Case Study – Sustainable Sanitation Projects
Home fecal Sludge Management in SantaCruz de la Sierra
Santa Cruz de la Sierra, Bolivia

Fig. 1: Project Location

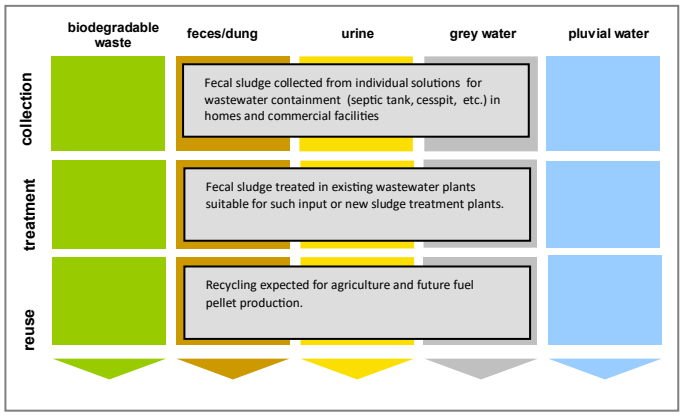

Fig. 2: Sanitation components applied to this project

1 Project Specifications

Type: Design for a pilot initiative to manage fecal slugged at homes located in periurban areas in Santa Cruz City, Bolivia.
Period
This project was implemented between years 2017 and 2019.

Scope/Category: 193,000 houses (51%) of the homes in the intervention area are not connected to wastewater collection systems and may be assisted by decentralized sanitation systems based on fecal sludge management.
Location:
Periurban area in Santa Cruz City, Bolivia: *Villa Primero de Mayo*
Institutions responsible for the Project Social Control and Surveillance for Basic Sanitation and Drinking Water Authority (AAPS) – Association of Wastewater Cleaning and Transport (ADELTAR) - *1º de Mayo* Service Cooperative (COOPAGUAS) – Departmental Autonomous Government (GAD) – Autonomous Government of Santa Cruz Municipality (GAM) – Water and Environment Ministry (MMAyA) – Sanitary Sewage and Drinking water Service (SAGUAPAC) – Basic Sanitation and Drinking water Vice-Ministry (VAPSB) – World Bank.

2 Purpose and Cause of the Project

General Objective:

This Project is intended to improve home fecal sludge management for periurban areas in Santa Cruz City. This includes collection and cleaning service in the stages of generation, collection, transportation and treatment, as well as regulation of cleaning, transportation and safe disposal services for collected sludge. This pilot initiative is oriented to provide guidance and supplies for a national policy and strategy by promoting its replicability in cities with similar characteristics and conditions regarding sanitation system.

Specific Objectives:

I. Better coordination between users and providers of fecal sludge collection and cleaning services.

II. Improving operational conditions for Sludge Collection and Transportation Companies (ETRL), thus reducing environmental and social risks in collection and transportation services.

III. Generating supplies to regulate and promote safe disposal and/or recycling.

IV. Adopting a fecal sludge management project by participating entity actors.

3 Location and Conditions

The Plurinational State of Bolivia is located in the western central part of South America. It has an estimated population of 11 million people (2019) in an area of 1.098.581 km2. It is located in the tropical area of the planet; however this country is characterized by a wide climate variety due to great differences in altitude and topographical diversity.
This country is a unitary state divided into 9 departments, being Santa Cruz the largest in territorial extension and the wealthiest department in the country. The capital of this department, located in the eastern part of the country, is Santa Cruz de la Sierra, located in Andres Ibanez Province. Its metropolitan area hosts 1.9 million inhabitants, distributed in six municipalities: Santa Cruz de La Sierra, Warnes, Porongo, Cotoca, La Guardia and El Torno.
This city produces around 35% of the Gross National Product (GNP), and it is considered the financial center in the country. This has resulted in an internal migration from different parts of Bolivia. Currently, Santa Cruz is one of the cities with the greatest demographic growth rate in the world, as established between 2006 and 2020.
This initiative is focused in a periurban area of this city, in a plain location with generally wide streets and moderate residential density. Home occupancy widely varies; in some cases reaching 8 people and 4 in others. The average considered is 6 to 7 people per home.

