SFD Promotion Initiative

Santa Cruz, Bolivia

Final Report

This SFD Report was created through desk based research by WEDC as part of the SFD Promotion Initiative.
It is primarily based on a recent World Bank FSM diagnostic report.
See Acknowledgments.

Date of production: 21/9/2016
Last update: 3/1/2017

SFD Promotion Initiative

sustainable sanitation alliance

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

On behalf of Federal Ministry for Economic Cooperation and Development

UNIVERSITY OF LEEDS

WORLD BANK GROUP Water

wsp water and sanitation program

WEDC

Loughborough University

CSE

eawag aquatic research

Sandec Sanitation, Water and Solid Waste for Development

Bill & Melinda Gates foundation

SFD Report **Santa Cruz, Bolivia,** 2017

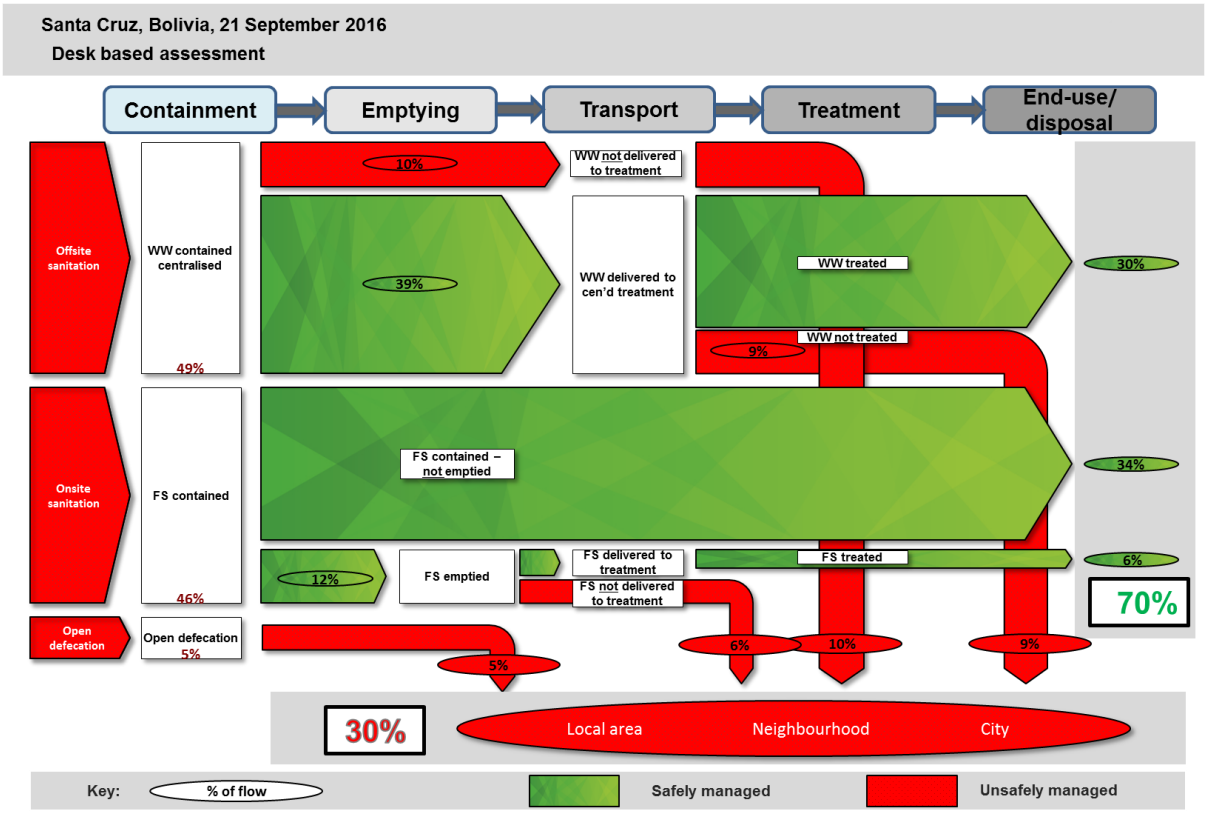
Produced by:

Claire Furlong

This Executive Summary and SFD Report are available from:

www.sfd.susana.org

1. The Diagram



2. Diagram information

The excreta flow diagram (SFD) was created through desk based research by WEDC (Water, Engineering and Development Centre) Loughborough University.

