Case study of sustainable sanitation projects

Large-scale ecological sanitation in peri-urban area El Alto city, Bolivia

Fig. 1: Project location

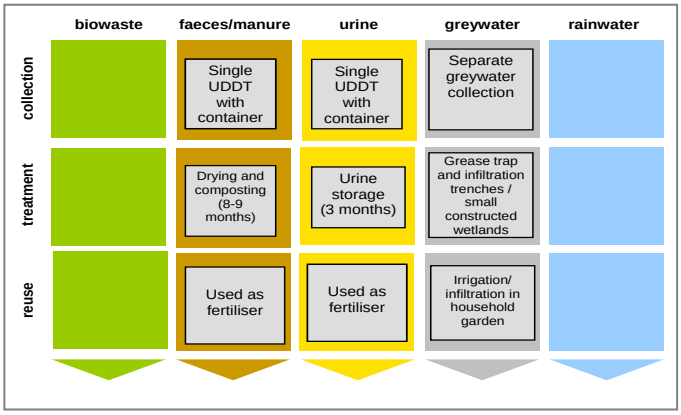

Fig. 2: Applied sanitation components in this project. UDDT stands for urine-diverting dry toilet.

1 General data

Type of project:
Sanitation coverage in peri-urban area – pilot project progressively transformed into a sanitation coverage project.

Project period:
Start of construction: January 2008
End of construction: March 2012
Start of operation: January 2009 (construction and use of toilets)
Monitoring: Ongoing, done in connection with the collection and management of sub-products (urine and faecal matter).
Project end: Administrative closure July-August 2012, final evaluation January 2013.

Project scale:
Total of 897 units for an equal number of households, developed in four phases (5 people per toilet); around 4,500 persons benefited; sanitation facilities consist of urine diversion dehydration toilets (UDDT), showers, hand washing basins, and on-site greywater treatment. Management of sub-products at collective level.

Total investment (in EUR) over the project period: 1.33 million

Address of project location:
District 7, El Alto city, La Paz, central-western Bolivia

Planning and executing institution:
Fundación Sumaj Huasi, La Paz, Bolivia

Supporting agency:
Swedish International Development Cooperation Agency (Sida), Stockholm, Sweden.
Political support from Ministry of Environment and Water of Bolivia, Vice Ministry of Potable Water and Basic Sanitation, Federation of Neighbourhood Association of El Alto city (Fejuve), and local sub municipalities.

2 Objective and motivation of the project

The general objective is to improve the health and living conditions of the families settled in peri-urban areas of El Alto city by providing ecological toilets that are sustainable and also enhance agricultural productivity.
The cities of El Alto and La Paz – Bolivia's capital – depend on groundwater and meltwater from glaciers and snowy mountains for their water supplies. In recent years, scientists have documented accelerated melting and retreat of the glaciers, raising deep concerns about future water availability. Meanwhile, demand for water has risen rapidly, exceeding the supply and leading to shortages and to rationing on weekends. This makes water conservation, as promoted by this project, an important adaptation measure in the face of rising temperatures, less water availability and other climate change impacts.

Fig. 3: Users of an implemented household UDDT (Andersson, 2011).

Large-scale ecological sanitation in peri-urban area El Alto city, Bolivia

3 Location and conditions

El Alto

El Alto originates from the expansion process of La Paz in the 1940s and 1950s, people began settling an elevated area to the city's southwest, which would become El Alto. In 1982, El Alto was incorporated as a separate city with its own government. Since then, its population growth has been driven by migration from rural areas[1].

El Alto is 5 km away from La Paz, on a plateau at 4,050 meters elevation. Its estimated population as of 2009 was roughly 929,000[2], growing at a rate of 5.1% per year. El Alto is divided into 13 districts, and more than 95% of the population lives in urban areas[3]. This project was developed in District 7, a peri-urban area with an estimated population of roughly 27,000 in 2008[4]. In the period 2001-2010, temperatures ranged from -4°C and 21°C, with an annual average of 7°C, and annual precipitation averaged 600 mm[5].

The population of District 7 is composed mainly of Aymara indigenous people, farmers who migrated from villages close to the Titicaca Lake. Their religion combines Catholicism and indigenous beliefs; most parents' education is limited elementary school, with few high school graduates (Silveti, 2012). The average family size is six or seven people; dwellings are one- or two-room adobe houses with yards, typically surrounded by a high adobe wall (Silveti, 2012).

