SB	Plan Sectorial de Desarrollo de Saneamiento Básico
Sandec	Sanitation, Water and Solid Waste for Development
SENASBA	Servicio Nacional de Apoyo a la Sostenibilidad en Sanemiento Básico
UASB	Upflow Anaerobic Sludge Blanket
UDDT	Urine-Diverting Dry Toilets
VAPSB	Viceministerio de Agua Potable y Saneamiento Básico
WWTP	Wastewater treatment plant

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Cuestionarios

Este apéndice incluye cuatro cuestionarios:

- Cuestionario a los ingenieros responsables de saneamiento básico en el municipio
- Cuestionario a los representantes de las OTBs (Presidente y Comité de Agua)
- Encuesta a los hogares con baños ecológicos
- Encuesta a los hogares sin baños ecológicos

Algunas preguntas de las encuestas a los hogares incluyen posibilidades de respuestas en una escala de 1 a 5, inspirado por el enfoque RANAS¹, pero no se aplica el enfoque de manera sistemática. La meta del enfoque RANAS es el diseño y la evaluación de estrategias de cambio de comportamiento que apunta y cambia un factor de comportamiento específico de una población específica. Así, RANAS permite identificar los factores que explican el por qué sí o por qué no la población cumple con un comportamiento. Más información sobre el enfoque se puede encontrar aquí: www.eawag.ch/fileadmin/Domain1/Abteilungen/ess/projekte/EHPsy/Methodological_Fact_Sheets.pdf

¹*Risks, Attitudes, Norms, Abilities, and Self-regulation.* Riesgos, Actitudes, Normas, Capacidades, y Auto-regulación.

Cuestionario para la alcaldía de Arbieta

Número de encuesta			
Fecha		Duración	
Inicio		Fin	
Completo	<input type="checkbox"/> sí <input type="checkbox"/> no	Fotos	

A. Encuestado/a			
Apellido		Nombre	
Función		Telf.	

B. Situación general en el Distrito 4	
1. ¿Cuántos ... hay en el distrito? • habitantes • hogares • viviendas	
2. ¿Cuántas personas viven en un hogar (valor medio)?	
3. ¿Hay variaciones en el número de habitantes (día de semana/fin de semana, temporada, ...)?	
4. ¿Cuáles son las ocupaciones principales de los habitantes?	
5. ¿Hay diferencias sociales importantes entre los habitantes? ↪ ¿Cuáles son las categorías?	
6. ¿Hay miembros de la comunidad que tienen un rol especial? ↪ ¿Quién, qué rol?	
7. ¿Hay pequeñas actividades industriales en el distrito (fábricas de leche, granjas de ganado,...)? ↪ ¿Qué, dónde?	

C. Situación de agua potable y saneamiento	
8. ¿Procedencia del agua potable: ¿Hay ...	
• cañería de red?	<input type="checkbox"/> sí <input type="checkbox"/> no
• piletas públicas?	<input type="checkbox"/> sí <input type="checkbox"/> no
• carros repartidores (aguateros)?	<input type="checkbox"/> sí <input type="checkbox"/> no
• pozos o norias?	<input type="checkbox"/> sí <input type="checkbox"/> no
• otros: ¿qué?	

9. ¿Se usa agua de diferente procedencia dependiente de la actividad (beber, lavar, animales,...)? ↪ Sí: ¿cuál procedencia para cuál actividad?	<input type="checkbox"/> sí	<input type="checkbox"/> no
10. ¿Qué piensa de la calidad del suministro de agua? • Cantidad • Constancia • Sabor • Contaminación con gérmenes patógenos • ¿Accesible a todos?	<input type="checkbox"/> suf	<input type="checkbox"/> insuf.
	<input type="checkbox"/> suf.	<input type="checkbox"/> insuf.
	<input type="checkbox"/> suf.	<input type="checkbox"/> insuf.
	<input type="checkbox"/> suf.	<input type="checkbox"/> insuf.
	<input type="checkbox"/> sí	<input type="checkbox"/> no
11. ¿Es necesario hervir/filtrar el agua antes del consumo?	<input type="checkbox"/> sí	<input type="checkbox"/> no
12. ¿Hay un sistema de alcantarillado? ↪ Sí: ¿Un único red o varios? • ¿Existe una mapa?	<input type="checkbox"/> sí	<input type="checkbox"/> no
	<input type="checkbox"/> uno	<input type="checkbox"/> varios
	<input type="checkbox"/> sí	<input type="checkbox"/> no
13. ¿Hay aguas subterráneas? ↪ ¿A qué profundidad?	<input type="checkbox"/> sí	<input type="checkbox"/> no
		m
14. ¿Hay problemas ambientales/de salud ocasionados por la falta de saneamiento básico? ↪ Sí: ¿qué?	<input type="checkbox"/> sí	<input type="checkbox"/> no
15. ¿Hay habitantes que tienen ganado? ↪ Sí: ¿qué hacen con el abono?	<input type="checkbox"/> sí	<input type="checkbox"/> no
16. ¿Hay actividades de reciclaje (plástico, metal,...)? ↪ Sí: ¿cuáles materiales? • ¿Organizado por quién?	<input type="checkbox"/> sí	<input type="checkbox"/> no
17. ¿Qué hacen los habitantes con los residuos orgánicos?		
18. ¿Hay ... qué realizan campañas de saneamiento básico? ¿Qué soluciones proponen, como promueven? • ONGs • iglesias • escuelas • otros: ¿quién?		
D. Uso de los baños ecológicos		
19. ¿Hay una mayoría de los habitantes que usan los baños ecológicos? ↪ ¿Aproximadamente qué porcentaje usa los baños?	<input type="checkbox"/> sí	<input type="checkbox"/> no
20. ¿En su opinión, a qué se debe que una parte de los habitantes no usan los baños ecológicos?		
21. Los habitantes que usan los baños ecológicos, los usan correctamente? ↪ No: ¿en su opinión, a qué se debe el uso incorrecto? • ¿Qué son los efectos del uso incorrecto?	<input type="checkbox"/> sí	<input type="checkbox"/> no

22. ¿El baño ecológico le parece una tecnología conveniente?	<input type="checkbox"/> sí	<input type="checkbox"/> no
↳ No: ¿porqué no?		
• ¿Qué otra opción sería más adaptada?		

23. ¿Que practican los habitantes que no tienen/no usan los baños ecológicos?		
• Pozo séptico	<input type="checkbox"/>	
• Pozo ciego	<input type="checkbox"/>	
• Baño público	<input type="checkbox"/> sí	<input type="checkbox"/> no
• Orinal	<input type="checkbox"/> sí	<input type="checkbox"/> no
• Defecación al aire libre	<input type="checkbox"/> sí	<input type="checkbox"/> no
• Otros: ¿qué?		

E. Organización y financiamiento de los servicios

24. ¿Qué fueron las condiciones negociadas con la ONG ADRA?		
• Recolección y transporte		
• Tratamiento		
• Uso de los productos finales		

25. ¿Qué piensa ahora?		
• ¿Planifica una tasa de recolección y tratamiento?	<input type="checkbox"/> sí	<input type="checkbox"/> no
↳ Sí: ¿vinculada a otras tarifas?	<input type="checkbox"/> sí	<input type="checkbox"/> no
• ¿Cómo estructuraría las tarifas?		
• ¿Cómo querría financiar el servicio?		

26. ¿En su opinión, qué es la mejor manera de organizar la recolección de los tachos de heces/bidones de orina?		
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27. ¿Qué recursos tiene para la recolección y el transporte?		
• Vehículos		
• Recursos humanos		
• Financiamiento		

28. ¿En su opinión, qué es la mejor manera de gestionar el tratamiento?		
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29. ¿Cómo se organiza la tarifa de agua?		
• ¿Quién fija la tarifa?		
• ¿Cómo es fijada? (¿Medidor de agua o tarifa fija? ¿Hay categorías de usuarios?)		
• ¿Qué es la frecuencia de recaudación?		
• ¿Ha tenido conflictos por tema de recaudación?		

30. ¿Hay un servicio de recolección de los residuos sólidos? ↔ Sí: ¿Con qué frecuencia? • ¿Quién es responsable? (nombre, telf.) • ¿Cómo es financiado? • ¿Cuánto cuesta?	<input type="checkbox"/> sí <input type="checkbox"/> no /mes
31. ¿El municipio ha tenido conflictos por tema de tasas de aseo? ↔ Sí: ¿porqué, cuándo?	<input type="checkbox"/> sí <input type="checkbox"/> no
32. ¿Qué sistema de tarifa le parece apropiado?	

F. Normas y reglamentaciones municipales

33. ¿Hay normas o reglamentaciones en el municipio que podrían influir sobre la elección de un sistema de saneamiento?	
34. ¿Hay normas o reglamentaciones en el municipio que podrían influir sobre la elección de un sistema de tarifa?	
35. ¿Hay normas o reglamentaciones en el municipio que podrían influir sobre la elección de un sistema de recolección?	
36. ¿Hay normas o reglamentaciones en el municipio que podrían influir sobre la reutilización de los productos finales (e.g. compost, orina tratada)?	

G. Planes futuros en el distrito

37. ¿Cuál es la necesidad la más urgente del distrito? • Saneamiento básico • Agua potable • Basura	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
38. ¿Hay planes de inversiones en el sector de saneamiento? ↔ Sí: ¿Qué, cuánto, cuándo?	<input type="checkbox"/> sí <input type="checkbox"/> no

¡Muchas gracias para su ayuda!

Cuestionario para los representantes de los OTB

Número de encuesta			
Comunidad	<input type="checkbox"/> Cristal Mayu <input type="checkbox"/> Fortaleza <input type="checkbox"/> Florida <input type="checkbox"/> 20 de Mayo <input type="checkbox"/> Villa Montes <input type="checkbox"/> Yuraj Jallpa		
Fecha		Duración	
Inicio		Fin	
Completo	<input type="checkbox"/> sí <input type="checkbox"/> no	Fotos	

A. Encuestado/a			
Apellido		Nombre	
Función		Telf.	

B. Situación general del OTB	
1. ¿Cuántos ... hay en el OTB?	
<ul style="list-style-type: none"> • habitantes • hogares • viviendas 	
2. ¿Cuántas personas viven en un hogar (valor medio)?	
3. ¿Hay variaciones en el número de habitantes (día de semana/fin de semana, temporada, ...)?	
4. ¿Cuáles son las ocupaciones principales de los habitantes?	
5. ¿Hay diferencias sociales importantes entre los habitantes? ↪ ¿Cuáles son las categorías?	
6. ¿Hay miembros de la comunidad que tienen un rol especial? ↪ ¿Quién, qué rol?	
7. ¿Hay pequeñas actividades industriales en el OTB (fábricas de leche, granjas de ganado,...)? ↪ ¿Qué, dónde?	

C. Situación de saneamiento	
8. ¿Procedencia de agua potable: ¿Hay ...	
<ul style="list-style-type: none"> • cañería de red <ul style="list-style-type: none"> • ¿cuántos hogares tienen cañería de red? • piletas públicas? • carros repartidores (aguateros)? • pozos o norias? • otros: ¿qué? 	<input type="checkbox"/> sí <input type="checkbox"/> no
	<input type="checkbox"/> sí <input type="checkbox"/> no
	<input type="checkbox"/> sí <input type="checkbox"/> no
	<input type="checkbox"/> sí <input type="checkbox"/> no

9. ¿Se usa agua de diferentes procedencias dependiente de la actividad (beber, lavar, animales,...)? ↪ Sí: ¿cuál procedencia para cuál actividad?	<input type="checkbox"/> sí	<input type="checkbox"/> no
10. ¿Qué piensa de la calidad del suministro de agua? • Cantidad • Constancia • Sabor • Contaminación con gérmenes patógenos • ¿Accesible a todos?	<input type="checkbox"/> suf	<input type="checkbox"/> insuf.
	<input type="checkbox"/> suf.	<input type="checkbox"/> insuf.
	<input type="checkbox"/> suf.	<input type="checkbox"/> insuf.
	<input type="checkbox"/> suf.	<input type="checkbox"/> insuf.
	<input type="checkbox"/> sí	<input type="checkbox"/> no
11. ¿Es necesario hervir/filtrar el agua antes del consumo?	<input type="checkbox"/> sí	<input type="checkbox"/> no
12. ¿Hay un sistema de alcantarillado?	<input type="checkbox"/> sí	<input type="checkbox"/> no
13. ¿Hay aguas subterráneas? ↪ ¿A qué profundidad?	<input type="checkbox"/> sí	<input type="checkbox"/> no
		m
14. ¿Hay problemas ambientales/de salud ocasionados por la falta de saneamiento básico? ↪ Sí: ¿qué?	<input type="checkbox"/> sí	<input type="checkbox"/> no
15. ¿Hay habitantes que tienen ganado? ↪ Sí: ¿qué hacen con el abono?	<input type="checkbox"/> sí	<input type="checkbox"/> no
16. ¿Hay actividades de reciclaje (plástico, metal,...)? ↪ Sí: ¿cuáles materiales? • ¿Organizado por quién?	<input type="checkbox"/> sí	<input type="checkbox"/> no
17. ¿Qué hacen los habitantes con los residuos orgánicos?		
18. ¿Hay ... qué realizan campañas de saneamiento básico? ¿Qué soluciones proponen, como promueven? • ONGs • iglesias • escuelas • otros: ¿quién?		
D. Uso de los baños ecológicos		
19. ¿Cuántos baños ecológicos hay en el OTB? ↪ ¿Dónde?		
20. ¿Hay una mayoría de los habitantes que usan los baños ecológicos? ↪ ¿Aproximadamente cuantos hogares usan los baños?	<input type="checkbox"/> sí	<input type="checkbox"/> no
21. ¿En su opinión, a qué se debe que una parte de los habitantes no usan los baños ecológicos?		