Collaborating partners:
The World Bank Water and Sanitation Program and Oxford Policy Management Ltd.
Status: Final
Date of production: 21/9/2016

3. General city information

Santa Cruz de la Serria Metropolitan Area (SCMA) is the second largest urban area in Bolivia. It is located in eastern Bolivia on the Pirai Riva at an altitude of 416 m above sea level. It is a major economic centre in Bolivia. SCMA produces nearly 35% of Bolivia's gross domestic product, and receives over 40% of all foreign direct investment in the country.

There are approximately 1.9 million inhabitants in SCMA and it is home to 70% of the population from the Department of Santa Cruz. Population growth is driven by rural-urban migration, with growth averaging approximately 4% between 2001 and 2012 (Magnus, 2015; Rivera, 2010). Most of these new urban inhabitants have settled in the suburbs or peri-urban areas of the city, where growth has been estimated to be 7% (WSP, 2016). It is considered to be one of the fastest growing cities in the world (Wikipedia, 2016).

SCMA has a tropical savanna climate, with an average annual temperature around 23°C. There are two seasons in SCMA: cold season from May to September and a hot, rainy season from October to April. Maximum temperatures of up to 38°Care reached in the summer months (December to March), while minimum temperatures of approximately 6°C are experienced in the winter months (June to August) (Magnus, 2015).

4. Service delivery context

The Municipal Ordinance No. 031 of 2001 enacts the Municipal Regulation for Wastewater and Sludge Management in SCMA. It states that households without access to sewerage must have alternative systems for containment, emptying and transport of wastewater or faecal sludge. It also sets out the standards for emptying and

transport services (i.e. types of trucks to be used, health and safety equipment for workers). Articles 53, 55 and 57 forbid the disposal of wastewater or sludge in public roads, natural water bodies or any other unauthorised area.

The Autoridad de Fiscalización y Control Social de Agua Potable y Saneamiento Básico (AAPS) Administrative Regulatory Resolution No. 227 of 2010 (i) promotes the use of septic tanks, latrines and ecological sanitation in areas with no access to sewerage; (ii) enables water supply and sanitation utilities / cooperatives (Empresa Prestadora de Servicios de Agua Potable y Alcantarillado (EPSA)) to provide low-cost faecal sludge emptying and transport services, and (iii) regulates faecal sludge emptying and transport service providers (Empresa de Recolección y Transporte de Lodos (ERTL)). Furthermore, AAPS Resolution No. 546 (2014) establishes the operational and technical standards under which ERTLs must operate, and the 2016-20 National Sanitation Plan sets out a wastewater reuse policy.

Despite the existence of a comprehensive policy framework, understanding of the roles and responsibilities of municipal and national institutions remains unclear and there is limited engagement from municipal authorities in the provision of sanitation services and faecal sludge management. This hinders the implementation of regulatory mechanisms stipulated in the resolutions mentioned above. A major issue is related to the extensive rules for formal registration and certification of ERTLs. As many of these service providers are family owned or micro businesses, they are unable to fully comply with the specified requirements.

The main challenges faced by ***institutions*** in this sector are:

• While roles and responsibilities across national, departmental and municipal governments are clearly defined, they are not clearly understood.

• The lack of understanding of roles and responsibilities for FSM impacts on the availability and allocation of financial and human resources for FSM services both regarding budget and planning and for the effective implementation of the regulatory framework.

The provision of emptying, transport and treatment is provided by the EPSAs when this responsibility is delegated by the municipality (usually with either formal or informal agreements). They can outsource pit emptying and fecal sludge transport services to ERTLs (FS Collection and Transport Enterprises). However, although there are 27 ERTLs in the city, the cost of services is uniform across the city, resulting in a lack of competition.

Resources are currently being directed towards the expansion of the sewerage network and the construction of new wastewater treatment plants. Currently SAGUAPAC is the only utility (1 out of 10) running a wastewater treatment facility that is adapted to receive fecal sludge discharges in the metropolitan area of Santa Cruz,. Adapting the remaining four treatment facilities that are currently in operation in the city to receive fecal sludge would require minimum investment and could have a positive impact on FSM services pricing since distance to treatment plants, and therefore hauling costs, could be reduced.

FS discharge capacity at treatment plants and the AAPS working on improving regulatory mechanisms. Due to this, services cannot be deemed equitable. Although the city has made significant investments in improving FSM services, these have mainly focused on the supply side. Recent initiatives aimed at increasing competitiveness across ERTLs may reduce prices charged for emptying and allow for increased access to emptying services among the urban poor.