General Sanitary Conditions:

In general, low basic drainage coverage in Bolivia, comprising approximately 57% of the population, is closely related to implementation of sanitary systems and population growth in the country. Since collection system coverage depends on great

investments, it complicates the access mainly to the poorest sectors of the population. In this context, individual drainage solutions rise as an important and common practice in the periurban areas where collection systems are not present.

According to a study performed in the metropolitan area of Santa Cruz de la Sierra in 2016, (WSP, 2016), approximately over 150,000 homes use individual drainage systems, which represents approximately 46% of urban population. From this estimate, only 30% of these dwellings empty their containment systems with a maximum frequency of two years. This portion drops to 15% when homes that annually clean their wells are represented. More recent data, issued by a regulating entity in 2017, shows that the amount of homes using individual systems has increased to 182,088, which represents approximately 48% of homes in the city.

Forecasts made show that by 2030, this participation percentage should be reduced. Therefore, in order to achieve objectives proposed by the Patriotic Agenda 2025 (a governmental plan until that year), such as universal access to water and basic sanitary system that is planned for 2025, and the Economic Development Plan (PDES 2015-2020), which establishes a goal of 95% regarding water supply to urban areas and 70% for urban drainage, considering individual drainage systems is crucial.

Legal Framework

Technical and financial issues to implement drainage systems in certain locations have increased in the country for a number of homes that used individual drainage systems. Despite being a solution, its implementation also causes new problems such as maintenance, cleaning and final disposal of fecal sludge accumulated in the pits. This situation has caused informal fecal sludge cleaning and collection services for individual systems, where final disposal of collected material is frequently unknown due to lack of control and inadequate management.

According to Regulatory Administrative Resolution 227, dated December 3, 2010, issued by AAPS, the country made a significant step on regulation and management of individual systems by validating them as an alternative to sanitary sewage, and establishing ETRLs as service providers for fecal sludge cleaning and collection and subsequent treatment and final disposal in Wastewater Treatment Plants (PTAR).

In Santa Cruz City, due to a large number of homes with individual drainage, the municipality issued the Municipal Regulation for Wastewater and Fecal Sludge Management in 2015, and the Water Protection and Conservation Law in 2016, both to promote some progress on fecal sludge management.

4 Project Background

Background:

Bolivia has faced significant progress in the last two decades towards compliance with UN Millennium Development Goals. According to the Environment and Water Ministry (Ministerio de Medio Ambiente y Agua - MMAyA), coverage in drinking water service increased from 72% to 84% between 2005 and 2014. In the same period, sewage system services increased from 43% to 57%, although below the proposed goal of 64% (VAPSB, 2017). This progress was centered in an accelerated urban and demographic growth that put a lot of pressure on essential utilities, particularly, drinking water supply and basic sanitation services. In this context, challenge for municipalities and entities providing water and drainage services is to fulfill increasing demand, byexpanding coverage and quality of services being offered.

One of the greatest breaches regarding wastewater coverage is that related to conventional drainage service that could be acknowledged as centralized systems for wastewater collection and treatment. This breach was caused by a rapid urban growth that imposed occupancy from far locations of city central areas and sometimes irregular topographic and occupation conditions. This made access difficult and increased investment required to implement so called sewage networks. It is also worth mentioning that in places with low population density, the cost required to implement centralized sewage networks does not correspond with the number of homes that are connected to the sewage system and would pay for collection and treatment services.

In this context, decentralized solutions seem to be a viable alternative from a technical and economical point of view, especially for periurban areas in cities where access to centralized systems is a common shortage. This is a potential alternative due to both adaptability of decentralized systems to local contexts, (including low occupancy and regions where topography and soil profile are not suitable to install collection systems), and a great number of homes that currently depend on individual systems (both septic tanks or cesspits).

Environment and Water Ministry (MMAyA) through its Five-Year Strategic Plan, established the use of centralized sewage as prevailing technology in expanding coverage of basic drainage services. However, despite being the most common service, a significant portion of the population uses or could be better assisted by decentralized sewage systems.

Fecal sludge and other liquid and solid waste generated by individual systems are an increasing challenge in places with a rapid urban growth, since only a small percentage has an appropriate management and treatment service (WSP, 2013). Most fecal sludge ends up accumulating in pits, often infiltrating underground or being dumped into open channels, pluvial water, vacant lots or unhealthy dumpsites.