22. Los habitantes que usan los baños ecológicos, los usan correctamente? ↪ No: ¿en su opinión, a qué se debe el uso incorrecto? <ul style="list-style-type: none"> ¿Qué son los efectos del uso incorrecto? 	<input type="checkbox"/> sí <input type="checkbox"/> no
23. ¿El baño ecológico le parece una tecnología conveniente? ↪ No: ¿porqué no? <ul style="list-style-type: none"> ¿Qué otra opción sería más adaptada? 	<input type="checkbox"/> sí <input type="checkbox"/> no
24. ¿Que practican los habitantes que no tienen/no usan los baños ecológicos? <ul style="list-style-type: none"> Pozo séptico Pozo ciego Baño público Orinal Defecación al aire libre Otros: ¿qué? 	 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> sí <input type="checkbox"/> no <input type="checkbox"/> sí <input type="checkbox"/> no <input type="checkbox"/> sí <input type="checkbox"/> no

D. Organización y financiamiento de los servicios	
25. ¿Cómo se organiza la tarifa de agua? <ul style="list-style-type: none"> ¿Quién fija la tarifa? ¿Cómo es fijada? (¿ Medidor de agua o tarifa fija? ¿Hay categorías de usuarios?) ¿Qué es la frecuencia de recaudación? ¿Ha tenido conflictos por tema de recaudación? 	
26. ¿Hay un servicio de recolección de los residuos sólidos? ↪ Sí: ¿Con qué frecuencia? <ul style="list-style-type: none"> ¿Quién es responsable? (nombre, telf.) ¿Cómo es financiado? ¿Cuánto cuesta? 	<input type="checkbox"/> sí <input type="checkbox"/> no /mes
27. ¿En su opinión, qué es la mejor manera de organizar la recolección de los tachos de heces/bidones de orina?	
28. ¿En su opinión, qué es la mejor manera de gestionar el tratamiento?	
29. ¿El OTB ha tenido conflictos por tema de tasas de aseos? ↪ Sí: ¿porqué, cuándo?	<input type="checkbox"/> sí <input type="checkbox"/> no
30. ¿Qué sistema de tarifa le parece apropiado?	

E. Planes futuros en el OTB

31. ¿Cuál es la necesidad la más urgente del OTB?	
• Saneamiento básico	<input type="checkbox"/>
• Agua potable	<input type="checkbox"/>
• Basura	<input type="checkbox"/>
32. ¿Hay planes de inversiones del OTB en el sector de saneamiento?	<input type="checkbox"/> sí <input type="checkbox"/> no
↳ ¿Qué, cuánto, cuándo?	

¡Muchas gracias para su ayuda!

Encuesta a los hogares con baños ecológicos

El objetivo de esta encuesta es de identificar las principales preocupaciones de la comunidad en el sector de saneamiento. Con su ayuda, esperamos contribuir al mejoramiento de los servicios de saneamiento en el distrito.

Para responder a esta encuesta necesitará aproximadamente 45 minutos. Toda la información será tratada de manera confidencial y no será distribuida a terceras partes.

¿Está de acuerdo con participar a la encuesta? No Sí Firma:

Número de encuesta			
Comunidad	<input type="checkbox"/> Cristal Mayu <input type="checkbox"/> Llave Mayu <input type="checkbox"/> Fortaleza <input type="checkbox"/> Florida <input type="checkbox"/> 20 de Mayo <input type="checkbox"/> Villa Montes <input type="checkbox"/> Yuraj Jallpa		
Longitud		Latitud	
Fecha		Duración	
Inicio		Fin	
Completo	<input type="checkbox"/> sí <input type="checkbox"/> no	Fotos	

A. Encuestado/a	
1. Nombre y apellido	
2. Jefe/a del hogar	<input type="checkbox"/> sí <input type="checkbox"/> no
3. ¿Nació en el municipio de Arbieto?	<input type="checkbox"/> sí <input type="checkbox"/> no
↪ No: ¿dónde?	
4. ¿Cuál es el máximo nivel de estudio alcanzado?	
• No educación formal	<input type="checkbox"/>
• Primaria	<input type="checkbox"/>
• Secundaria	<input type="checkbox"/>
• Licenciatura universitaria	<input type="checkbox"/>
• Técnico	<input type="checkbox"/>

B. Hogar	
5. ¿Cuántas personas viven en el hogar?	
• Total	pers.
• Mayores de edad - hombres	pers.
• Mayores de edad - mujeres	pers.
• Menores/niños	pers.
↪ ¿Hay variaciones en el número de personas? (día de semana/fin de semana, temporada, ...)	
↪ ¿Hay personas presentes en la vivienda durante el día (lunes a sábado)?	<input type="checkbox"/> sí <input type="checkbox"/> no
• ¿Quién, cuántas?	
6. ¿La vivienda le pertenece?	<input type="checkbox"/> sí <input type="checkbox"/> no
↪ No: ¿cuánto es el alquiler?	Bs./mes
7. ¿Cuál es la ocupación principal/fuente de ingresos?	
• Agricultor/a	<input type="checkbox"/>
• Comerciante	<input type="checkbox"/>
• Obrero/a	<input type="checkbox"/>
• Empleado/a	<input type="checkbox"/>
• Otro: ¿qué?	



8. ¿Dónde trabaja?	
• OTB	<input type="checkbox"/>
• Arbieto (municipio)	<input type="checkbox"/>
• Cochabamba (ciudad)	<input type="checkbox"/>
• Otro: ¿dónde?	
9. ¿Tiene electricidad?	<input type="checkbox"/> sí <input type="checkbox"/> no
↪ Sí: ¿qué electrodomesticos tiene en su hogar?	
• Celular	<input type="checkbox"/>
• Televisor	<input type="checkbox"/>
• Refrigerador	<input type="checkbox"/>
• Lavadora	<input type="checkbox"/>
• Otros: ¿qué?	

C. Suministro de agua y saneamiento	
10. ¿Cuál es la procedencia principal del agua?	
• Cañería de red	<input type="checkbox"/>
• Pileta pública	<input type="checkbox"/>
• Carro repartidor (aguatero)	<input type="checkbox"/>
• Pozo o noria	<input type="checkbox"/>
• Lluvia, río, vertiente, acequia	<input type="checkbox"/>
• Otros: ¿qué?	
11. ¿Para las siguientes actividades, cuál es la procedencia del agua?	
• Beber	
• Cocinar	
• Lavar la vajilla	
• Ducharse/bañarse	
• Lavar la ropa	
12. ¿Qué hace con el agua residual de las siguientes actividades?	
• Lavar la vajilla	
• Ducharse/bañarse	
• Lavar la ropa	
• Si usa pozo de drenaje: ¿hay problemas de infiltración?	<input type="checkbox"/> sí <input type="checkbox"/> no
13. ¿Sabe cuánto agua se usa en el hogar?	<input type="checkbox"/> sí <input type="checkbox"/> no
↪ Sí: ¿cuánto?	
14. ¿Paga por el suministro de agua	<input type="checkbox"/> sí <input type="checkbox"/> no
↪ Sí: ¿cuánto?	Bs./mes
• ¿Cómo se calcula el pago por agua?	
• Medidor de agua	<input type="checkbox"/>
• Tarifa fija	<input type="checkbox"/>
• Otro: ¿qué?	
15. ¿Qué piensa de la calidad del suministro de agua?	
• Cantidad: <input type="checkbox"/> mucho <input type="checkbox"/> suficiente <input type="checkbox"/> poco <input type="checkbox"/> muy poco <input type="checkbox"/> nada	
• Constancia: <input type="checkbox"/> siempre <input type="checkbox"/> frecuentemente <input type="checkbox"/> regularmente <input type="checkbox"/> rara vez <input type="checkbox"/> nunca	
• Sabor: <input type="checkbox"/> muy bueno <input type="checkbox"/> bueno <input type="checkbox"/> normal <input type="checkbox"/> malo <input type="checkbox"/> muy malo	
• Presión (si hay cañería): <input type="checkbox"/> muy alta <input type="checkbox"/> alta <input type="checkbox"/> normal <input type="checkbox"/> baja <input type="checkbox"/> muy baja	
16. ¿Hierva/filtra el agua antes del consumo?	
<input type="checkbox"/> siempre <input type="checkbox"/> frecuentem. <input type="checkbox"/> regularmente <input type="checkbox"/> rara vez <input type="checkbox"/> nunca	



17. ¿Hay un servicio de recolección de los residuos sólidos?	<input type="checkbox"/> sí	<input type="checkbox"/> no
↪ Sí: ¿con qué frecuencia?	vez/sem.	
• ¿Paga por el servicio?	<input type="checkbox"/> sí	<input type="checkbox"/> no
• Sí: ¿cuánto cuesta?	Bs./vez	
↪ No: ¿qué hace con la basura?		
18. ¿Cuánta gente en la OTB cree que defeca al aire libre?		
<input type="checkbox"/> casi todos <input type="checkbox"/> muchos <input type="checkbox"/> algunos <input type="checkbox"/> pocos <input type="checkbox"/> nadie		
↪ ¿Cuál es su percepción la defecación al aire libre?		
• ¿Le parece aceptable esta práctica? <input type="checkbox"/> completamente <input type="checkbox"/> mayormente <input type="checkbox"/> pasable <input type="checkbox"/> poco <input type="checkbox"/> no		
• ¿Le da asco esta práctica? <input type="checkbox"/> mucho asco <input type="checkbox"/> asco <input type="checkbox"/> poco asco <input type="checkbox"/> indeciso <input type="checkbox"/> no		
• ¿Cuáles cree que son los problemas principales de la defecación al aire libre?		

D. Experiencia con ADRA		
19. ¿Porqué quiso un baño ecológico de ADRA?		
20. ¿ADRA exigió alguna contraparte para la implementación del baño?	<input type="checkbox"/> sí	<input type="checkbox"/> no
↪ Sí: ¿qué?		
21. ¿ADRA le explicó...		
↪ cómo se usa el baño?	<input type="checkbox"/> sí	<input type="checkbox"/> no
↪ cómo funcionaría el servicio de recolección?	<input type="checkbox"/> sí	<input type="checkbox"/> no
• Sí: ¿cómo?		
↪ cuánto costaría el servicio de recolección	<input type="checkbox"/> sí	<input type="checkbox"/> no
• Sí: ¿cuánto?		

E. Baño ecológico		
22. ¿El baño ecológico es el baño principal que usa?	<input type="checkbox"/> sí	<input type="checkbox"/> no
↪ Sí	⇒ F.1	
↪ No	⇒ F.2	

F.1 Baño ecológico - en uso		
23. ¿Piensa que usar el baño ecológico es importante para la salud?		
<input type="checkbox"/> muy imp. <input type="checkbox"/> imp. <input type="checkbox"/> relativamente imp. <input type="checkbox"/> poco imp. <input type="checkbox"/> no imp.		
24. ¿El baño ecológico le parece una tecnología higiénica?		
<input type="checkbox"/> muy hig. <input type="checkbox"/> hig. <input type="checkbox"/> relativamente hig. <input type="checkbox"/> poco hig. <input type="checkbox"/> no hig.		
25. ¿Piensa que usar el baño ecológico es económico?		
<input type="checkbox"/> muy econ. <input type="checkbox"/> econ. <input type="checkbox"/> relativamente econ. <input type="checkbox"/> no econ. <input type="checkbox"/> caro		
26. ¿El baño ecológico aumentó su sentimiento de seguridad?		
<input type="checkbox"/> muchísimo <input type="checkbox"/> mucho <input type="checkbox"/> relativamente <input type="checkbox"/> poco <input type="checkbox"/> no		
27. ¿Le gusta la posibilidad de reutilizar los productos (orina, compost)?		
<input type="checkbox"/> gusta mucho <input type="checkbox"/> gusta <input type="checkbox"/> gusta relativamente <input type="checkbox"/> indiferente <input type="checkbox"/> no gusta		
28. ¿Con qué frecuencia usa el baño ecológico?		
<input type="checkbox"/> siempre <input type="checkbox"/> frecuentemente <input type="checkbox"/> regularmente <input type="checkbox"/> rara vez <input type="checkbox"/> casi nada		