Livelihoods in El Alto tend to combine farm and non-farm activities. Incomes are derived mostly from commerce, construction, transportation and agriculture, often from informal and temporary activities. In this context, commerce refers to the selling of food, clothes and household goods at the local markets. Some people maintain parcels with crops in rural areas and travel constantly to take care of their crops. Additionally, people get jobs linked to the harvest seasons, commonly in the eastern part of the country. In addition, women are involved in housekeeping and bringing up the children. The typical household income is 200 to 300 *bolivianos* per week, about 20-30 EUR[6] (Fundación Sumaj Huasi 2009, cited in Silveti 2012).

Many families have household gardens, though this varies across El Alto. People in the outermost peri-urban areas have more space and therefore more possibilities to have household gardens. But as the city becomes more densely settled, the available space for household gardens is decreasing. Still, agriculture remains an important activity in the periphery of El Alto. The produce is consumed by the households and also sold at the local markets.

However, agriculture in the region is hindered by the low fertility of the soil, which has been found to contain low levels of organic matter and nutrients (Garnica n.d.). Plowing is done with oxen, and animal manure, mostly from sheep, is used as fertiliser, though chemical fertilisers are used as well.

Water and sanitation

Situation

As of 2010, 48% of the people living in rural areas in Bolivia lacked access to potable water, as did 12% in urban areas. In addition, 62% of the rural population lacked access to sanitation services, as did 45% of the urban population[7]. In urban settlements, the most common sanitation technology is flush toilets connected to centralised sewer systems with wastewater treatment plants (however, the level of treatment efficiency is not known). In rural areas, people use pit latrines, flush toilets connected to septic tanks, urine diverting dry toilets (UDDT), and open defecation.

In El Alto, 51% of the population lacks adequate water and sanitation services[8]. Part of the population is connected to a centralised sewer system, which is planned to be expanded to connect new areas of the city. However, this kind of project takes a long time to be implemented, since infrastructure is expensive and there are political issues related to the location of a new wastewater treatment plant within the communities of El Alto (Silveti, 2012). Consequently, projects such as the one described here, with international support, local political support, and a local implementing organisation with knowledge of ecological sanitation (ecosan), have provided a faster, economically advantageous and suitable alternative solution to the sanitation needs of the population.

Institutional framework

The Vice Ministry of Potable Water and Basic Sanitation – under the Bolivian Ministry of Environment and Water[9] – defines the political and technical framework for water and sanitation provision of services in the country. The Deputy Minister of Public Investment and External Financing[10] manages the resources, donation and credits for public investment in the country. The Authority of Social Control of Drinking Water and Sanitation[11] and the National Service for Sustainable Sanitation Services[12] are the organisations responsible for oversight and capacity-building of the operators in charge of the provision of water and sanitation services.

[1] El Alto Government (2012). http://www.elalto.gob.bo/index.php/ubicacion-geografica.html

[2] Population projection based on the 2001 census; no more recent information is available.

[3] Instituto Nacional de Estadística (INE) (2001). http://www.ine.gob.bo/indice/visualizador.aspx?ah=PC2031002.HTMhttp://www.ine.gob.bo/indice/visualizador.aspx?ah=PC20102.HTM

[4] The census counts the peri-urban population as urban. El Alto Government (2012). http://www.elalto.gob.bo/index.php/datos-demograficos.html

[5] INE (2012). http://www.ine.gob.bo/indice/EstadisticaSocial.aspx?codigo=80101

[6] 28-42 USD converted to EUR using 2009 exchange rate http://www.xe.com/currencytables/?from=USD&date=2009-06-06

[7] Viceministerio de Agua Potable y Saneamiento Básico (2011). http://www.mmaya.gob.bo/#

[8] INE (2001). http://www.ine.gob.bo/indice/EstadisticaSocial.aspx?codigo=30602

[9] In Spanish: Ministerio de Medio Ambiente y Agua (2012). http://www.mmaya.gob.bo/#

[10] In Spanish: Viceministerio de Inversión Pública y Financiamiento Externo (2012). http://www.vipfe.gob.bo/index.php?opcion=com_contenido&ver=contenido&id=2140&id_item=657#&id_item=682

[11] In Spanish: Autoridad de Fiscalización y Control Social de Agua Potable y Saneamiento Básico (2012). http://www.aaps.gob.bo/?p=103

[12] Servicio Nacional para la Sostenibilidad de Servicios en Saneamiento Básico (2012). http://www.senasba.gob.bo/index.php?option=com_content&view=article&id=47&Itemid=54

Finally, the implementation of water and sanitation programs and projects is led by the Executing Agency for Environment and Water[13] and the National Productive Social Investment Fund (Torrico, 2012 cited in Silveti, 2012). In addition, international cooperation and civil society also contribute to the development of water supply and sanitation in the country.