Before this issue, MMAyA along with the Social Control and Surveillance for Basic Sanitation and Drinking Water Authority (AAPS - Autoridad para Fiscalización y Control Social de Agua Potable y Saneamiento Básico - AAPS) and a technical financial support by the World Bank, developed a pilot initiative intended to improve sanitation conditions in Santa Cruz City by managing home fecal sludge in periurban areas.

Project Methodology and Design:

Starting from objectives proposed by the initiative and establishment definition of a performing area, the project was developed from a surveying and characterization process about local status and the basis of potential solutions for critical points in Santa Cruz. A deep knowledge about conditions and issues related to local sewage service chain enabled the initiative to propose actions in order to improve and complement existing systems with structural actions. Project development was based on diagnosis and prognosis stages and an action plan.

Regarding diagnosis, a study performed by this initiative identified some issues to be solved within the value chain related to fecal sludge management. The first issue, related to

the first link of fecal sludge generation, refers to people unawareness about technical aspects of construction, operation and maintenance activities for individual sewage systems.

Regarding sludge collection and transportation, the need to create standards to regulate service provided by ETRL was identified. Regarding treatment, a potential double risk on PTAR operation efficiency due to reliance on a single plant to collect fecal sludge was observed. Finally, regarding the last chain link, it was established that rules and experiences related to fecal sludge disposal and safe recycling are unavailable. From this diagnosis, the initiative proposes solutions for service chains related to fecal sludge management through structural actions.

For this activity, a strategic arrangement of actors to discuss, define and implement proposed solutions was structured. Distribution of process responsibilities was structured as follows:

VAPSB – Promote fecal sludge management strategy, and standard and regulation disclosure on a national basis, as well as facilitate investment involved in this project;

AAPS – Supervise provision of sanitary wastewater transport and collection services established by RAR 227, and regulate these services as established by RAR 546;

GAD Santa Cruz – Monitor and issue any environmental permit required to develop this project in compliance with relevant standards and regulations;

GAM Santa Cruz – Invest on infrastructure for fecal sludge inspection and control, enhancement of municipality mechanism for home monitoring, and compliance with standards established by guidelines to build alternative systems;

EPSA – Build technical and logistic infrastructure required by corresponding PTARs to operate according to relevant standards; assist on coordination of entity actors involved in this initiative, and contribute to a better organization involving users, based on information collection through a register of local systems;

ETRL – Offer standard services and provide technical assistance to users of individual sanitation systems;

CTC – Promote an inter-organizational agreement among actors involved in this initiative and establish a project schedule; prepare an operational regulation for this initiative; identify the entity responsible for leading the committee; identify criteria and select a project implementation area.

5 Applied Technologies

In order to comply with proposed objectives, this project is based on five basic parts, four of which are technical and related to the service chain:

Part 1: Improving individual sanitation solutions

The first part of this initiative is intended to improve individual sanitation systems (septic tanks and cesspits) and increase the use of collection, discharge, transportation and cleaning services, for those who use this sanitation form. For this activity, a series of actions are proposed:

- Preparing a registry for users of individual sanitation systems.
- Implementing a system to register and monitor individual system cleaning activities.
- Developing standardized construction and control protocols for cesspit maintenance.
- Training and certifying professionals on construction of individual sanitation systems.
- Implementing a call center where ETRLs will register and, according to user requirement for a service, provide quotes/budgets for services with more competitive costs.

Part 2 – Improving fecal sludge collection and transportation services.

This second part is intended to improve ETRL operational conditions, thus reducing environmental and social risk in collecting and transporting fecal sludge. For this part, the following actions were involved:

- Developing protocols for ETRL equipment and operations.
- Implementing rules for ETRL truck operations involving septic tank cleaning, including:

i. a register number for each truck, including technical information (brand, capacity, year of manufacture) and the owning company;

ii. an identification plate on the truck tank

iii. tank inspection to comply with established technical requirements;

iv use of a satellite tracking system that enables knowing truck location, sludge collection and disposal points, etc.