The main challenges in service provision are related to ***planning and budgets*** which have been focused on sewerage services. Although FSM has been integrated into policy and legislation, there is no investment planned and hence no budget allocated. There is a lack of targets relating to FSM services, which is possibly due to it being seen as a short term solution.

Additionally there is a lack of incentives for investment in FSM services, especially as the sector is relatively informal (i.e. operation of the ERTLs).

The ***norms, standards and regulations*** for FSM are set out in the Municipal Ordinance No. 031 (2011) and the AAPS regulations. Although the local environmental authority is in charge of defining the norms and standards for OSS facilities, data is not readily available.

Reporting on FSM is currently being undertaken for registered ERTLs, but there is no data for informal service providers. There is also a lack of monitoring on the effectiveness of the containment of FS and the frequency of maintenance of OSS facilities by households.

5. Service outcomes

49% of the populations' excreta discharge directly to sewers. Of this, only 80% (or 39% of the populations' excreta) is considered to reach a wastewater treatment plant due to estimated leakage from the sewers. This waste stream is partially treated, resulting in a total of 30% of all wastewater being considered as treated.

46% of the population are reliant on onsite sanitation systems, with a majority using septic tanks connected to a soak pit (35%). Of the onsite sanitation systems only 12% are reported to be emptied, with half of this stream of faecal sludge taken to a wastewater treatment plant and treated. 5% of the population have no access to sanitation systems and practice open defecation.

6. Overview of stakeholders

The National Ministry of Environment and Water oversees the sanitation sector via the Vice Ministry of Water Supply and Sanitation.

Due to decentralisation, the local government are required to ensure the provision of sanitation and also issue the permits for faecal sludge emptiers. Sanitation and water services are provided by cooperatives such as SAGUAPAC who provide faecal sludge emptying services and wastewater treatment. There is small scale private sector involvement, but this is largely in the emptying services. Regulation of the sector is through the local Environmental Authority.

7. Credibility of data

The fate of infiltrate from soakaways and pit latrines has been disregarded in the SFD. It was deemed to have little, if any, direct impact on health.The SFD represents only the flows of wastewater and faecal sludge through the sanitation service chain.

8. Process of development

A majority of the data in this report unless stated otherwise is taken from:

The World Bank Water and Sanitation Program 2016 Report: Fecal Sludge Management: Diagnostics for Service Delivery in Urban Areas, Case study report – Fecal sludge management in Santa Cruz, Bolivia.

The World Bank study was based on a household survey, transect walks, observations, key informant interviews and focus group discussions. It also incorporates a review of the enabling environment for FSM in Santa Cruz, Bolivia.

It should be noted that no other stakeholders were involved in the production of this report and the focus of this report was on FSM rather than sanitation.

9. References

Magnus, H. C. 2015. The political economy of faecal sludge management in the city of Santa Cruz de la Sierra.

Rivera, J. 2010. Los Servicios De Limpieza De Cámaras Sépticas, Recolección Y Disposición Final De Lodos Fecales En Zonas Periurbanas De La Ciudad De Santa Cruz (Bolivia). Water And Sanitation Program (WSP).

Wikipedia 2016. Santa Cruz de la Sierra. https://en.wikipedia.org/wiki/Santa_Cruz_de_la_Sierra#cite_note-5 Last accessed 6/9/2016

Water and Sanitation Program (WSP). 2016. Bolivia: Strengthening Institutional Capacity to Improve Wastewater Management in Peri-Urban Areas - Technical Assistance P132278.

Santa Cruz, Bolivia, 2017

Produced by:
WEDC in collaboration with the World Bank Water and Sanitation Program and Oxford Policy Management Ltd.

This Executive Summary and the SFD Report are available from:
www.sfd.susana.org

Table of Contents

List of tables

List of figures

Abbreviations

AAPS	Autoridad de Fiscalización y Control Social de Agua Potable y Saneamiento Básico (Water Supply and Basic Sanitation Supervision and Societal Oversight Authority)
EPSA	Empresa Prestadora de Servicios de Agua Potable y Alcantarillado (Water Supply and Sanitation Service Provider)
ERTL	Empresa de Recolección y Transporte de Lodos (Faecal Sludge Emptying and Transport Service Providers)
FS	Faecal Sludge
FSM	Faecal Sludge Management
OSS	Onsite Sanitation
SAGUAPAC	Cooperativa de Servicios Públicos de Santa Cruz Ltda (Public Services Cooperative of Santa Cruz)
SCMA	Santa Cruz Metropolitan Area
SFD	Excreta Flow Diagram
SIN	Servicio de Impuestos Nacionales (National Tax Service)
WASH	Water, Sanitation and Hygiene
WEDC	Water, Engineering and Development Centre
WSP	Water and Sanitation Program
WSS	Water Supply and Sanitation
WWTP	Wastewater Treatment Plant