29. ¿Tiene problemas con el baño? ↪ Sí: ¿qué tipo? • Olor: <input type="checkbox"/> siempre <input type="checkbox"/> frecuentemente <input type="checkbox"/> regularmente <input type="checkbox"/> rara vez <input type="checkbox"/> casi nada • Moscas: <input type="checkbox"/> siempre <input type="checkbox"/> frecuentemente <input type="checkbox"/> regularmente <input type="checkbox"/> rara vez <input type="checkbox"/> casi nada • Atascamiento con las heces: <input type="checkbox"/> siempre <input type="checkbox"/> frecuentem. <input type="checkbox"/> regularmente <input type="checkbox"/> rara vez <input type="checkbox"/> casi nada • Otros: ¿qué?	<input type="checkbox"/> sí <input type="checkbox"/> no
30. ¿Usa el baño ecológico correctamente? <input type="checkbox"/> siempre <input type="checkbox"/> frecuentemente <input type="checkbox"/> regularmente <input type="checkbox"/> rara vez <input type="checkbox"/> casi nada • ¿Qué significa “usar el baño correctamente”?	
31. ¿Usa material secante? ↪ Sí: ¿qué tipo, cuánto cuesta? • Papel • Ceniza • Tierra • Aserrin • Otros: ¿qué?	<input type="checkbox"/> sí <input type="checkbox"/> no <input type="checkbox"/> Bs. <input type="checkbox"/> Bs. <input type="checkbox"/> Bs. <input type="checkbox"/> Bs.
32. ¿Con qué frecuencia se llenan ... • los bidones de orina? • el tacho de heces?	/semana /mes
33. ¿Usa un servicio de recolección de las heces? ↪ Sí: ¿organizado por quién? • ¿Cuánto cuesta? ↪ No: ¿qué hace con las heces? • ¿Quién es responsable de la eliminación de las heces en la familia? • ¿Cómo maneja las heces? • ¿Cómo se siente manejar las heces? <input type="checkbox"/> muchísimo asco <input type="checkbox"/> mucho as. <input type="checkbox"/> as. <input type="checkbox"/> poco as. <input type="checkbox"/> no as. • ¿Es un esfuerzo manejar las heces? <input type="checkbox"/> muchísimo <input type="checkbox"/> mucho <input type="checkbox"/> relativamente <input type="checkbox"/> poco <input type="checkbox"/> no • ¿Dónde deja las heces?	<input type="checkbox"/> sí <input type="checkbox"/> no Bs./vez
34. ¿Usa un servicio de recolección de la orina? ↪ Sí: ¿organizado por quién? • ¿Cuánto cuesta? ↪ No: ¿qué hace con las orina? • ¿Quién es responsable de la eliminación de las orina en la familia? • ¿Cómo maneja las orina? • ¿Cómo se siente manejar la orina? <input type="checkbox"/> muchísimo asco <input type="checkbox"/> mucho as. <input type="checkbox"/> as. <input type="checkbox"/> poco as. <input type="checkbox"/> no as. • ¿Es un esfuerzo manejar la orina? <input type="checkbox"/> muchísimo <input type="checkbox"/> mucho <input type="checkbox"/> relativamente <input type="checkbox"/> poco <input type="checkbox"/> no • ¿Dónde deja la orina?	<input type="checkbox"/> sí <input type="checkbox"/> no Bs./vez
35. ¿Cómo hacía sus necesidades antes de la construcción del baño ecológico? • Pozo séptico • Pozo ciego • Baño público • Orinal • Defecación al aire libre • Otros: ¿qué?	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
36. ¿Ha cambiado el diseño del baño? ↪ Sí: ¿porqué? • ¿Cómo?	<input type="checkbox"/> sí <input type="checkbox"/> no
37. ¿Tiene otro baño? ↪ Sí: ¿qué tipo? • Lo prefieres al baño ecológico? ¿Porqué?	<input type="checkbox"/> sí <input type="checkbox"/> no



F.2 Baño ecológico - no usado	
38. ¿Cómo hace sus necesidades? <ul style="list-style-type: none"> • Pozo séptico • Pozo ciego • Baño público • Orinal • Defecación al aire libre • Otros: ¿qué? 	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
39. ¿Usaba el baño después de la construcción? ↪ Sí: ¿por cuánto tiempo? <ul style="list-style-type: none"> • ¿Porqué dejó de usar el baño ecológico? 	<input type="checkbox"/> sí <input type="checkbox"/> no
40. ¿El baño ecológico le parecía una tecnología insalubre? <input type="checkbox"/> muy insalubre <input type="checkbox"/> insalubre <input type="checkbox"/> relativamente insalubre <input type="checkbox"/> poco insalubre <input type="checkbox"/> salubre	
41. ¿Tenía algunos de los problemas siguientes? <ul style="list-style-type: none"> • Olor: <input type="checkbox"/> siempre <input type="checkbox"/> frecuentem. <input type="checkbox"/> regularmente <input type="checkbox"/> rara vez <input type="checkbox"/> casi nada • Moscas: <input type="checkbox"/> siempre <input type="checkbox"/> frecuentem. <input type="checkbox"/> regularmente <input type="checkbox"/> rara vez <input type="checkbox"/> casi nada • Atascamiento con las heces: <input type="checkbox"/> siempre <input type="checkbox"/> frecuentem. <input type="checkbox"/> regularmente <input type="checkbox"/> rara vez <input type="checkbox"/> casi nada 	
42. ¿Sabe cómo se usa el baño ecológico correctamente? <input type="checkbox"/> muy bien <input type="checkbox"/> bien <input type="checkbox"/> relativamente bien <input type="checkbox"/> no realmente <input type="checkbox"/> no <ul style="list-style-type: none"> • ¿Si tuviese un taller de capacitación, usaría el baño? <input type="checkbox"/> con seguridad <input type="checkbox"/> alta <input type="checkbox"/> media <input type="checkbox"/> baja <input type="checkbox"/> no	
43. ¿Si tendría un servicio de recolección, usaría el baño ecológico? <input type="checkbox"/> con seguridad <input type="checkbox"/> alta <input type="checkbox"/> media <input type="checkbox"/> baja <input type="checkbox"/> no	
G. Producción y uso de compost	
44. ¿Separa la basura orgánica? ↪ Sí: ¿qué hace con los residuos orgánicos? <ul style="list-style-type: none"> • Compostaje • Alimentación de animales • Botado en el predio de la casa • Aplicación directa a la tierra • Otros: ¿qué? 	<input type="checkbox"/> sí <input type="checkbox"/> no <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
45. ¿Tiene tierra agrícola/huerto? ↪ Sí: ¿usa fertilizante químico? <ul style="list-style-type: none"> • ¿Usa abono? • ¿Usa orina? • ¿Usa compost? 	<input type="checkbox"/> sí <input type="checkbox"/> no <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
46. ¿Tiene animales? ↪ Sí: ¿cuáles, cuántos? <ul style="list-style-type: none"> • Ganado ovino/caprino • Ganado vacuno • Gallinas • Otros: ¿qué? • ¿Qué hace con el abono? 	<input type="checkbox"/> sí <input type="checkbox"/> no <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>

H. Percepción de la situación de saneamiento y propuestas de mejoramiento	
47. ¿En general, está satisfecho/a con la situación de saneamiento?	
<ul style="list-style-type: none"> Agua potable: <input type="checkbox"/> muy satisf. <input type="checkbox"/> satisf. <input type="checkbox"/> rel. satisf. <input type="checkbox"/> poco satisf. <input type="checkbox"/> no satisf. ¿Cuáles son los problemas principales? Saneamiento básico (baños): <input type="checkbox"/> muy satisf. <input type="checkbox"/> satisf. <input type="checkbox"/> rel. satisf. <input type="checkbox"/> poco satisf. <input type="checkbox"/> no satisf. ¿Cuáles son los problemas principales? Residuos sólidos (basura): <input type="checkbox"/> muy satisf. <input type="checkbox"/> satisf. <input type="checkbox"/> rel. satisf. <input type="checkbox"/> poco satisf. <input type="checkbox"/> no satisf. ¿Cuáles son los problemas principales? 	
48. ¿Cuáles son sus prioridades? (1...3, 1 = prioridad)	
<ul style="list-style-type: none"> Saneamiento básico (baños) Agua potable Residuos sólidos (basura) 	
49. ¿En su opinión, cuáles son las ventajas del baño ecológico?	
50. ¿En su opinión, cuáles son los inconvenientes del baño ecológico?	
51. ¿Qué otro tipo de baño le gustaría? ¿Porqué?	
52. ¿Usaría el compost de los baños ecológicos?	<input type="checkbox"/> sí <input type="checkbox"/> no
↪ No: ¿porqué no?	
53. ¿Actualmente, paga una tasa de aseos?	<input type="checkbox"/> sí <input type="checkbox"/> no
↪ Sí: ¿cuánto?	Bs./mes
54. ¿Pagaría por un servicio de recolección de...	
<ul style="list-style-type: none"> los bidones de orina? los tachos de heces? 	<input type="checkbox"/> sí <input type="checkbox"/> no <input type="checkbox"/> sí <input type="checkbox"/> no
55. ¿Qué tipo de servicio de recolección le gustaría?	
<ul style="list-style-type: none"> ¿Un servicio que se puede llamar cuándo los contenedores están llenos? Sí: ¿cuánto pagaría? ¿Un servicio que viene periódicamente? Sí: ¿con qué frecuencia? Cuánto pagaría para un servicio que viene una vez por semana? Cuánto pagaría para un servicio que viene una vez por mes? 	<input type="checkbox"/> sí <input type="checkbox"/> no Bs./vez <input type="checkbox"/> sí <input type="checkbox"/> no Bs./mes Bs./mes
56. ¿Si tuviese un servicio de recolección, que sería su voluntad de usarlo?	
<input type="checkbox"/> con seguridad <input type="checkbox"/> alta <input type="checkbox"/> media <input type="checkbox"/> baja <input type="checkbox"/> no	
57. ¿En su opinión, cómo están las acciones/inversiones del municipio en su OTB en el sector de agua y saneamiento?	
58. ¿Tiene alguna propuesta de cómo podría funcionar mejor?	

¡Muchas gracias para su ayuda!

Encuesta a los hogares sin baños ecológicos

El objetivo de esta encuesta es de identificar las principales preocupaciones de la comunidad en el sector de saneamiento. Con su ayuda, esperamos contribuir al mejoramiento de los servicios de saneamiento en la OTB.

Para responder a esta encuesta necesitará aproximadamente 45 minutos. Toda la información será tratada de manera confidencial y no será distribuida a terceras partes.

¿Está de acuerdo con participar a la encuesta? No Sí Firma:

Número de encuesta			
Comunidad	<input type="checkbox"/> Cristal Mayu <input type="checkbox"/> Llave Mayu <input type="checkbox"/> Fortaleza <input type="checkbox"/> Florida <input type="checkbox"/> 20 de Mayo <input type="checkbox"/> Villa Montes <input type="checkbox"/> Yuraj Jallpa		
Longitud		Latitud	
Fecha		Duración	
Inicio		Fin	
Completo	<input type="checkbox"/> sí <input type="checkbox"/> no	Fotos	

A. Encuestado/a	
1. Nombre y apellido	
2. Jefe/a del hogar	<input type="checkbox"/> sí <input type="checkbox"/> no
3. ¿Nació en el municipio de Arbieto?	<input type="checkbox"/> sí <input type="checkbox"/> no
↪ No: ¿dónde?	
• ¿Porqué se cambió de domicilio?	
4. ¿Desde cuándo vive en esta casa?	
5. ¿Cuál es el máximo nivel de estudio alcanzado?	
• No educación formal	<input type="checkbox"/>
• Primaria	<input type="checkbox"/>
• Secundaria	<input type="checkbox"/>
• Licenciatura universitaria	<input type="checkbox"/>
• Técnico	<input type="checkbox"/>

B. Hogar	
6. ¿Cuántas personas viven en el hogar?	
• Total	pers.
• Mayores de edad - hombres	pers.
• Mayores de edad - mujeres	pers.
• Menores/niños	pers.
↪ ¿Hay variaciones en el número de personas? (día de semana/fin de semana, temporada, ...)	
↪ ¿Hay personas presentes en la vivienda durante el día (lunes a sábado)?	<input type="checkbox"/> sí <input type="checkbox"/> no
• ¿Quién, cuántas?	
7. ¿La vivienda le pertenece?	
↪ Sí: ¿la compró de alguien o la construyó usted?	<input type="checkbox"/> sí <input type="checkbox"/> no
↪ No: ¿cuánto es el alquiler?	Bs./mes

8. ¿Cuál es la ocupación principal/fuente de ingresos?	
• Agricultor/a	<input type="checkbox"/>
• Comerciante	<input type="checkbox"/>
• Obrero/a	<input type="checkbox"/>
• Empleado/a	<input type="checkbox"/>
• Otro: ¿qué?	
9. ¿Dónde trabaja?	
• OTB	<input type="checkbox"/>
• Arbieta (municipio)	<input type="checkbox"/>
• Cochabamba (ciudad)	<input type="checkbox"/>
• Otro: ¿dónde?	
10. ¿Tiene electricidad?	<input type="checkbox"/> sí <input type="checkbox"/> no
↪ Sí: ¿qué electrodomesticos tiene en su hogar?	
• Celular	<input type="checkbox"/>
• Televisor	<input type="checkbox"/>
• Refrigerador	<input type="checkbox"/>
• Lavadora	<input type="checkbox"/>
• Otros: ¿qué?	