- Training ETRL operators on fecal sludge operation and management protocols
- Processing a certification of competency for professionals in this sector

Part 3 – Improving fecal sludge discharge and treatment process

This part is intended to improve fecal sludge treatment process through technical standards to minimize performance risks for receiving PTAR. These actions include:

- Implementing two independent systems for fecal sludge treatment in SAGUAPAC and COOPAGUAS PTARs. These systems should comprise a physical-biological treatment system including some stages involving a grid to remove coarse and solid materials; sand removal; a sedimentation and thickening system (or bioreactors in any case), and drying beds.
- Improving road access to project PTARs, prioritizing this process before relevant entities so investment on vial infrastructure is made and free truck transit is available during the whole year;
- Preparing, revising and adjusting fecal sludge discharge, characterization and monitoring;
- Training SAGUAPAC and COOPAGUAS professionals on operation and maintenance of relevant systems
- Systematizing and analyzing sludge samples in different disposal and treatment processes.

Part 4 – Baseline for appropriate recycling and disposal of treated fecal sludge

The fourth part of this project is intended to promote safe recycling and disposal of collected fecal sludge. In order to

achieve this objective, implementing an investigation program for safe recycling and/or disposal of treated domestic fecal sludge is proposed, in order to:

- Develop and test scalable business models for safe recovery and recycling such as: biofuel, biogas, animal feeding proteins, components for construction material and fertilizers;

- Evaluate risks to human health and the environment originated by recycling in different sectors, and promote mitigating measures for these risks;

- Promote and enhance private initiatives for technological innovation on safe recycling of fecal sludge (exploring optimization activities by combination with solid organic waste) identified in tenders.

6 Project Setup

Implementation and operation structure for this proposed solution is organized into structuring and structural aspects.

Structuring aspects include: configuration of institutional competencies, standard definition, protocols and regulations, communication mechanisms, educational and awareness campaigns, capacity development, service to clients and providers, including activity management, operation and infrastructure involved, and therefore: a business model, follow up measures, fecal sludge collection and transportation; fecal sludge provision and treatment, and final disposal or recycling of processed materials.

This structured pilot project, which will be applied in two towns under COOPAGUAS and SAGUAPAC service, includes improvement to fecal sludge management chain, focusing on control and inspection stages of individual solutions for fecal sludge drainage, collection and transportation, treatment of collected material and disposal and recycling activities for processed sludge.

Under the scope of individual sanitation solutions at homes, improvement is focused on structural interventions to improve systems quality. Thus, actions such as improvement of construction standards and local builder capability to implement systems; inspection and control to installations performed by the municipality (taking advantage of collection events to relieve local conditions); and sludge collection under demand managed by a call center are planned.

Regarding fecal sludge collection and transportation, proposals are directed to improve procedures involved in this step, by standardizing these activities. For collection, trucks for septic tank cleaning including vacuum pumps and proper use of PPE (personal protection equipment by operators are proposed. In order to improve operational capability of this process, service management protocols by controlling vehicles and equipment in each collection, including satellite tracking, are proposed. Training and certification activities for professionals and service inspection by government administration are also included.

For fecal sludge supply and treatment, an adaptation of existing wastewater treatment plants by creating specific lines for an appropriate sludge processing is proposed. Transported material is taken to a plant, and discharged in a sludge tank, where grid and sand crushing pre-treatment is performed. From there, sludge is taken to sediment and thickening tanks that anticipate separation of a supernatant liquid phase that goes to another treatment in the optional tank, into an existing wastewater treatment system and a phase of thick sludge, that moves to a drainage section and drying beds. After drying process, the sludge is sent to final disposal or recycling systems. The whole sludge transport within the plant, from the entrance to the discharge chamber, is produced by gravity.

Additional processing to enable recycling, as well as destinations to apply recovered material, are still to be defined according to specific studies that will be performed during the project.

7 Recycling Type and Level

In the future, this initiative foresees implementation of resource recovery systems by performing an appropriate treatment of fecal sludge to be safely implemented in agriculture. In order to make this practice possible, after going through stabilization and drying stages, for example, fecal sludge may co-compost with urban pruning waste and get disinfected by lime application. Other practices such as biogas production and pelletizing of solid waste from sludge processing may also contribute to more sustainable processes.

However, this initiative has not advance significantly yet in planning these processes, including specific studies in the short term, in order to define more strategic configurations for recycling considering local contexts.