In Bolivia, the under-five child mortality rate as of 2010[14] was **54 children per 1,000;** this is down significantly from 1990, when the rate was 151 deaths per 1,000, - a major achievement.

4 Project history

In 2005, a social organisation called Federation of Neighbourhoods of El Alto city (Fejuve[15]) demanded that the Superintendence of Water and Sanitation address the precarious water and sanitation situation in District 7. This happened at a time of political changes connected with the presidential election of 2005, and the creation of an independent Bolivian Ministry of Environment and Water, taking on responsibilities that until then had been handled by the Ministry of Housing and Basic Services.

Also in 2005, the Superintendence of Water and Sanitation Services, working with the World Health Organisation (WHO), called for project proposals to improve water and sanitation conditions for the District 7 population. Drawing on more than 10 years of experience, the Fundación Sumaj Huasi, a non-governmental organisation, proposed the development of ecosan solutions. At the end of 2007, the Swedish International Development Cooperation Agency (Sida) and Fundación Sumaj Huasi signed an agreement, and the project implementation started in 2008.

In 2006, there had been a study to evaluate ecosan projects implemented in Bolivia aiming to understand the drivers and constraints in their implementation and functioning, and consequently to come up with an improved implementation model. The study involved a survey of 228 households, 51 technical inspections of toilets and 38 microbiological samples of dried faecal matter. Fundación Sumaj Huasi participated in this initiative and strengthened its proposal for the El Alto project with the findings of this study (Warpinski, 2006), which included:

- Education and monitoring are crucial.
- UDDT single-vault toilets require more frequent maintenance than UDDT double-vault toilets, which is regarded as a positive aspect since it encourages households to learn to maintain the units and practise what they have learned.
- The contributions of the households are more effective when they are planned to be accomplished within the project implementation, and not afterwards. This process facilitates the complete functionality of the sanitary units.

In the beginning, the District 7 project was proposed as a pilot project in order to explore the viability of ecosan technologies in the spectrum of sanitation solutions and support decision-making processes and investments in the region. After positive results in the initial implementation, the project was expanded; it completed its fourth phase in March 2012. The project has benefited about 4,500 persons of the 27,000 inhabitants living in District 7.

Two aspects of the project's methodological approach have been important and contributed to its success. The first one is the continuous identification of lessons learned and the corresponding development of improvements, phase after phase. Secondly, special attention has been given to the educational component, aiming to engage the households and to offer them opportunities to participate. Also important in this project has been the promotion and strengthening of several ecosan initiatives across the country (e.g. Copacabana town and Uyuni city), and the political support and will related to water supply and sanitation at the national level.

5 Technologies applied

In the context of El Alto, the ecosan approach offers significant advantages, which have been confirmed during this project. The ecosan approach was chosen due to its basic principle of zero or minimal use of water, while closing loops of water and nutrients. UDDTs and separate greywater treatment also have been shown to be effective and lower in cost than centralised sanitation technologies.

Sanitary units at household level

Since the beginning of the project in 2008, the design of the ecosan units at household level have been improved based on the experiences gained. The development of the project in phases has facilitated this process.

Figures 4 to 9 show the current improved model of the ecosan unit which was developed. The technology used is a UDD toilet with container, treatment of greywater at the household level, and communal management of the urine and faeces. The toilets are located close to the houses, and access is through built-in steps within the toilet unit, supported with internal walls facilitating the use for people with mobility limitations (Andersson, 2011). Showers are incorporated and adapted according to the availability of water in each area. In Phase 1, the shower consisted of a room with a tank to store water, since there was no water supply service. In recent project phases, the shower has been connected to the water supply system. The hand-washing basin is located outside of the toilet unit, which makes it possible to use it for laundry as well. In previous phases, greywater from the shower and hand-washing basin were treated in situ with a grease trap and infiltration trenches. More recently, the greywater has been used to provide water for small wetlands in the backyards of the houses, with ornamental and edible plants.

Communal management of the urine and faeces

The system includes collection, transportation, treatment of the faecal matter and urine, and use of the ecosan fertilisers. Also here, the learning gained during the process has contributed to improvements in the project. The techniques used for the treatment of the sub-products and their further

[13] In Spanish Entidad Ejecutora de Medio Ambiente y Agua (2012). http://www.emagua.gob.bo/index.php?option=com_content&view=article&id=7&Itemid=3

[14] The under-five mortality rate is the probability (expressed as a rate per 1,000 live births) of a child born in a specified year dying before reaching the age of five if subject to current age-specific mortality rates (http://www.childmortality.org/).

[15] In Spanish: Juntas Vecinales de la ciudad de El Alto.

use in agriculture and marketing in local markets have not changed during the project.