C. Suministro de agua y saneamiento	
11. ¿Cuál es la procedencia principal del agua?	
• Cañería de red	<input type="checkbox"/>
• Pileta pública	<input type="checkbox"/>
• Carro repartidor (aguatero)	<input type="checkbox"/>
• Pozo o noria	<input type="checkbox"/>
• Lluvia, río, vertiente, acequia	<input type="checkbox"/>
• Otros: ¿qué?	
12. ¿Para las actividades siguientes, cuál es la procedencia del agua?	
• Beber	
• Cocinar	
• Lavar la vajilla	
• Ducharse/bañarse	
• Lavar la ropa	
13. ¿Qué hace con el agua residual de las siguientes actividades?	
• Lavar la vajilla	
• Ducharse/bañarse	
• Lavar la ropa	
• Si usa pozo de drenaje: ¿hay problemas de infiltración?	<input type="checkbox"/> sí <input type="checkbox"/> no
14. ¿Sabe cuánto agua se usa en el hogar?	<input type="checkbox"/> sí <input type="checkbox"/> no
↪ Sí: ¿cuánto?	
15. ¿Paga por el suministro de agua	<input type="checkbox"/> sí <input type="checkbox"/> no
↪ Sí: ¿cuánto?	Bs./mes
• ¿Cómo se calcula el pago por agua?	
• Medidor de agua	<input type="checkbox"/>
• Tarifa fija	<input type="checkbox"/>
• Otro: ¿qué?	



16. ¿Qué piensa de la calidad del suministro de agua?	
• Cantidad: <input type="checkbox"/> mucho <input type="checkbox"/> suficiente <input type="checkbox"/> poco <input type="checkbox"/> muy poco <input type="checkbox"/> nada	
• Constancia: <input type="checkbox"/> siempre <input type="checkbox"/> frecuentemente <input type="checkbox"/> regularmente <input type="checkbox"/> rara vez <input type="checkbox"/> nunca	
• Sabor: <input type="checkbox"/> muy bueno <input type="checkbox"/> bueno <input type="checkbox"/> normal <input type="checkbox"/> malo <input type="checkbox"/> muy malo	
• Presión (si hay cañería): <input type="checkbox"/> muy alta <input type="checkbox"/> alta <input type="checkbox"/> normal <input type="checkbox"/> baja <input type="checkbox"/> muy baja	
17. ¿Hierve/filtra el agua antes del consumo?	
<input type="checkbox"/> siempre <input type="checkbox"/> frecuentem. <input type="checkbox"/> regularmente <input type="checkbox"/> rara vez <input type="checkbox"/> nunca	
18. ¿Hay un servicio de recolección de los residuos sólidos?	<input type="checkbox"/> sí <input type="checkbox"/> no
↪ Sí: ¿con qué frecuencia?	vez/sem.
• ¿Paga para el servicio?	<input type="checkbox"/> sí <input type="checkbox"/> no
• Sí: ¿cuánto cuesta?	Bs./vez
↪ No: ¿qué hace con la basura?	

D. Percepción del baño actual

19. ¿Qué baño usa?	
↪ Baño propio	⇒ D.1
↪ Otro baño	⇒ D.2
↪ No usa baño	⇒ D.3

D.1 Usa su propio baño

20. ¿Qué tipo de baño usa ?	
• Pozo séptico	<input type="checkbox"/>
• Pozo ciego (¿cuánto cuesta la evacuación, con qué frecuencia?)	<input type="checkbox"/>
• Otro: ¿qué?	
21. ¿Es un baño dónde tiene que ponerse en cuclillas o sentado?	<input type="checkbox"/> en cucl. <input type="checkbox"/> sentado
22. ¿Porqué seleccionó este tipo de baño?	
23. ¿Piensa qué usar este baño...	
• es importante para la salud? <input type="checkbox"/> muy imp. <input type="checkbox"/> imp. <input type="checkbox"/> relativamente imp. <input type="checkbox"/> poco imp. <input type="checkbox"/> no imp.	
• es económico? <input type="checkbox"/> muy econ. <input type="checkbox"/> econ. <input type="checkbox"/> relativamente econ. <input type="checkbox"/> no econ. <input type="checkbox"/> caro	
• ha aumentado su seguridad? <input type="checkbox"/> muchísimo <input type="checkbox"/> mucho <input type="checkbox"/> relativamente <input type="checkbox"/> poco <input type="checkbox"/> no	
24. ¿Hay un otro tipo de baño que preferiría? ¿Porqué?	

D.2 Usa un otro baño

25. ¿A quién pertenece el baño que usa? ¿Dónde está?	
• A una otra familia (¿parientes o vecinos?)	<input type="checkbox"/>
• Baño publico	<input type="checkbox"/>
• Al trabajo	<input type="checkbox"/>
• Otro: ¿a quién pertenece, dónde está?	
25. ¿Tiene que pagar para el uso del baño?	<input type="checkbox"/> sí <input type="checkbox"/> no
↪ Sí: ¿cuánto?	
26. ¿Qué tipo de baño usa?	
• Baño ecológico	<input type="checkbox"/>
• Pozo séptico	<input type="checkbox"/>
• Pozo ciego	<input type="checkbox"/>
• Otro: ¿qué?	
27. ¿Es un baño dónde tiene que ponerse en cuclillas o sentado?	<input type="checkbox"/> en cucl. <input type="checkbox"/> sentado



28. ¿Piensa qué usar este baño...	
• es importante para su salud? <input type="checkbox"/> muy imp. <input type="checkbox"/> imp. <input type="checkbox"/> relativamente imp. <input type="checkbox"/> poco imp. <input type="checkbox"/> no imp.	
• es económico? <input type="checkbox"/> muy econ. <input type="checkbox"/> econ. <input type="checkbox"/> relativamente econ. <input type="checkbox"/> no econ. <input type="checkbox"/> caro	
• ha aumentado su seguridad? <input type="checkbox"/> muchísimo <input type="checkbox"/> mucho <input type="checkbox"/> relativamente <input type="checkbox"/> poco <input type="checkbox"/> no	
29. ¿Tiene planes de construir su propio baño?	<input type="checkbox"/> sí <input type="checkbox"/> no
↪ Sí: ¿Cuándo, qué tipo, sentado o en cuclillas?	

D.3 No usa baño

30. ¿Porqué no tiene baño?	
31. ¿Dónde hace sus necesidades? Puede ir a este lugar durante el día o solo durante la noche?	
32. Se siente incómodo/a haciendo sus necesidades al aire libre? <input type="checkbox"/> muchísimo <input type="checkbox"/> mucho <input type="checkbox"/> relativamente <input type="checkbox"/> poco <input type="checkbox"/> no	
33. ¿Piensa qué hacer sus necesidades al aire libre es...	
• un riesgo para su salud? <input type="checkbox"/> muchísimo <input type="checkbox"/> mucho <input type="checkbox"/> relativamente <input type="checkbox"/> poco <input type="checkbox"/> no	
• un riesgo para su seguridad? <input type="checkbox"/> muchísimo <input type="checkbox"/> mucho <input type="checkbox"/> relativamente <input type="checkbox"/> poco <input type="checkbox"/> no	
34. ¿Tiene planes de construir su propio baño?	<input type="checkbox"/> sí <input type="checkbox"/> no
↪ Sí: ¿Cuándo, qué tipo, sentado o en cuclillas?	

E. Percepción de los baños ecológicos

35. ¿Vivía en la OTB cuándo ADRA construyó los baños?	<input type="checkbox"/> sí <input type="checkbox"/> no
↪ Sí: ¿porqué no tiene baño ecológico?	
• ¿Quiso un baño ecológico pero ADRA rechazó su solicitud? ¿Porqué?	
• ¿No quiso un baño ecológico? ¿Porqué no?	
36. ¿Conoce ventajas del baño ecológico?	
37. ¿Conoce inconvenientes del baño ecológico?	
38. ¿Cuántas familias con baños ecológicos cree que usan los baños? <input type="checkbox"/> casi todas <input type="checkbox"/> muchas <input type="checkbox"/> algunas <input type="checkbox"/> pocas <input type="checkbox"/> nada	
↪ ¿Porqué hay familias que no usan los baños?	
39. ¿Piensa que usar el baño ecológico es importante para la salud? <input type="checkbox"/> muy imp. <input type="checkbox"/> imp. <input type="checkbox"/> relativamente imp. <input type="checkbox"/> poco imp. <input type="checkbox"/> no imp.	
40. ¿El baño ecológico le parece una tecnología higiénica? <input type="checkbox"/> muy hig. <input type="checkbox"/> hig. <input type="checkbox"/> relativamente hig. <input type="checkbox"/> poco hig. <input type="checkbox"/> no hig.	
41. ¿Piensa que usar el baño ecológico es económico? <input type="checkbox"/> muy econ. <input type="checkbox"/> econ. <input type="checkbox"/> relativamente econ. <input type="checkbox"/> no econ. <input type="checkbox"/> caro	
42. ¿Piensa que el baño ecológico aumentaría su sentimiento de seguridad? <input type="checkbox"/> muchísimo <input type="checkbox"/> mucho <input type="checkbox"/> relativamente <input type="checkbox"/> poco <input type="checkbox"/> no	
43. ¿Le gustaría la posibilidad de reutilizar los productos (orina, compost)? <input type="checkbox"/> gusta mucho <input type="checkbox"/> gusta <input type="checkbox"/> gusta relativamente <input type="checkbox"/> indiferente <input type="checkbox"/> no gusta	
↪ ¿Usaría el compost de los baños ecológicos?	<input type="checkbox"/> sí <input type="checkbox"/> no
↪ No: ¿porqué no?	
44. ¿Querría un baño ecológico? <input type="checkbox"/> muchísimo <input type="checkbox"/> mucho <input type="checkbox"/> relativamente <input type="checkbox"/> poco <input type="checkbox"/> no	
↪ ¿Dedicaría una contraparte por el baño (dinero, mano de obra)? ¿Cuánto?	
↪ ¿Preferiría un otro tipo de baño? ¿Cuál?	



G. Producción y uso de compost	
45. ¿Separa la basura orgánica?	<input type="checkbox"/> sí <input type="checkbox"/> no
↪ Sí: ¿qué hace con los residuos orgánicos?	
• Compostaje	<input type="checkbox"/>
• Alimentación de animales	<input type="checkbox"/>
• Botado en el predio de la casa	<input type="checkbox"/>
• Aplicación directa a la tierra	<input type="checkbox"/>
• Otros: ¿qué?	
46. ¿Tiene tierra agrícola/huerto?	<input type="checkbox"/> sí <input type="checkbox"/> no
↪ Sí: ¿usa fertilizante químico?	<input type="checkbox"/>
• ¿Usa abono?	<input type="checkbox"/>
• ¿Usa orina?	<input type="checkbox"/>
• ¿Usa compost?	<input type="checkbox"/>
47. ¿Tiene animales?	<input type="checkbox"/> sí <input type="checkbox"/> no
↪ Sí: ¿cuáles, cuántos?	
• Ganado ovino/caprino	<input type="checkbox"/>
• Ganado vacuno	<input type="checkbox"/>
• Gallinas	<input type="checkbox"/>
• Otros: ¿qué?	
• ¿Qué hace con el abono?	
H. Percepción de la situación de saneamiento y propuestas de mejoramiento	
48. ¿En general, está satisfecho/a con la situación de saneamiento?	
• Agua potable: <input type="checkbox"/> muy satisf. <input type="checkbox"/> satisf. <input type="checkbox"/> rel. satisf. <input type="checkbox"/> poco satisf. <input type="checkbox"/> no satisf.	
• ¿Cuáles son los problemas principales?	
• Saneamiento básico (baños): <input type="checkbox"/> muy satisf. <input type="checkbox"/> satisf. <input type="checkbox"/> rel. satisf. <input type="checkbox"/> poco satisf. <input type="checkbox"/> no satisf.	
• ¿Cuáles son los problemas principales?	
• Residuos sólidos (basura): <input type="checkbox"/> muy satisf. <input type="checkbox"/> satisf. <input type="checkbox"/> rel. satisf. <input type="checkbox"/> poco satisf. <input type="checkbox"/> no satisf.	
• ¿Cuáles son los problemas principales?	
49. ¿Cuánta gente en la OTB cree que defecan al aire libre?	
<input type="checkbox"/> casi todos <input type="checkbox"/> muchos <input type="checkbox"/> algunos <input type="checkbox"/> pocos <input type="checkbox"/> nadie	
↪ ¿Cuál es su percepción la defecación al aire libre?	
• ¿Le parece aceptable esta práctica? <input type="checkbox"/> completamente <input type="checkbox"/> mayormente <input type="checkbox"/> pasable <input type="checkbox"/> poco <input type="checkbox"/> no	
• ¿Le da asco esta práctica? <input type="checkbox"/> mucho asco <input type="checkbox"/> asco <input type="checkbox"/> poco asco <input type="checkbox"/> indeciso <input type="checkbox"/> no	
• ¿Cuáles son los problemas principales de la defecación al aire libre?	
50. ¿Cuáles son sus prioridades? (1...3, 1 = prioridad)	
• Saneamiento básico (baños)	
• Agua potable	
• Residuos sólidos (basura)	
51. ¿Actualmente, paga una tasa de aseos?	<input type="checkbox"/> sí <input type="checkbox"/> no
↪ Sí: ¿cuánto?	Bs./mes
52. ¿En su opinión, cómo están las acciones/inversiones del municipio en su OTB en el sector de agua y saneamiento?	
53. ¿Tiene alguna propuesta de cómo podría funcionar mejor?	

¡Muchas gracias para su ayuda!