8 Other Project Components

This project foresees an environmental awareness campaign and standard disclosure for construction and maintenance of individual sanitation systems directed to institutional actors in the chain of home fecal sludge. This awareness activity will be undertaken through communication campaigns that include preparing institutional videos, information brochures, workshops and educational fairs, developing a call center, and others.

Furthermore, campaigns along with local communities directly impacted by the project in order to inform and educate about appropriate handling and management regarding collection, transportation, treatment and recycling of fecal sludge at home will also be organized. In order to ensure project effectiveness, demonstrating benefits of the treatment and safe disposal of fecal sludge at home, by making regular visits to places where this initiative is intended to assess progress performed and potential adjustments required.

Another part of the project foresees preparation and disclosure of a guide to plan and build alternative forms of sanitary sewages. This guide will include different technical and standard components present in the project and will be consequently delivered to relevant professional organizations (engineers, architects), as well as public entities that provide environmental permits to authorize works and constructions. Accordingly, the project has included training courses on planning and commissioning to professionals related to the sector such as architects, engineers, master builders, etc.

During the entire project development, participation in events such as EXPOCRUZ annual fair in Santa Cruz de la Sierra, resulted in a very strategic activity to aware public on sanitation and fecal material management. In this regard, significant efforts, such as creating illustrative characters like “Fecalito” to demonstrate the cause and matters related to wastewater and fecal sludge management, resulted in greater awareness and support to this initiative.

9 Costs and Financial Aspects

When analyzing financial aspects involving implementation and operation of individual systems, it is essential to mention costs of centralized sewage systems. A study performed in Cotoca Municipality (also located in the metropolitan area of Santa Cruz) demonstrates relevance on fecal sludge management. Results show that initial investment required by decentralized systems are 1.64 times more cost-effective, and total investment during system life are 2.21 times lower than centralized systems. This conclusion is based on bibliography about this topic, despite a great variation between sewage system costs and individual systems with septic tanks. Such variation that could rise from 1 to 5 times, is mainly explained by the analysis methodology employed, since some studies ignore, for example, implementation cost for pits by users, this is, costs to connect this system to collection network, among others.

Regarding operation and maintenance costs, Santa Cruz users connected to the sewage network pay a fee to EPSA, which is a percentage of water consumption that generally varies from 75% to 80%, according to EPSA. This percentage for COOPAGUAS and SAGUAPAC (EPSAs participating in this project) is 75% and 80%, respectively. On the other hand, sludge cleaning and transport from individual systems has an average cost of US$ 72 in ETRLs having a proper operation permit. This cost could be reduced to US$ 50 in places where a great number of informal ETRLs are operating.

10 Operation & Maintenance

Operation and maintenance of this system comprises different stages in the service chain, from inspection and regulation of individual solutions, sludge collection and transportation, to discharge, treatment and disposability of material to be recycled. These activities will have specific actions and will be distributed among different entities involved.

This initiative anticipates a first stage where individual solutions will be registered in the operation area established by COOPAGUAS EPSA, in a pilot mode. This involves technical visits to homes by COOPAGUAS professionals who will interview residents to obtain information about cause and frequency of individual system cleaning and economic capacity of these residents. Based on information obtained, changes and new technical and standard procedures for fecal sludge cleaning, collection, transportation and treatment will be proposed.

According to Santa Cruz municipality regulations, users of individual systems must clean and discharge their systems at least once a year (although as established by the initiative itself, a few users follow these instructions). This service is provided by different ETRL that clean and collect fecal sludge using tank trucks to discharge material in the PTAR for its treatment and final disposal.

According to proposed model, users must communicate with a call center, operated by Santa Cruz Municipality to require services and ETRL quotes, thus making this sector a more competitive and cost-effective service. So that the ETRL be able to discharge fecal sludge in the PTARs, a contract with corresponding EPSA – SAGUAPAC or COOPAGUAS-must be signed in order to comply with the following requirements:

i. Have AAPS authorization

ii. send a contract form

iii. have a valid environmental permit

iv. comply with technical specifications and safety and hygiene measures for vehicles and transportation personnel

v. no restricted substances is transported or concentration limit is exceeded, as established by Technical Administrative Procedure (PTA)

Currently, a single fecal sludge discharge point for ETRL, Industrial Park PTAR (PTAR-PI) operated by SAGUAPAC, is available. However, this initiative foresees building another fecal sludge treatment system in the PTAR to be operated by COOPAGUAS.