Due to the pilot nature and small scale of the project, initially each household managed their own sub-products, basically burying the faecal matter and using or disposing of the urine in the ground. As the number of houses covered by the project has grown, a collective management system has been implemented by Fundación Sumaj Huasi. The collection and transportation of the sub-products is done by two teams. One of them is from a local company called Abona ("fertilise"), which was created and supported in the framework of the project. Recently, Fundación Sumaj Huasi developed an additional team to strengthen these components.

Each collection team includes two people who also support users and monitor and provide maintenance for the toilets. Collections are done weekly, with vans that are equipped with a horn to alert the households, (see Section 10 for details).

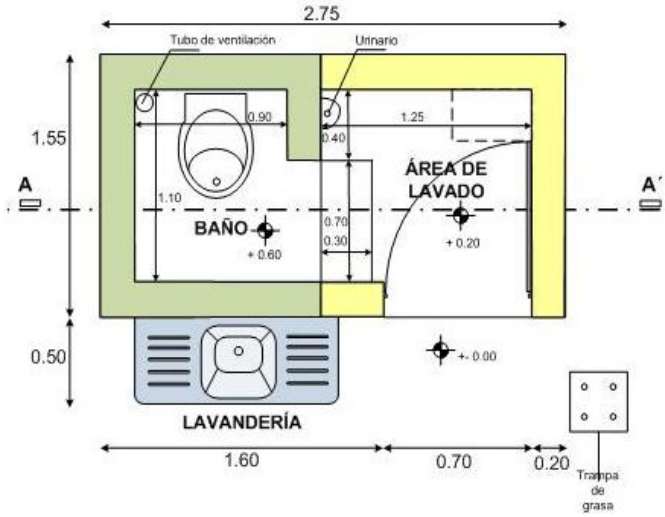

Fig. 4: Floor plan of the single vault UDDT with shower; dimensions given in metres (Suntura, 2012).

The sub-products are transported by van to a new 1.6-hectare compost centre, located in Villa Andrani village (District 9, rural area of El Alto); 10 minutes drive away from District 7. In this place the faecal matter is composted for 8 to 9 months with red Californian worms, i.e. vermicompost. The process takes place in 24 ground trenches, each 2.2 m x 8.0 m and 70 cm deep, with covers. The urine is stored for 3 months in 5,000-liter plastic-tanks as a treatment to increase the pH and eliminate pathogens to produce a safe liquid fertiliser.

The location of the compost centre was chosen to be as close as possible to the households, to take advantage of the nutrients locally while reducing the cost of transportation. The new composting site has been designed with the goal of developing an integrated centre that provides opportunities for learning and demonstration. The centre will integrate treatment and use of the sub-products, capacity building, recreation and promotion of environmental improvements. Community members from Villa Andrani have contributed the land for the project through a risk and benefit sharing deal. In return, they will have access to capacity-building, the fertilizers from the UDDTs, and the proceeds from the sale of the produce grown. The liquid fertiliser will be used to maintain the lawn of a new local soccer field. In addition, there are plans for new studies of crop production with these fertilisers and of the introduction of water saving devices at the centre.

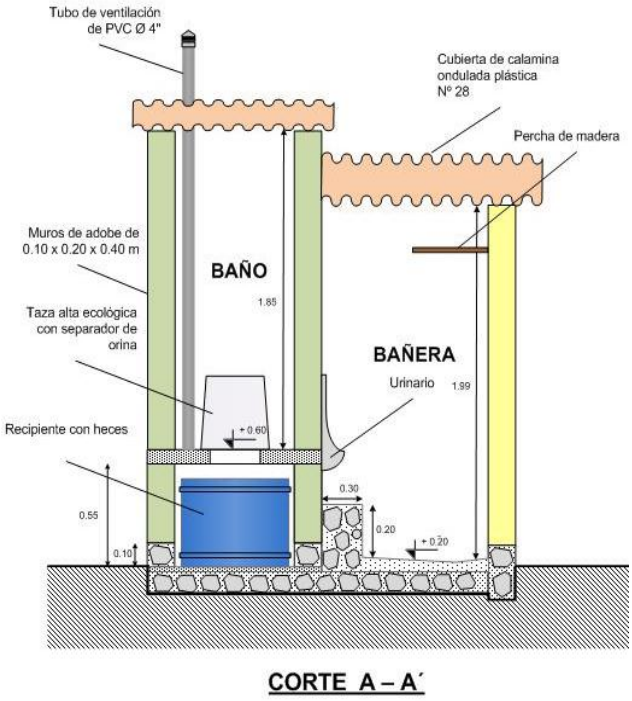

Fig. 5: Cross sectional view of the single vault UDDT with container and shower (Suntura, 2012).