APPENDIX B

Mapa de las OTBs

El mapa en la próxima página presenta la ubicación de los baños en las 7 OTBs según un levantamiento en el terreno. No incluye los baños no completados. Tampoco se pudieron contar los baños que están adentro de las casas. Los límites entre OTBs son solo indicativas: no corresponden a los límites oficiales, ya que no existen mapas oficiales y que hay conflictos de terreno entre las OTBs.

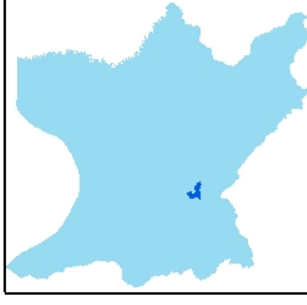
**Ubicación de Baños Secos Municipio Arbietao
Distrito 4**

170000



170000

Departamento de Cochabamba:



Leyenda

OTB

- 20 de Mayo
- Cristal Mayu
- Fortaleza
- La Florida
- Liave Mayu
- Villa Montes
- Yuraj Jalpa

1 cm = 200 metros

Sistema de Proyección:
Universal Transverse Mercator
Sistema de Referencia: WGS 84 - Zona 19

Escala Gráfica:



DEPARTAMENTO DE COCHABAMBA

ESTUDIO DE IDENTIFICACIÓN Y UBICACIÓN DE BAÑOS SECOS EN EL DISTRITO 4 DEL MUNICIPIO DE BAÑOS SECOS

Ubicación de Baños Secos Municipio Arbietao
Distrito 4

Elaborado por: Israel Ruben Borelio Campopero
Fuente: Elaboración propia

Características de los actores principales

Para cada actor clave, se resumen (adaptado de [19]):

- el implicación: el rol del actor
- los intereses: la motivación del actor para participar en el proyecto
- los fortalezas: características del actor beneficiaras al éxito del proyecto
- los debilidades: características del actor potencialmente dañables al éxito del proyecto
- los oportunidades: perspectivas positivas del proyecto para el actor¹
- los amenazas: perspectivas negativas del proyecto para el actor
- el impacto: el tipo de influencia que el proyecto puede tener sobre el actor

¹En [19], se refiere a las oportunidades para el proyecto. Sin obstante, en nuestro caso es más interesante identificar las oportunidades para el actor; las oportunidades para el proyecto (si hay) están parte de las fortalezas. El mismo comentario se aplica a las amenazas.

Actor	Implicación	Intereses	Fortalezas	Debilidades	Oportunidades	Amenazas	Impactos
Alcalde y consejo municipal	El municipio es responsable de la provisión de los servicios básicos.	<ol style="list-style-type: none"> Interés político de cumplir con las demandas de los OTBs; 2. Obligación de cumplimiento de la Ley. 	Disponibilidad de fondos por el arranque de la planta de tratamiento de las heces (POA: 40'000 Bs.)	Presión social y política en la toma de decisiones.	<ol style="list-style-type: none"> Disponibilidad de fondos de donantes; 2. Cumplimiento con la obligación de brindar un servicio sostenible. 	Si el proyecto no funciona: 1. Desconfianza de la población; 2. Pérdida de fondos.	<ol style="list-style-type: none"> Credibilidad de la gente hacia la gestión municipal; 2. Impacto político positivo; 3. Cumplimiento de metas en saneamiento.
Ingenieros municipales responsables de saneamiento básico	Los ingenieros son responsables de la implementación de servicios básicos en el municipio.	Cumplir con la demanda del alcalde que la planta funciona lo antes posible.	<ol style="list-style-type: none"> Conocimiento técnico; 2. Conocimiento de la realidad en el terreno. 	<ol style="list-style-type: none"> Cambios de personal frecuentes (poco experiencia); 2. Disponibilidad reducida (responsables para proyectos en todo el municipio); 3. Falta de personal técnico operativo. 	Cumplimiento con la demanda del alcalde.	Si el proyecto no funciona: 1. Desconfianza del alcalde; 2. Pérdida de tiempo.	Credibilidad del alcalde hacia su competencia de gestión de proyectos.
Representantes OTBs (Presidente, Comité de agua)	Los representantes OTB comunican las necesidades de los habitantes a las autoridades municipales.	<ol style="list-style-type: none"> Solucionar los problemas de saneamiento básico de sus OTBs; 2. Récito social y político. 	<ol style="list-style-type: none"> Poder de persuasión sobre la población; 2. Convocatoria a espacios de participación; 3. Nexos entre autoridades, actores y población. 	<ol style="list-style-type: none"> Falta de conocimiento técnico; 2. Falta de recursos (tiempo, información, movilización); 3. Gestiones cortas en relación al ciclo del proyecto. 	<ol style="list-style-type: none"> Reconocimiento social a su gestión; 2. Emergencia de poderamiento; 3. Mejoramiento de sus condiciones de vida. 	Si el proyecto no funciona: 1. Pérdida de confianza de la población; 2. Pérdida de tiempo.	<ol style="list-style-type: none"> Mayor confianza por parte de la población hacia la autoridad; 2. Mayor legitimidad; 3. Aliado en futuros proyectos.
Población de las OTBs	La población sufre de la falta de servicios de saneamiento básico (incomodidad, salud, inseguridad)	<ol style="list-style-type: none"> Contar con un servicio de acuerdo a sus necesidades (salud, seguridad, economía) y aceptación; 2. Reducción del número de gente que defeca al aire libre (olores, salud, medio ambiente). 	<ol style="list-style-type: none"> Existe capacitación sobre la tecnología y conocimiento de su uso; 2. La mayoría está dispuesta al pago por el servicio. 	<ol style="list-style-type: none"> Falta de conocimiento técnico; 2. Falta de una visión conjunta de la situación; 3. Desconfianza en el trabajo de ONGs 	<ol style="list-style-type: none"> Mejora de las condiciones de salud y seguridad; 2. Fuentes de trabajo en el proyecto. 	<ol style="list-style-type: none"> Conservación del statu quo; 2. Falta de fondos por otros proyectos de saneamiento básico; 	<ol style="list-style-type: none"> Mejora de las condiciones de salud y seguridad; 2. Valorización de sus propiedades; 3. Posiblemente integración de otros servicios.
Fundación Aguatuya (Proyecto GAM)	Aguatuya brinda apoyo técnico al municipio de Arbieta.	Lograr servicios sostenibles de gestión ambiental (tratamiento de aguas residuales y gestión de residuos sólidos) en ciudades intermedias, y reducir la contaminación ambiental.	<ol style="list-style-type: none"> Buena relación con el municipio; 2. Conocimiento técnico; 3. Experiencia en la provisión de servicios sostenibles. 	<ol style="list-style-type: none"> Poco experiencia en la gestión de residuos sólidos; 2. Fracaso de proyectos de baños ecológicos secos. 	Credibilidad del municipio hacia sus capacidades técnicas; 2. Ganar experiencia en la gestión de residuos sólidos.	<ol style="list-style-type: none"> Desconfianza del municipio hacia sus capacidades técnicas; 2. Mayor dificultad para implementar otros proyectos en el municipio 	Aliados en futuros proyectos.

Tratamiento de datos y pruebas estadísticas

En este apéndice, se presentan algunas explicaciones sobre el tratamiento de datos y los métodos estadísticos utilizados (diagramas de caja, prueba de significación de Kruskal-Wallis, correlación de Pearson).

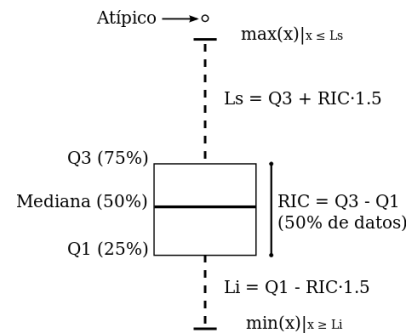
1. Tratamiento de datos

- Se corrigieron las respuestas donde los interrogadores manifiestamente se equivocaron cuando hicieron la cruz (por ejemplo marcaron que el encuestado no sabe cuanto agua se usa en el hogar, pero dieron un valor de consumo).
- También se corrigieron las respuestas donde los interrogadores manifiestamente mécomprendieron las respuestas. Por ejemplo, en Fortaleza, muchos encuestados respondieron que su fuente de agua es un pozo (pozo de la OTB) y los interrogadores marcaron pozo (privado).
- No se corrigieron las respuestas para las cuales los encuestados posiblemente mécomprendieron las preguntas. Algunas respuestas no tienen sentido a primera vista, pero a veces hay una explicación concluyente. Por ejemplo, un encuestado estaba muy satisfecho de la situación de agua y muy insatisfecho de la situación de baños y de basura. Sin obstante, su prioridad de intervención era el suministro de agua, porque estaba satisfecho del suministro *en su caso personal* (tenía un tanque de 12'000L), pero *a nivel de la OTB* le parecía el problema el más urgente.
- Para algunas preguntas abiertas (por ejemplo las razones para dejar de usar el baños), la respuestas posteriormente se clasificaron en diferentes categorías

2. Diagrama de caja

El diagrama de caja visualiza la distribución de un conjunto de datos. Suministra información sobre los siguientes valores:¹

- líneas verticales (los “bigotes”): valores mínimo y máximo en el intervalo $[Q_{25}-1.5\cdot\text{RIC}, Q_{75}+1.5\cdot\text{RIC}]$
- límites inferiores y superiores del rectángulo (la “caja”): cuartiles Q_{25} y Q_{75}
- línea horizontal adentro de la caja: mediana
- círculos: valores atípicos que salen del intervalo $[Q_{25}-1.5\cdot\text{RIC}, Q_{75}+1.5\cdot\text{RIC}]$



Fuente: es.wikipedia.org/wiki/Diagrama_de_caja

Con estos valores, el diagrama proporciona una visión de la simetría de la distribución de los datos. La distribución es asimétrica si la mediana no está en el centro de la caja. También se pueden fácilmente identificar los valores atípicos (“outliers”).

3. Prueba de significación de Kruskal-Wallis

Una prueba de significación nos permite determinar si las características de dos poblaciones (e.g. habitantes que usan los baños ecológicos y habitantes que no les usan) son estadísticamente diferentes. Siempre se basa en una hipótesis nula, H_0 . En nuestro caso la hipótesis nula es que no hay una diferencia significativa entre las dos poblaciones. La hipótesis alternativa, H_a , es que hay una diferencia significativa entre las poblaciones.

El valor p se define como la probabilidad de obtener un resultado al menos tan extremo como el que realmente se ha obtenido y se calcula dependiente de la distribución de los datos. Basado en un nivel de significación α , podemos

- rechazar H_0 en favor de H_a si $p < \alpha$
- no rechazar H_0 si $p > \alpha$

El valor α corresponde a la probabilidad de rechazar la hipótesis H_0 cuando era correcta. En el informe, se usa un valor α de 0.05, lo que significa que tenemos una probabilidad de 5 % de concluir que no hay diferencia entre las poblaciones cuando en realidad están diferentes.

Se usa una prueba de significación de Kruskal-Wallis. Es una prueba non-paramétrica, lo que significa que no tenemos que hacer asunciones sobre la distribución de la población. Para más detalle, se refiere a las siguientes páginas web:

- Ventajas y inconvenientes de pruebas de significación non-paramétricas: www.jerrydallal.com/lhsp/npar.htm

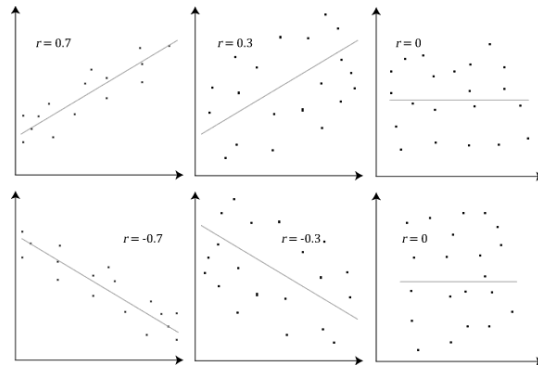
¹Recordatorio. 25 % de los valores son inferiores al Q_{25} ; 75 % de los valores son inferiores al Q_{75} ; el rango intercuartílico corresponde a $\text{RIC} = Q_{75} - Q_{25}$.

- Descripción de la prueba de significación de Kruskal-Wallis: vassarstats.net/textbook/ch14a.html
- Documentación R (R Core Team) sobre la prueba de significación de Kruskal-Wallis: stat.ethz.ch/R-manual/R-patched/library/stats/html/kruskal.test.html

4. Correlación de Pearson

La correlación de Pearson es una medida de la dependencia lineal de dos variables. Los valores del coeficiente de correlación de Pearson r se encuentran en el intervalo $[-1,1]$.