Treatment stations will receive daily sludge materials from ETRL tank trucks during a procedure supervised by PTAR personnel, complying with relevant operation regulations. Up to three trucks will be allowed to discharge simultaneously once they have completed registration form and their plates have been verified. Hoses will be used to empty their tanks during a procedure that lasts approximately 10 minutes. For every discharge, a sample will be collected to further test basic parameters for sludge quality. Besides these procedures, actions to supervise operations of every treatment and maintenance step and spare replacement whenever necessary are also foreseen.

11 Experiences and Learned Lessons

Along with developing this initiative, some strategies and challenges led to greatly relevant lessons for effective actions. Furthermore, some determining behaviors during this project were observed.

The first point established by the project team describes a commitment and support strategy to the initiative. A connection between wastewater generated and contamination risk for water supply that caused more concern and mobilization regarding discussed measures was observed. In Santa Cruz, due to 100% supply of underground water resources, this became a highly sensitive impact and generated a great support to the initiative of proper containment systems and fecal sludge management.

Another point observed refers to participation of septic tank cleaning providers in the process. A high disposition from these actors to discuss about this matter and explore improvements in their operational procedures was evidenced. This situation has a great impact on achieving project efforts, thus allowing effective results on optimizing service quality and personnel safety.

Besides these aspects, in order to involve and acknowledge actors involved in the initiative development, a field trip to Dakar, Senegal was made during the initial stages of the project in order to know the actions that are performed there for fecal sludge management. Knowing structured systems and their dynamics had a significant impact on empowerment and enthusiasm to plan and develop actions in Santa Cruz.

Finally, a greatly relevant aspect to advance on this kind of initiative involves challenges found during formation and empowering of public sector for new approaches, proceedings and development of public policies. A risk is always present when changes on management orders are present, because

they might interrupt capability and progress of the initiative; whenever technical teams are replaced efforts achieved could be lost.

12 Sustainability Assessment and Long-Term Impacts

A basic assessment was performed (Table 1) to indicate which of all five sustainability criteria regarding sanitation, according to Document 1 in SuSanA Vision) this project has its strengths in and what aspects were not outlined (weaknesses).

Table 1: Qualitative Reference about System Sustainability

	Collection & Transportation			Treatment			Transportation & Reuse		
Sustainability Criteria	+	0	-	+	0	-	+	0	-
Health & Hygiene	X				X			X	
Natural and Environmental Resources	X				X			X	
Technology & Operations		X			X			X	
Economics & Financing		X			X			X	
Institutional & Sociocultural	X				X			X	

Regarding sustainability aspects assessed, measures that have been adopted so far are focused on collection, transportation and treatment stages, but with a relatively low emphasis on recycling stage. For collection and transportation, a strong impact on public health and hygiene, environment and natural resources is evidenced due to level and quality of service proposed by the initiative, which tends to reduce irregular disposal of sludge on land and body waters, thus reducing contamination risks.

From a technological, operational and financial point of view, measures adopted show significant progress considered as moderate. From the institutional and sociocultural point of view, measures proposed for collection and transportation stage involve great efforts on the usual way of service provided and user habits.

Regarding treatment, for every aspect, a more positive but moderate behavior was considered, given the level of preparation and development for fecal sludge treatment systems. Regarding recycling stage, which is located in a more incipient level, a quite high potential was considered. However, given the incipient level of studies and definitions for the initiative, a moderate level was considered for every aspect.

13 Available Documentation

SNV. Diseño de una iniciativa piloto para el manejo de lodos fecales domiciliarios en áreas periurbanas de la ciudad de Santa Cruz - Bolivia. Bolivia: Stichting Nederlandse Vrijwilligers, 2017. Available at: <https://snv.org/cms/sites/default/files/explore/download/lodos_feales._informe_final.pdf>. Accessed on Aug 1, 2020.

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14 Entities – Organizations - People

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Case Study for SuSanA Projects

Sewage Service through Scheduled Pit Cleaning in Rio Grande do Sul

SuSanA 2020

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