Fig. 6: Composting trenches for treatment of the faecal matter (Andersson, 2011).

Fig. 7: Storage of urine at the composting centre in 5,000 L plastic-tanks (Andersson, 2011).

6 Design information

Sanitary unit

The first UDDT model in 2008 had a single vault with solar heating; it was based on the evaluation of previous ecosan projects in Bolivia, mentioned in Section 4. However, a validation process of this model conducted with households by Fundación Sumaj Huasi during Phase 1 found a preference for UDDTs with containers.

The UDDT was designed for an average family of five persons. The faeces are collected in a 100-liter plastic container and the urine in 20-liter jerricans. The faeces container typically fills up in 1 or 2 months, and the urine jerrican in one week.

Each unit is built by a mason and household members. This process takes 10 days and involves three phases, each with some work done first by the mason, and some by the household. Households contribute their labour and materials such as sand, stone, water, sifted soil and bricks. In addition, households often contribute materials and accessories that improve the quality of the sanitary unit, such as electric installations, a shower, tiles and decorations.

The walls of the units are made with bricks, or occasionally with adobe. Inside the unit, the walls are waterproofed with cement plaster and fine plaster. Externally the walls are protected with a mixture of cement and sand, and finally they are painted with coloured lime. The urine diversion pedestal and the waterless urinal are made of fibreglass. The urine collection system has an odour trap, a rubber membrane at the end of the pipe before entering the urine container. The hand washing basin is built in reinforced concrete on brick walls.

Fig. 8: Front view of the UDDT unit with handwash basin on the outside (Andersson, 2011).

Fig. 9: View of the interior of the UDDT unit. Right picture shows also the urinal (Andersson, 2011).

Treatment of the faeces sub-product

At the beginning of the project, composting took 12 to 14 months, in three phases: composting with humidity control (4 to 5 months), composting with red Californian worms (4 to 5 months), and composting and storage (4 months). Later, the red Californian worms were integrated into the whole composting cycle, which generated better results and reduced the total composting time to 8 to 9 months.

At the composting centre, each trench is initially prepared with a bed of worms together with processed compost, and then layers of faecal matter are deposited on top. Humidity is constantly measured and adjusted by adding water. The worms degrade the organic matter contained in the faecal matter from the bottom to the top, while producing humus and eliminating the pathogens. The compost is carefully mixed once or twice during the process. The result is a rich humus. It is packed and distributed free of charge to local farmers as a part of the marketing of the ecosan fertilisers.

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7 Type and level of reuse

The project has pursued the reuse of nutrients and water in a manner that is safe for all involved. The goal is to protect the health of the people, to promote the use of fertiliser from human excreta while generating income, and to offer evidence-based learning and demonstration on the feasibility of the ecosan approach in the El Alto context.

At the household level, greywater from showers and hand-washing is used to irrigate household gardens with ornamental and edible plants after pre-treatment in the grease trap. At the community level, the ecosan fertilisers are used in crop cultivation in the composting centre and on agricultural land provided by collaborating farmers. However, at this stage of the project the agricultural demand in the area is less than the production of ecosan fertilisers, especially urine, which is produced at a volume of about 10-12 m^3 per week; hence the surplus is given away for demonstration purpose. At the same time Sumaj Huasi is exploring new ways to manage large quantities of urine.

Fundación Sumaj Huasi has conducted several studies to evaluate the composition and quality of the ecosan fertilisers to sell them in local markets. The results show that the fertilisers from human excreta can be safely used for food crops. In 2011 a comparison between the composition of nutrients in ecosan fertilisers and a range of organic fertilisers commonly used in the region showed higher nutrient values for the ecosan fertilisers compared to peat and animal manure (see Table 1).

Table 1. Comparative study of the nutrient content of different organic fertilisers. (Source: Fundación Sumaj Huasi, 2012)

Nutrient	Fertiliser from animal manure (g/kg)				Peat (g/kg)	Ecosan fertilisers	
	Cow	Sheep	Chicken	Pig		Vermi-compost (g/kg)	Urine (g/lt)
Nitrogen	2,09	0,95	3,07	1,50	2,70	1,20	4,60
Phosphorus	0,59	0,35	0,45	1,26	-	9,80	3,03
Potassium	2,06	1,00	0,59	1,83	-	17,20	1,90
Calcium	1,47	-	1,30	1,07	1,00	35,10	0,03
Magnesium	0,53	-	0,37	0,48	0,50	12,60	0,03
Organic matter	60%	48%	37%	54%	-	74%	-

During 2011 and 2012, seven hectares of potato fields were fertilised with different combinations of ecosan fertilisers and cow manure as a control. The plot was divided into four equal sections and a different kind of fertiliser was applied in each section. When the potatoes were harvested in April 2012, the combination of vermicompost and urine was found to produce twice the crop yield compared with cow manure (see Table 2).