- $r < 0$: relación negativa, si el valor de una variable incrementa, el valor de la otra variable disminuye
- $r = 0$: no hay ninguna relación lineal entre las dos variables
- $r > 0$: relación positiva, si el valor de una variable incrementa, el valor de la otra variable también incrementa



Fuente: statistics.laerd.com/statistical-guides/pearson-correlation-coefficient-statistical-guide.php

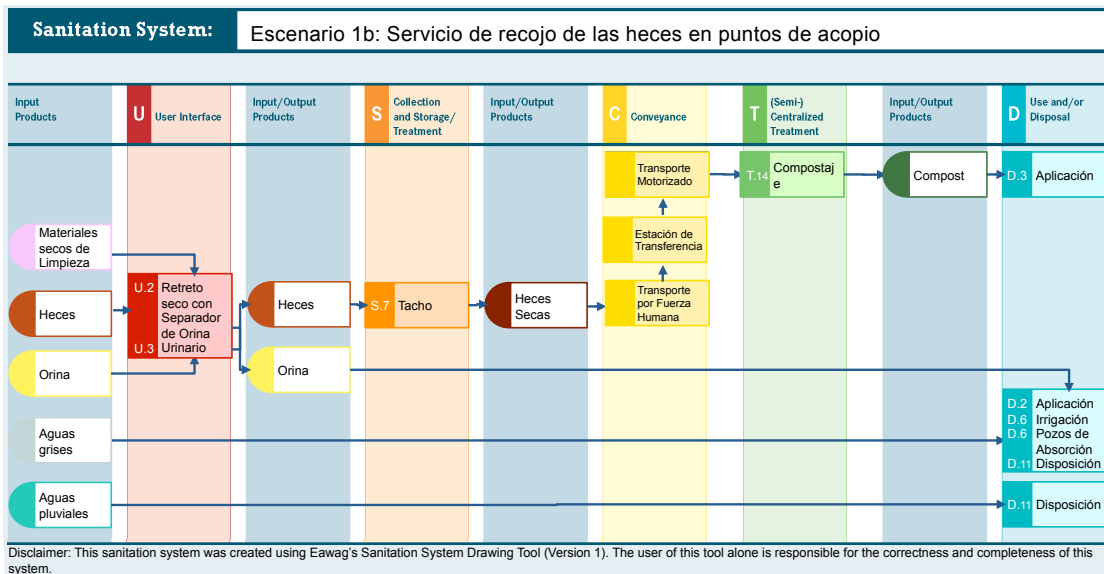
Es importante darse cuenta de dos limitaciones del coeficiente de correlación de Pearson:

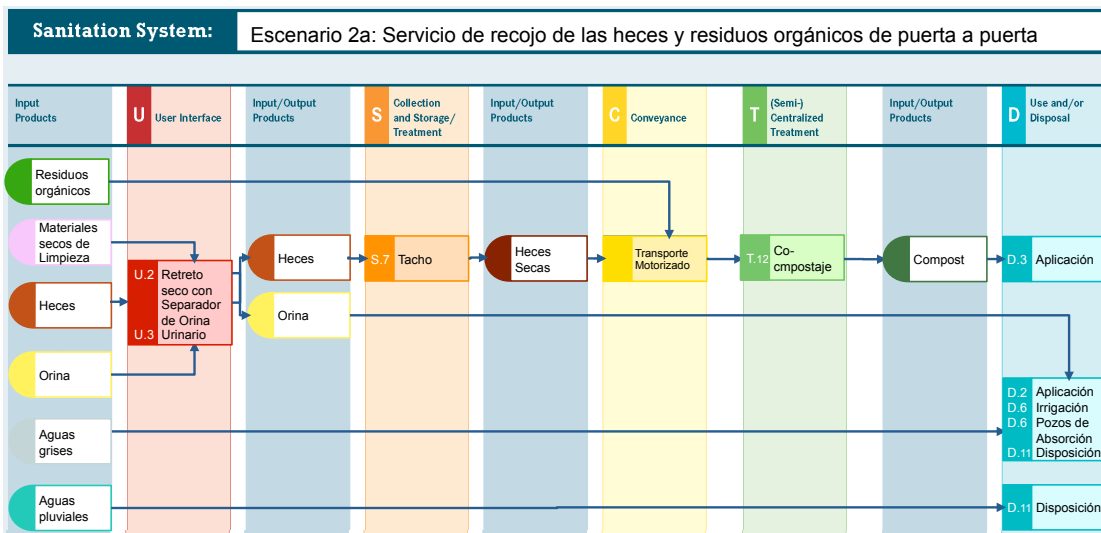
- Detecta solo relaciones lineales entre las variables, pero existen varios otros tipos de relaciones (p.ej. polinomial)
- *Correlation does not imply causation*. Una correlación entre dos variables no significa que están conectados causalmente.

Se puede encontrar información más amplia en las siguientes páginas web:

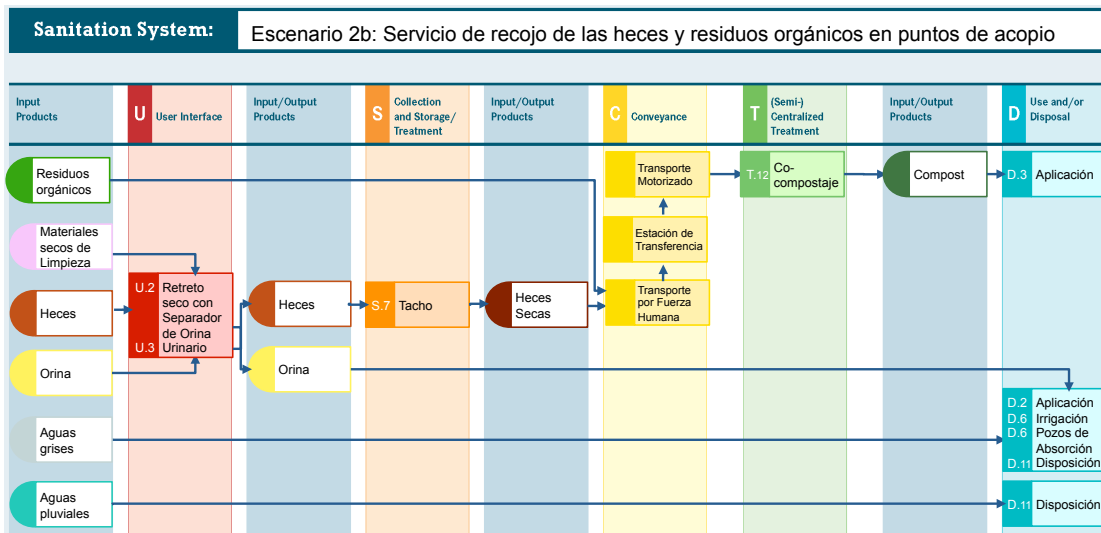
- Diferencia entre correlación y causa: www.stats.org/causation-vs-correlation/
- Definición del coeficiente de correlación de Pearson: statistics.laerd.com/statistical-guides/pearson-correlation-coefficient-statistical-guide.php

Sistemas de saneamiento evaluados





Disclaimer: This sanitation system was created using Eawag's Sanitation System Drawing Tool (Version 1). The user of this tool alone is responsible for the correctness and completeness of this system.



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Opciones de cadenas de servicio, mantenimiento y tarifa

El documento resume todas las alternativas de las siguientes dimensiones del servicio:

1. Cadena de servicios
2. Mantenimiento
3. Tarifa

El documento sirvo de base para el desarrollo de los escenarios de servicio estudiados. También es útil para afinar los escenarios.

1. Cadena de servicios

Dimensión	Aspecto	Alternativas				
Recolección	Heces	Recolección en los tachos actuales	Recolección en tachos más pequeños	Recolección en tachos con salida de líquidos	Recolección en bolsas	
	Orina	Servicio sin recolección de orina (utilización o infiltración al nivel del hogar)		Recolección en bidones		
	Residuos orgánicos	Servicio con recolección de residuos orgánicos		Servicio sin recolección de residuos orgánicos		
	Residuos sólidos (sin orgánicos)	Servicio con recolección de residuos sólidos		Servicio sin recolección de residuos sólidos		
Transporte	Heces	Operador recoge en las viviendas	Colector de la OTB recoge las heces en las viviendas y les lleva a un punto de acopio		Usuarios llevan las heces a un punto de acopio	
	Orina	Servicio sin recolección de orina	Operador recoge la orina en las viviendas	Colector de la OTB recoge la orina en las viviendas y la lleva a un punto de acopio	Usuarios llevan la orina a un punto de acopio	
	Residuos orgánicos	Servicio sin recolección de los residuos orgánicos	Operador de la planta recoge los orgánicos en las viviendas	Colector de la OTB lleva los orgánicos a un punto de acopio	Usuarios llevan los orgánicos a un punto de acopio	
	Residuos sólidos (sin org.)	Servicio sin recolección de los residuos sólidos	Operador de la planta recoge los residuos sólidos en las viviendas	Colector de la OTB lleva los orgánicos a un punto de acopio	Usuarios llevan los residuos sólidos a un punto de acopio	
	Personal	Uso exclusivo para el servicio		Uso para otras actividades del municipio sin contraparte financiera	Uso para otras actividades del municipio con contraparte financiera	
	Vehículo	Tiempo completo exclusivo para el servicio		Tiempo parcial exclusivo para el servicio	Tiempo completo con otras responsabilidades en el municipio	
Tratamiento	Instalación electricidad	Municipio		ELFEC	Empresa privada	
	Instalación agua	Municipio		Trabajo comunitario	Empresa privada	
	Equipaje de la planta					
	Arranque de la planta					
	Lombrices					
	Agua					
	Operador de planta	Uso exclusivo para el servicio		Uso para otras actividades del municipio sin contraparte financiera	Uso para otras actividades del municipio con contraparte financiera	
	Tipo de compostaje	Lombricompostaje		Thermocompostaje	Combinación de lombri- y thermocompostaje	
	Tratamiento de la orina	Servicio sin tratamiento de orina	Fermentación		Cristalización	Otro tipo de tratamiento
	Material adicional por el compostaje (estiércol, pasto, paja)	Orgánicos del recolección		Material del municipio		Comprar material
Instalación/Construcción punto de acopio	Municipio		Trabajo comunitario		Empresa privada	

Reutilización	Compost	Utilización por la producción de plantas	Utilización en el municipio	Venta en el sitio	Venta por encargo	
	Orina tratada	Servicio sin tratamiento de orina	Utilización por la producción de plantas	Utilización en el municipio	Venta en el sitio	Venta por encargo
	Plantas	Servicio sin producción de plantas	Utilización en el municipio	Venta en el sitio	Venta en el mercado	Venta por encargo
Distribución	Bolsas	Servicio sin bolsas	Distribución por el operador	Distribución por el colector de la OTB	Distribución por el comité agua	Venta en las tiendas
	Aserrín	Servicio sin aserrín	Distribución por el operador	Distribución por el colector de la OTB	Distribución por el comité agua	Venta en las tiendas

2. Mantenimiento

Mantenimiento	Mantenimiento de los baños	Usuarios	Operador	Colector de la OTB	Comité de agua	Municipio
	Mantenimiento de la planta	Operador				
	Mantenimiento punto de acopio	Operador	Colector de la OTB	Comité de agua	Municipio	

3. Tarifa

Dimensión	Aspecto	Alternativas				
Financiamiento	Servicio de recojo	Tarifa única mensual	Tarifa mensual separada por los diferentes servicios (heces, orina, res. org, res. sol.)		Tarifa dependiente de la frecuencia del uso	
	Bolsa	Parte de la tarifa de recojo			Venta a parte	
	Aserrín	Parte de la tarifa de recojo			Venta a parte	
	Promoción	Promoción en reunión OTB (pers. externa)	Promoción en reunión OTB (dirigente OTB)	Obligación de utilizar	Servicios complementarios	Promoción de boca a boca
	Método de paga	Directamente al operador	Directamente al colector OTB	Recaudador del municipio	En la factura de agua (comité de agua)	En la factura de luz (ELFEC)
	Incentivo de paga	Multa	Presión social (publicación de nombres de hogares con débitos)		Cese del servicio	Bonus (e.g. aserrín para los hogares que pagan)

Modelos organizacionales

Los modelos organizacionales resumen como planificamos servir a nuestros clientes. Les presentamos desde el punto de visto del proveedor de servicios, que en nuestro caso es la Unidad de Saneamiento Básico (USB) del Municipio de Arbieto. Es un buen ejercicio para verificar que el servicio propuesto realmente tiene un valor para cada segmento de clientes. Por ejemplo, contemplamos proveer un servicio de recojo de los residuos orgánicos, pero nos damos cuenta que no tenía una propuesta de valor para los hogares, ya que la disposición de los orgánicos no realmente es una preocupación de la población (es principalmente la disposición de los plásticos y papeles que resulta problemática).

Escenario 1a: Recolección de las heces de puerta a puerta

<p>Socios Clave</p> <p>Municipio</p> <p>Sindicatos agrarios</p>	<p>Actividades Clave</p> <p>Recojo de las heces</p> <p>Organización de la recaudación</p> <p>Transporte</p> <p>Producción de compost</p> <p>Organización de la venta</p>	<p>Propuesta de Valor</p> <p>Servicio de recojo de las heces de puerta a puerta fiable y regular</p> <p>Ejercicio de su competencia</p> <p>Personal y vehículo a su disposición</p> <p>Venta de compost de buena calidad</p>	<p>Relación con Clientes</p> <p>Material de capacitación sobre el uso de los baños</p> <p>Calendarios</p> <p>Asistencia personal</p>	<p>Segmentos de Clientes</p> <p>458 hogares con baños ecológicos secos</p> <p>Municipio</p> <p>Agricultores en la parte rural de Arbieta</p>
<p>Recursos Clave</p> <p>Recolectores</p> <p>Vehículo</p> <p>Planta de compostaje</p> <p>Operadores de planta</p> <p>Conocimiento técnico</p>	<p>Canales</p> <p>Directo a través de recolectores</p> <p>Directo a través USB</p> <p>Directo a través de operadores de la planta</p>	<p>Fuente de Ingresos</p> <p>Tarifa de los usuarios del servicio</p> <p>Subsidios del municipio</p> <p>Ingresos de la venta de compost</p>		
<p>Estructura de Costos</p> <p>Costos fijos de capacitación de los hogares</p> <p>Costos de salario variables del transporte</p> <p>Consumibles del transporte</p> <p>Amortización y mantenimiento del vehículo</p> <p>Costos de salario variables del tratamiento</p> <p>Consumibles del tratamiento</p> <p>Equipamiento inicial de la planta (incluyendo agua y electricidad)</p> <p>Amortización y mantenimiento de la planta</p> <p>Administración de la venta de compost</p>				

Escenario 1b: Recolección de las heces en puntos de acopio

<p>Socios Clave</p> <ul style="list-style-type: none"> Municipio Sindicatos agrarios 	<p>Actividades Clave</p> <ul style="list-style-type: none"> Recojo de las heces Organización de la recaudación Transporte Producción de compost Organización de la venta 	<p>Propuesta de Valor</p> <ul style="list-style-type: none"> Servicio de recojo de las heces desde un punto de acopio cercano Ejercicio de su competencia Personal y vehículo a su disposición Venta de compost de buena calidad 	<p>Relación con Clientes</p> <ul style="list-style-type: none"> Material de capacitación sobre el uso de los baños Calendarios Asistencia personal 	<p>Segmentos de Clientes</p> <ul style="list-style-type: none"> 458 hogares con baños ecológicos secos Municipio Agricultores en la parte rural de Arbieta
<p>Recursos Clave</p> <ul style="list-style-type: none"> Puntos de acopio Recolectores Vehículo Planta de compostaje Operadores de planta Conocimiento técnico 			<p>Canales</p> <ul style="list-style-type: none"> Directo a través de recolectores Directo a través USB Directo a través de operadores de la planta 	
<p>Estructura de Costos</p> <ul style="list-style-type: none"> Costos fijos de capacitación de los hogares Amortización de puntos de acopio Costos de salario variables del transporte Consumibles del transporte Amortización y mantenimiento del vehículo Costos de salario variables del tratamiento Consumibles del tratamiento Equipamiento inicial de la planta (incluyendo agua y electricidad) Amortización y mantenimiento de la planta Administración de la venta de compost 				<p>Fuente de Ingresos</p> <ul style="list-style-type: none"> Tarifa de los usuarios del servicio Subsidios del municipio Ingresos de la venta de compost

Escenario 2a: Recolección de las heces y de los residuos sólidos de puerta a puerta

Socios Clave	Actividades Clave	Propuesta de Valor	Relación con Clientes	Segmentos de Clientes
<p>Municipio</p> <p>Sindicatos agrarios</p> <p>Industria de reciclaje</p>	<p>Recojo de las heces y de los residuos sólidos</p> <p>Organización de la recaudación</p> <p>Transporte</p> <p>Producción de compost</p> <p>Organización de la venta de compost</p> <p>Organización de la venta de reciclables</p>	<p>Servicio de recojo de las heces y de los residuos sólidos de puerta a puerta fiable y regular</p> <p>Ejercicio de su competencia</p> <p>Personal y vehículo a su disposición</p> <p>Venta de compost de buena calidad</p> <p>Venta de reciclables correctamente separados</p>	<p>Material de capacitación sobre el uso de los baños y la separación de los residuos sólidos</p> <p>Calendarios</p> <p>Asistencia personal</p> <p>Asistencia personal</p>	<p>864 hogares que viven en las OTBs atendidas</p> <p>Municipio</p> <p>Agricultores en la parte rural de Arbieta</p> <p>Industria de reciclaje</p>
<p>Estructura de Costos</p> <p>Costos fijos de capacitación de los hogares</p> <p>Costos de salario variables del transporte</p> <p>Consumibles del transporte</p> <p>Amortización y mantenimiento del vehículo</p> <p>Costos de salario variables del tratamiento</p> <p>Consumibles del tratamiento</p> <p>Equipamiento inicial de la planta (incluyendo agua y electricidad)</p> <p>Amortización y mantenimiento de la planta</p> <p>Administración de la venta de compost</p>	<p>Recurso Clave</p> <p>Recolectores</p> <p>Vehículo</p> <p>Planta de compostaje</p> <p>Operadores de planta</p> <p>Conocimiento técnico</p>	<p>Fuente de Ingresos</p> <p>Tarifa de los usuarios del servicio</p> <p>Subsidios del municipio</p> <p>Ingresos de la venta de compost</p> <p>Ingresos de la venta de reciclables</p>	<p>Canales</p> <p>Directo a través de recolectores</p> <p>Directo a través USB</p> <p>Directo a través de operadores de la planta</p> <p>Directo a través de operadores de la planta</p>	

Escenario 2b: Recolección de las heces y de los residuos sólidos en puntos de acopio

Socios Clave	Actividades Clave	Propuesta de Valor	Relación con Clientes	Segmentos de Clientes
<p>Municipio</p> <p>Sindicatos agrarios</p> <p>Industria de reciclaje</p>	<p>Recojo de las heces y de los residuos sólidos</p> <p>Organización de la recaudación</p> <p>Transporte</p> <p>Producción de compost</p> <p>Organización de la venta de compost</p> <p>Organización de la venta de reciclables</p>	<p>Servicio de recojo de las heces y de los residuos sólidos desde un punto de acopio cercano</p> <p>Ejercicio de su competencia</p> <p>Personal y vehículo a su disposición</p> <p>Venta de compost de buena calidad</p> <p>Venta de reciclables correctamente separados</p>	<p>Material de capacitación sobre el uso de los baños y la separación de los residuos sólidos</p> <p>Calendarios</p> <p>Asistencia personal</p> <p>Asistencia personal</p>	<p>864 hogares que viven en las OTBs atendidas</p> <p>Municipio</p> <p>Agricultores en la parte rural de Arbieta</p> <p>Industria de reciclaje</p>
<p>Estructura de Costos</p> <p>Costos fijos de capacitación de los hogares</p> <p>Amortización de puntos de acopio</p> <p>Costos de salario variables del transporte</p> <p>Consumibles del transporte</p> <p>Amortización y mantenimiento del vehículo</p> <p>Costos de salario variables del tratamiento</p> <p>Consumibles del tratamiento</p> <p>Equipamiento inicial de la planta (incluyendo agua y electricidad)</p> <p>Amortización y mantenimiento de la planta</p> <p>Administración de la venta de compost</p>	<p>Recursos Clave</p> <p>Puntos de acopio</p> <p>Recolectores</p> <p>Vehículo</p> <p>Planta de compostaje</p> <p>Operadores de planta</p> <p>Conocimiento técnico</p>	<p>Fuente de Ingresos</p> <p>Tarifa de los usuarios del servicio</p> <p>Subsidios del municipio</p> <p>Ingresos de la venta de compost</p> <p>Ingresos de la venta de reciclables</p>	<p>Canales</p> <p>Directo a través de recolectores</p> <p>Directo a través USB</p> <p>Directo a través de operadores de la planta</p> <p>Directo a través de operadores de la planta</p>	

Recorridos del recojo de puerta a puerta

En los siguientes mapas, se presentan los recorridos en cada OTB. Los recorridos son seleccionados de manera que el vehículo pasa solo por los caminos en buen estado. Ya que hay sólo pocos caminos en buen estado, la selección de los recorrido se hizo a mano. En caso de contextos más complicados, sería mejor calcularlo con una herramienta de Sistema de Información Geográfica (SIG).

Ruteo de recolección Municipio Arbieta
OTB 20 de Mayo



Departamento de Cochabamba:

Legenda

— Ruteo_20mayo

1 cm = 20 metros

Sistema de Proyección:
Universal Transverse Mercator
Sistema de Referencia: WGS 84 - Zona 19

Escala Gráfica:
0 10 20 30 metros

HELVETIAS AGUATUYA
DEPARTAMENTO DE COCHABAMBA

OFICIO DE PLANEAMIENTO Y CARTA EN MANERA DE LA PRODUCCIÓN
DE PLANOS Y DISEÑOS PARA LA OBRAS PÚBLICAS
LOCALIZADO EN EL CUARTO A DEL NOROCCIDENTE DE ARBIETA

Ruteo de recolección Municipio Arbieta
OTB 20 de Mayo

Elaborado por: Jorge Rubén Espinoza Camacho
Fuente: Elaboración propia

Ruteo recolección Municipio Arbieta
OTB Cristal Mayu



Departamento de Cochabamba:

Legenda

— Ruteo recolección

1 cm = 60 metros

Sistema de Proyección:
Universal Transverse Mercator
Sistema de Referencia: WGS 84 - Zona 19

Escala Gráfica:
0 100 200 300 metros

HELVETIAS AGUATUYA
DEPARTAMENTO DE COCHABAMBA

OFICIO DE PLANEAMIENTO Y CARTA EN MANERA DE LA PRODUCCIÓN
DE PLANOS Y DISEÑOS PARA LA OBRAS PÚBLICAS
LOCALIZADO EN EL CUARTO A DEL NOROCCIDENTE DE ARBIETA

Ruteo recolección Municipio Arbieta
OTB Cristal Mayu

Elaborado por: Jorge Rubén Espinoza Camacho
Fuente: Elaboración propia

Ruteo de recolección Municipio Arbieta
OTB La Florida



Leyenda

— Ruteo de recolección

1 cm = 20 metros

Sistema de Proyección:
Universal Transverse Mercator
Sistema de Referencia: WGS 84 - Zona 19

Escala Gráfica:

HELVETIAS AGUATUYA

DEPARTAMENTO DE COCHABAMBA

OFICIO DE PLANEAMIENTO Y CARTA EN MANA DE LA PRODUCCIÓN
Y EL MANEJO DE LOS DATOS ESPACIALES PARA LOS SERVICIOS
ECOLÓGICOS EN EL CUADRO DEL MUNICIPIO DE ARBIETA

Ruteo de recolección Municipio Arbieta
OTB La Florida

Elaborado por: José Luis Espino Camacho

Fecha: 23/06/2023

Ruteo recolección Municipio Arbieta
OTB Fortaleza



Leyenda

— Ruteo recolección

1 cm = 20 metros

Sistema de Proyección:
Universal Transverse Mercator
Sistema de Referencia: WGS 84 - Zona 19

Escala Gráfica:

HELVETIAS AGUATUYA

DEPARTAMENTO DE COCHABAMBA

OFICIO DE PLANEAMIENTO Y CARTA EN MANA DE LA PRODUCCIÓN
Y EL MANEJO DE LOS DATOS ESPACIALES PARA LOS SERVICIOS
ECOLÓGICOS EN EL CUADRO DEL MUNICIPIO DE ARBIETA

Ruteo recolección Municipio Arbieta
OTB Fortaleza

Elaborado por: José Luis Espino Camacho

Fecha: 23/06/2023

Ruteo recolección Municipio Arbieta
OTB Llave mayu



Legenda

— Ruteo recolección

1 cm = 60 metros

Sistema de Proyección:
Universal Transverse Mercator
Sistema de Referencia: WGS 84 - Zona 19

Escala Gráfica:

HELVETIAS AGUATUYA

DEPARTAMENTO DE COCHABAMBA

OFICIO DE PLANEAMIENTO Y OBRAS DE MANEJO DE LA PRODUCCIÓN Y EL MANEJO DE LOS RECURSOS HUMANOS PARA LOS SERVICIOS EDUCACIONALES EN EL DEPARTAMENTO DE COCHABAMBA

Ruteo recolección Municipio Arbieta
OTB Llave mayu

Elaborado por: Jorge Zubizarreta Camacho

Fecha: 21/06/2024

Ruteo de recolección Municipio Arbieta
OTB Villa Montes



Legenda

— Ruteo de recolección

1 cm = 20 metros

Sistema de Proyección:
Universal Transverse Mercator
Sistema de Referencia: WGS 84 - Zona 19

Escala Gráfica:

HELVETIAS AGUATUYA

DEPARTAMENTO DE COCHABAMBA

OFICIO DE PLANEAMIENTO Y OBRAS DE MANEJO DE LA PRODUCCIÓN Y EL MANEJO DE LOS RECURSOS HUMANOS PARA LOS SERVICIOS EDUCACIONALES EN EL DEPARTAMENTO DE COCHABAMBA

Ruteo de recolección Municipio Arbieta
OTB Villa Montes

Elaborado por: Jorge Zubizarreta Camacho

Fecha: 21/06/2024

170000

Ruteo de recolección Municipio Arbieta
OTB Yuraj Jallpa



Leyenda

— Ruteo de recolección

1 cm = 20 metros

Sistema de Proyección:
Universal Transversa Mercator
Sistema de Referencia: WGS 84 - Zona 19

Escala Gráfica:

DEPARTAMENTO DE COCHABAMBA
 OFICINA DE PLANEAMIENTO Y CARTOGRAFIA EN MATERIA DE LA PRODUCCION
 DE INFORMACION DE DATOS RELEVANTES PARA LOS SERVICIOS
 EDUCACIONALES EN EL DEPARTAMENTO DE COCHABAMBA

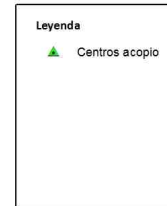
Nivel de recolección: Municipio Arbieta
 OTB Yuraj Jallpa

Ubicación de los puntos de acopio

En los siguientes mapas, se presentan los puntos de acopio previstos en cada OTB. Los puntos de acopio están localizados de manera que cada familia tiene que caminar como máximo 200 m. Para optimizar el recojo están bien accesibles, localizados sólo en los caminos en buen estado.