Table 2. Potato production with different combinations of ecosan fertilisers and cow manure. (Source: Fundación Sumaj Huasi 2012)

Fertiliser	Yield reached (kg/m²)
Vermicompost + urine	46
Vermicompost	34
Cow manure + urine	29
Cow manure (control)	23

This project was coordinated with the Association of Agricultural Apa Inti and people from Villa Andrani village (District 9 of El Alto), who provided the land and participated in the growing and harvesting process. The positive results have helped to strengthen confidence in ecosan and to spread knowledge about it in the region. There is now demand for ecosan UDDTs in Villa Andrani, and residents are supporting the development of the new composting centre.

Fig. 10: Trials of fertilisers from UDDTs with vegetables at the composting centre (Andersson, 2011).

Fig. 11: Commercialisation of "Ecosan compost fertilisers" (Andersson, 2011).

8 Further project components

The following aspects have been essential for the positive impact and scaling-up of ecosan in the El Alto project, and for its contribution to the national framework on sustainable sanitation.

Development of political and technical national framework:
At the beginning of the project a Project Committee was established with representation from the municipal authority, the sub-prefecture, grassroots organisations, households, Fundación Sumaj Huasi, the Decentralized Sustainable Sanitation Node, the Bolivian Ministry of Environment and Water, Vice Ministry of Potable Water and Basic Sanitation, and Sida (NCSSD, 2010; Suntura, 2012). The Committee has followed up the development of the project and has also contributed with national lessons to support the El Alto

experience. As a result, Bolivian national guidelines on water and sanitation have been developed, including on gender in sanitation projects, and technical specifications for the design of ecological dry toilets (see Section 13 for more information). Moreover, in 2012 the Ministry of Environment and Water formulated a National Programme of Ecological Sanitation Toilets that aims to increase the number of ecological toilets in the country and lays out a plan for unified norms, regulations, financing and promotion of the ecosan approach (Silveti, 2012).

The Decentralised Sustainable Sanitation Node in Bolivia (NSSD[16]):
This is part of a global initiative by Sida implemented by the Stockholm Environment Institute (SEI), aiming to support recognised organisations for networking and capacity development on sustainable sanitation issues at a regional level. One knowledge node was established in Bolivia within the Association of Sectoral Spaces on Basic Sanitation and Housing (ADESBVI[17]). The Bolivian Node has contributed to the development of National Technical Guidelines for Ecological Sanitation and National Guidelines for Implementation of Gender in Sanitation Projects. It is also providing capacity and knowledge development, and fostering communication between the actors involved or connected with sustainable sanitation. All of this is done in connection with several demonstrative and learning projects identified around the country such as the El Alto experience.

Collective management of the products:
In the context of a peri-urban population, this component has been essential for the acceptance of the system by the households. These treatment centres also protect public health through the proper sanitisation and use of the products in a controlled manner. The collection service has so far been free of charge for the households due to the pilot nature of the project, and also because of the lack of a legal framework to allow a non-governmental organisation to supply a public service. Therefore, the implementing organisation is now working to develop strategies to make the collection service economically sustainable and to influence the political stakeholders with competence in this area. For instance, in a group of 70 households where UDDTs will be built, a tariff system is being designed to be implemented as a learning and demonstration project.

Social marketing:
This refers to providing clear and experience-based evidence about the use of fertiliser from sanitised human excreta in agriculture. This has been done based on studies on stakeholder participation, costs of production and marketing, agricultural production and microbiological quality of the ecosan fertilisers. The dissemination of results and advances of the project has been done on local radio and television and through information fairs and educational campaigns (Fundación Sumaj Huasi, 2012).

Capacity development of stakeholders:
Household members have strengthened their knowledge related to the ecosan approach, the holistic conception of hygiene, sanitation and health, and operation and maintenance of the facilities. The education has been a central component during the introduction of the project, construction of the toilets and in the initial use of the sanitary unit. The applied techniques include workshops, learning-by-doing in the construction phase and household visits. The weekly collection of products from the UDDTs facilitates communication between households and the implementing organisation.

The social control was strengthened during the construction phase where there was an active participation of the Federation of Neighbourhood Association of El Alto city (Fejuve), local government, and representatives of the households, among others. The purpose was to ensure the transparent development of the investments.

The interaction with the local government has been positive, involving political support, follow-up and local information. The project has promoted institutional strengthening by increasing the capacity of local governments to implement similar programmes and projects. The programme has also produced guides for the training of the officials and technicians in related topics (NCSSD, 2010).

9 Costs and economics

Initial investment:
In total 1,33 millon EUR, contributed by:
- 88% from Sida
- 11% from households
- 1% from Fundación Sumaj Huasi

The break-down of this investment cost by project components is:
- 48% construction of sanitary units including UDDT, urinal, shower and wash/laundry basin
- 17% for technical and social supervision
- 8% community development
- 7% research and social marketing
- 4% capacity development of local micro enterprises
- 4% development of a knowledge transfer centre
- 4% evaluation and audit
- 4% administrative costs
- 3% installation of other technologies
- 1% workshops and technical assistance

The construction cost per sanitary unit was 713 EUR, including 556 EUR covered by Sida and Fundación Sumaj Huasi, and roughly 22% as labour and in-kind contributions from households. Additional investments made by users, for upgrades to the toilet units, are not included in this figure. In average each sanitary unit serves 5 persons.

Management of the products
Currently the collection service and treatment of the sub-products is handled by Fundación Sumaj Huasi with financial support from Sida. A pilot monthly fee scheme is being planned in which each household would pay around 10-20 Bolivianos (1.17-2.33 EUR) per month. This fee would cover collection and transport costs. Based on the demand for ecosan fertilisers, explored during the marketing study, it was estimated that the sale of fertilisers could cover the costs associated with the treatment.

[16] In Spanish: Nodo de Conocimiento en Saneamiento Sostenible Descentralizado de Bolivia.
[17] In Spanish: Asociación de Espacios Sectoriales de Saneamiento Básico y Vivienda.

10 Operation and maintenance

At household level:
The households are responsible for the appropriate use and cleaning of the toilet, and moving the containers with faeces and urine to the street outside the house on the established collection days. Sawdust is applied to cover the faeces after each defecation and a small quantity of water after urinating. Sawdust is easy to find in the area and costs about 5 Bolivianos (0.58 EUR) for a 20-kilo bag, which may last one month. At the beginning of the project, however, sawdust was easier to get and for free. The cleaning of the UDDT and urinal is done with a moist cloth and little detergent, to minimise spillage of water and chemicals into the containers.

At the community level:
Fundación Sumaj Huasi handles the collection and treatment of the products. Two teams with defined routes do the collection; once a week for urine containers and every 1.5 months for faeces containers. However, Sumaj Huasi is considering increasing the frequency of faeces collections to every month, because some households fill their containers in one month and some containers get very heavy after 1.5 months. Even though the containers for the faecal matter have a total capacity of 100 litres, the teams try to collect them when they are filled up to 50-60 litres.

At the compost centre there are two technical agronomists who manage the activities related to the treatment of the sub-products and trials of the ecosan fertilisers for crops. Finally, there is a supervisor responsible for supporting and coordinating the activities of collection and treatment.

11 Practical experience and lessons learnt

Scaling-up of ecosan approach in El Alto:

In this process the following drivers have been considered important:

- High focus on the hygienisation of UDDT fertiliser products to generate confidence among the stakeholders; this work draws on research, social marketing and normative influence.
- Communication and diffusion of the ecosan approach, pursuing an open dialogue about sanitation as a source for safe fertilisers to locally produce food, to save water and adapt to climate change. Finally, demand for ecosan solutions has emerged.
- Participation of the Bolivian Ministry of Environment and Water and the Vice Ministry of Potable Water and Basic Sanitation was relevant. The project objectives were aligned with the national aims of improving the quality of life and food security of the people.
- Transfer of technology and processes to governmental and social organisations and sharing of the learning gained by the project.

Acceptance of the ecosan approach by the households:

Based on the number of households that are delivering to the collection service and participating in the monitoring activities carried out by Fundación Sumaj Huasi, about 70% of the total households are using the UDDT. Lessons related to this situation are:

- Households located in the more populated areas have shown more acceptance and demand for the sanitary unit.
- The sustainability of the project is highly related to the contributions in the initial investment to construct the sanitary unit made by each household. The higher the contribution, the likelier the household is to keep using and maintaining the UDDT.
- There is a need to define criteria and agreements to frame the participation of the households in the project and thus reduce the occurrence of situations that lead to the abandonment of the UDDT. In the case of El Alto, ownership of the house with permanent residence has been identified as a fundamental criterion for the participation of a household.