Ubicación de los puntos de acopio

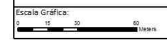
Centros de acopio Municipio Arbieta
OTB 20 de Mayo



1 cm = 20 metros

Sistema de Proyección:
Universal Transverse Mercator

Sistema de Referencia: WGS 84 - Zona 19



DEPARTAMENTO DE COCHABAMBA

 OFICIO DE PLANEAMIENTO Y POLÍTICA EN MATERIA DE LA PRODUCCIÓN

 Y EL MANEJO DE LOS SUELOS RURALES PARA LOS RÍOS

 EDUCADOS EN EL CUADRO 4 DEL NÚMERO DE ASESOR

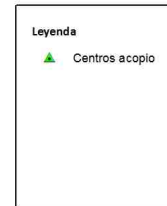
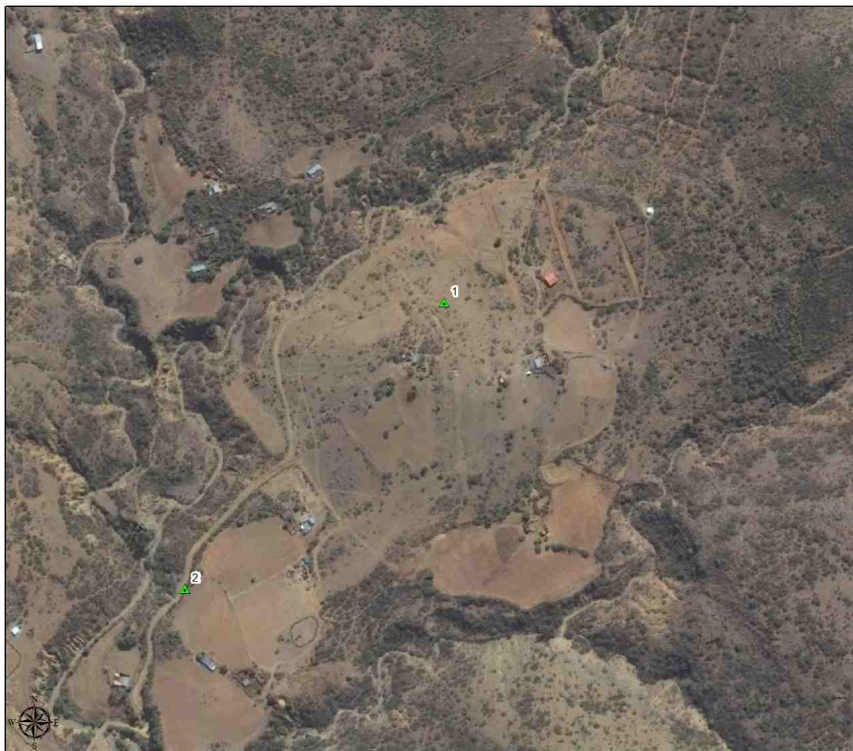
Centros de Acopio Municipio Arbieta

OTB 20 de Mayo

Elaborado por: Jorge Zubizarreta Camacho

Fecha: 23/06/2023

Centros de acopio Municipio Arbieta
OTB Cristal Mayu



1 cm = 40 metros

Sistema de Proyección:
Universal Transverse Mercator

Sistema de Referencia: WGS 84 - Zona 19



DEPARTAMENTO DE COCHABAMBA

 OFICIO DE PLANEAMIENTO Y POLÍTICA EN MATERIA DE LA PRODUCCIÓN

 Y EL MANEJO DE LOS SUELOS RURALES PARA LOS RÍOS

 EDUCADOS EN EL CUADRO 4 DEL NÚMERO DE ASESOR

Centros de Acopio Municipio Arbieta

OTB Cristal Mayu

Elaborado por: Jorge Zubizarreta Camacho

Fecha: 23/06/2023

Centros de acopio Municipio Arbieta
OTB La Florida



Leyenda

▲ Centros acopio

1 cm = 20 metros

Sistema de Proyección:
Universal Transverse Mercator
Sistema de Referencia: WGS 84 - Zona 19

Escala Gráfica:

DEPARTAMENTO DE COCHABAMBA

OFICIO DE PLANEAMIENTO Y POLÍTICA EN MATERIA DE LA PRODUCCIÓN
Y EL MANEJO DE LOS BOSQUES PARA EL SECTOR
RUDIMENTARIO EN EL CUADRO A DEL MUNICIPIO DE ARBIETA

Centros de Acopio Municipio Arbieta
OTB La Florida

Elaborado por: José Luis Espino Camacho

Fecha: Septiembre 2016

Centros de acopio Municipio Arbieta
OTB Fortaleza



Leyenda

▲ Centros acopio

1 cm = 20 metros

Sistema de Proyección:
Universal Transverse Mercator
Sistema de Referencia: WGS 84 - Zona 19

Escala Gráfica:

DEPARTAMENTO DE COCHABAMBA

OFICIO DE PLANEAMIENTO Y POLÍTICA EN MATERIA DE LA PRODUCCIÓN
Y EL MANEJO DE LOS BOSQUES PARA EL SECTOR
RUDIMENTARIO EN EL CUADRO A DEL MUNICIPIO DE ARBIETA

Centros de Acopio Municipio Arbieta
OTB Fortaleza

Elaborado por: José Luis Espino Camacho

Fecha: Septiembre 2016

Ubicación de los puntos de acopio

**Centros de acopio Municipio Arbieta
OTB Llave mayu**



Departamento de Cochabamba:

Leyenda

▲ Centros acopio

1 cm = 60 metros

Sistema de Proyección:
Universal Transverse Mercator
Sistema de Referencia: WGS 84 - Zona 19

Escala Gráfica:

HELVETIAS INSTITUTO AGUATUYA
DEPARTAMENTO DE COCHABAMBA
OFICINA DE PLANEAMIENTO Y POLÍTICA EN MATERIA DE LA PRODUCCIÓN Y EL MANEJO DE LOS SUELOS PARA LA AGRICULTURA FAMILIAR EN EL DEPARTAMENTO DE COCHABAMBA
Centros de Acopio Municipio Arbieta
OTB Llave mayu

Elaborado por: Jorge Zubizar, Esteban Camacho
Fecha: 2018/03/20/2018

**Centros de Acopio Municipio Arbieta
OTB Villa Montes**



Departamento de Cochabamba:

Leyenda

▲ Centros acopio

1 cm = 20 metros

Sistema de Proyección:
Universal Transverse Mercator
Sistema de Referencia: WGS 84 - Zona 19

Escala Gráfica:

HELVETIAS INSTITUTO AGUATUYA
DEPARTAMENTO DE COCHABAMBA
OFICINA DE PLANEAMIENTO Y POLÍTICA EN MATERIA DE LA PRODUCCIÓN Y EL MANEJO DE LOS SUELOS PARA LA AGRICULTURA FAMILIAR EN EL DEPARTAMENTO DE COCHABAMBA
Centros de Acopio Municipio Arbieta
OTB Villa Montes

Elaborado por: Jorge Zubizar, Esteban Camacho
Fecha: 2018/03/20/2018

I

Ubicación de los puntos de acopio

Centros de acopio Municipio Arbieto
OTB Yuraj Jallpa



Parámetros del calculo de costos

Se resumen los parámetros del calculo de costos relacionados a los siguientes temas:

1. Datos de base
2. Transporte
3. Tratamiento
4. Ingresos

1. Datos de base

1.1 Número de habitantes, familias y baños ecológicos

OTB	Habitantes (5.4/familia)	Familias	Baños ecológicos
20 de Mayo	400	74	48
Cristal Mayu	729	135	13
Florida	718	133	40
Fortaleza	470	87	40
Llave Mayu	1134	210	120
Villa Montes	653	121	117
Yuraj Jallpa	562	104	80
Total	4666	864	458

1.2 Producción de heces y residuos sólidos

Parámetro	Valor	Fuente
Heces	0.1 m ³ /familia-mes	Encuestas, Sumaj Huasi
Residuos sólidos		
-Total	17.6 kg/habitante-mes	Diagnóstico GAM
-Orgánicos	72% del total	Diagnóstico GAM
-Reciclables	16.7% del total	Diagnóstico GAM
-Plásticos	39% de los reciclables	Diagnóstico MMAyA
-Papel	27% de los reciclables	Diagnóstico MMAyA
-Metal	8% de los reciclables	Diagnóstico MMAyA
-Vidrio	26% de los reciclables	Diagnóstico MMAyA

1.3 Personal

Parámetro	Valor	Fuente
Salario mínimo 2016	1805 Bs./mes	Oficial
Aguinaldo	2 meses	Aguatuya
Aportes sociales patronales	16.71%	Modelo NSSD
Horas de trabajo mensuales	174 horas	Calculo (8h/día)
Reserve	15%	MOOC
Ropa de trabajo y equipo de protección	846 Bs./año-persona	NSSD

2. Transporte

2.1 Vehículo

Parámetro	Valor	Fuente
Valor inicial	140'000 Bs.	Estimación modelo NISSAN sim.
Vida útil	10 años	MOOC
Capacidad	2.5 m ³	Estimación según dimensiones
Mantenimiento	2.5% del valor inicial	MOOC
Seguro	1% del valor inicial	MOOC

2.2 Tiempo de transporte y recojo

Parámetro	Valor	Fuente
Velocidad de transporte	9 km/h	Estimación
Distancia de transporte (puerta a puerta)	20.1 km	Calculo SIG
Distancia de transporte (punto acopio)	48.7 km	Calculo SIG
Velocidad de recojo	5 km/h	Estimación
Distancia de recojo	10 km	Calculo SIG
Tiempo de recojo (heces)	1 min/usuario	Estimación
Tiempo de recojo (residuos sólidos)	2 min/usuario	Estimación
Tiempo de lavado de los tachos	2 min/usuario	Estimación
Tiempo de llenado (heces)	1 min/usuario	Estimación
Tiempo de llenado (residuos sólidos)	2 min/usuario	Estimación

2.3 Puntos de acopio

Parámetro	Valor	Fuente
Construcción	8000 Bs./punto	Estimación para capacidad 4 m ³
Equipamiento	2'000 Bs./punto	Estimación
Vida útil	10 años	MOOC
Mantenimiento	2.5 % del valor inicial	MOOC

2.5 Administración (recaudación)

Parámetro	Valor	Fuente
Recaudación	5 min/usuario-mes	Estimación

3. Tratamiento

3.1 Planta de tratamiento

Parámetro	Valor	Fuente
Valor inicial	200'000 Bs.	Estimación basada en modelo NSSD
Vida útil	40 años	Modelo NSSD
Mantenimiento	2.5 % del valor inicial	MOOC
Capacidad actual	25 m ³	Calculo
Superficie disponible	625 m ²	Calculo, mitad superficie total

3.2 Nuevas fosas de compostaje

Parámetro	Valor	Fuente
Volumen	32 m ³	Modelo NSSD
Superficie necesario	67.5 m ²	Modelo NSSD
Costo fosa	21'100 Bs./fosa	Modelo NSSD
Superficie cimiento	35.5 m ² /fosa	Modelo NSSD
Costo cimiento	18 Bs./m ²	Modelo NSSD

3.3 Compostaje

Parámetro	Valor	Fuente
Tiempo de compostaje	6 meses	ADRA 3 meses, Sumaj Huasi 9 meses
Tiempo de trabajo	1.25 h/m ³ _{heces}	Modelo NSSD
Agua para humedecer	0.01 m ³ _{agua} /m ³ _{heces} -mes	Modelo NSSD
Herramientas	28.50 Bs./persona-mes	Modelo NSSD

4 Ingresos

Parámetro	Valor	Fuente
Venta compost	120 Bs./m ³	Planta compostaje Tiquipaya
Potencial re-utilización reciclables	75%	Estimación
Venta plástico	1.5 Bs./kg	Estimación diagnóstico MMAyA
Venta papel/carton	1 Bs./kg	Estimación diagnóstico MMAyA
Venta metal	5 Bs./kg	Estimación diagnóstico MMAyA
Venta vidrio	0.5 Bs./kg	Estimación diagnóstico MMAyA
Costo de administración	5% de valor de venta	Estimación
Parte personal administración	50% de costo administración	Estimación

Fuentes:

-Modelo NSSD: Modelo de costos para baños ecológicos secos del Nodo de Saneamiento Sostenible Descentralizado

-Diagnóstico MMAyA: Diagnóstico de la Gestión de Residuos Sólidos en Bolivia (2011)

-Diagnóstico GAM: Anexo 7 Diagnóstico y líneas de acción Valle Alto de Cochabamba

-MOOC: Example of cost and tariff model (F. Schmidt, Coursera)