Learning from the technical aspects of the sanitary unit:

- The proximity of houses within peri-urban settlements limits the operation of single-vault UDDTs with solar heating. Instead, UDDT with containers have shown better results, since they require less space and less initial investment.
- Installation of urine containers in a more visible and accessible place of the sanitary unit showed better results among the households. The location of the urine containers was moved from a metal covered box underneath the unit, to the site below the hand washing basin. This facilitates the every-day checking of the urine level for the households.
- Integration of the shower and toilet in the same room is preferable to avoid sub-utilisation of the shower room, as a storage space, for instance. This change also reduced the cost of construction (NCSSD, 2010).
- Consideration to climate conditions and their impacts in building material is important to be included during the project planning and technical design. At the beginning of the project ferro-cement tanks were built to store water. However, the ferro-cement cracked due to extreme temperature changes. Plastic tanks were later introduced instead.

Feasibility of ecosan approach in the context of El Alto*:*

- The single vault UDDT with container is a viable option to increase the sanitation coverage in peri-urban areas of El Alto city.
- Composting of faecal matter from UDDT with red Californian worms produces organic fertiliser that meets World Health Organisation guidelines for a safe fertiliser for food agricultural production.
- Laboratory analysis of food produced with ecosan fertiliser show that it is safe for human consumption.
- The ecosan project in El Alto has succeeded in closing the loop of nutrients and water.

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12 Sustainability assessment and long-term impacts

A basic assessment (Table 1) was carried out to indicate in which of the five sustainability criteria for sanitation (according to the SuSanA Vision Document 1) this project met and which aspects were not sufficiently emphasised.

Table 1: Qualitative indication of sustainability of system. A cross in the respective column shows assessment of the relative sustainability of project ´+´ means: strong point of project; ´o´ means: average strength for this aspect and ´–´ means: no emphasis on this aspect for this project).

	collection and transport			treatment			transport and reuse		
Sustainability criteria:	+	o	-	+	o	-	+	o	-
• health and hygiene	X			X			X		
• environmental and natural resources	X			X			X		
• technology and operation	X			X			X		
• finance and economics		X			X			X	
• socio-cultural and institutional		X		X			X		

Sustainability criteria for sanitation:

Health and hygiene include the risk of exposure to pathogens and hazardous substances and improvement of livelihood achieved by the application of a certain sanitation system.

Environment and natural resources involve the resources needed in the project as well as the degree of recycling and reuse practiced and the effects of these.

Technology and operation relate to the functionality and ease of constructing, operating and monitoring the entire system as well as its robustness and adaptability to existing systems.

Financial and economic issues include the capacity of households and communities to cover the costs for sanitation as well as the benefit, such as from fertiliser and the external impact on the economy.

Socio-cultural and institutional aspects refer to the socio-cultural acceptance and appropriateness of the system, perceptions, gender issues and compliance with legal and institutional frameworks.

For details on these criteria, please see www.susana.org: the SuSanA Vision document "Towards more sustainable solutions" (www.susana.org).

The main accomplished impact of the project is that 4,500 people have improved their quality of life by gaining access to safe sanitation facilities. In addition, the model of implementation is closing the loop on nutrients and water, generating multiple local benefits, and the project has contributed to the framework for sustainable sanitation development in the country.

In the long term it is expected that the institutional collaboration and lessons learned will support the development of the National Program of Ecological Sanitation toilets formulated by the Bolivian Ministry of Environment and Water.

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Further reading

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14 Institutions, organisations and contact persons

Fundación Sumaj Huasi (planning and executing institution)
Juan Carlos Suntura, Project manager
Calle Landaeta Nro. 546, Esq. Pje Juan Pablo II
Tel./Fax (+591) (2) 2116098 / (+591) (2) 2493947
La Paz, Bolivia
www.sumaj.org
e-mail: contacto@sumaj.org

Stockholm Environment Institute (supporting institution)
Madeleine Fogde, Senior Project Manager
Kräftriket 2b, Stockholm, SE 106 9, Sweden
Tel. (+46) 8 674 70 70
www.sei-international.org
e-mail: madeleine.fogde@sei-international.org

Case study of SuSanA projects

Large-scale ecological sanitation in peri-urban area, El Alto city, Bolivia

SuSanA 2012

Authors: Juan Carlos Suntura (Fundación Sumaj Huasi, csuntura@sumaj.org) and Blanca Iris Sandoval (SEI intern, blancairisf@yahoo.com)

Reviewers: Madeleine Fogde (SEI, madeleine.fogde@sei-international.org), Kim Andersson (SEI, kim.andersson@sei-international.org) and Elisabeth von Muench (elisabeth.muench@ostella.de)

Editing: Marion Davis (SEI-US, marion.davis@sei-us.org)

This document is available at www.susana.org.