1 City context

Santa Cruz de la Serria Metropolitan Area (SCMA) commonly known as Santa Cruz, is the second largest urban area in Bolivia. It is located in eastern Bolivia on the Pirai Riva at an altitude of 416 m above sea level. It has six municipalities: Santa Cruz de la Sierra, Cotoca, Porongo, La Guardia, El Torno and Warnes and it is a major economic centre in Bolivia. SCMA produces nearly 35% of Bolivia's gross domestic product, and receives over 40% of all foreign direct investment in the country (Wikipedia, 2016).

There are approximately 1.9 million inhabitants in SCMA and it is home to 70% of the population from the Department of Santa Cruz. Population growth is driven by rural-urban migration, with growth averaging approximately 4% between 2001 and 2012 (Magnus, 2015; Rivera, 2010). Most of these new urban inhabitants have settled in the suburbs or peri-urban areas of the city, where growth has been estimated to be 7% (WSP, 2016). It is considered to be one of the fastest growing cities in the world (Wikipedia, 2016).

SCMA has a tropical savannah climate, with an average annual temperature around 23°C. There are two seasons in SCMA: cold season from May to September and a hot, rainy season from October to April. Maximum temperatures of up to 38°Care reached in the summer months (December to March), while minimum temperatures of approximately 6°C are experienced in the winter months (June to August) (Magnus, 2015).

2 Service delivery context description

2.1 *Policy and Laws*

The Municipal Ordinance No. 031 of 2001 enacts the Municipal Regulation for Wastewater and Sludge Management in SCMA. It states that households without access to sewerage must have alternative systems for containment, emptying and transport of wastewater or faecal sludge. It also sets out the standards for emptying and transport services (i.e. types of trucks to be used, health and safety equipment for workers). Articles 53, 55 and 57 forbid the disposal of wastewater or sludge in public roads, natural water bodies or any other unauthorised area.

The Autoridad de Fiscalización y Control Social de Agua Potable y Saneamiento Básico (AAPS) Administrative Regulatory Resolution No. 227 of 2010 (i) promotes the use of septic tanks, latrines and ecological sanitation in areas where with no access to sewerage; (ii) enables water supply and sanitation utilities / cooperatives (Empresa Prestadora de Servicios de Agua Potable y Alcantarillado (EPSA)) to provide low-cost faecal sludge emptying and transport services, and (iii) regulates faecal sludge emptying and transport service providers (Empresa de Recolección y Transporte de Lodos (ERTL)). Furthermore, AAPS Resolution No. 546 (2014) establishes the operational and technical standards under which ERTLs must operate, and the 2016-20 National Sanitation Plan sets out a wastewater reuse policy.

Despite the existence of a comprehensive policy framework, understanding of the roles and responsibilities of municipal and national institutions remains unclear (Section 2.2) and there is limited engagement from municipal authorities in the provision sanitation services and faecal sludge management (FSM). This hinders the implementation of regulatory mechanisms stipulated in the resolutions mentioned above. A major issue is related to the extensive rules for formal registration and certification of ERTLs. As many of these service providers are family owned or micro businesses, they are unable to fully comply with the specified requirements.

2.2 *Institutional roles*

The institutional roles can be found in Table 1, with the main challenges faced by the institutions listed in the final column. The detailed World Bank Study's analysis of the institutional roles is summarised below:

- Roles and responsibilities across national, departmental and municipal governments are clearly defined, but are not clearly understood.
- The lack of understanding of roles and responsibilities for FSM impacts on the availability and allocation of financial and human resources for FSM, both regarding budget and planning and for the effective implementation of the regulatory framework.
- There is a lack of competition in the sector due to the uniform pricing of services across the city

Table 1: Institutional responsibility for FSM (adapted from Magnus 2012, 2015)

Categories	Institution	Formal role	The reality	Core challenge
National government	Ministry of Environment and Water – in particular, the Vice Ministry for Water Supply and Sanitation	• Policy design and establishment • Ensure financial resources are allocated to the sanitation sector	• The implementation of these regulations has been limited and there are no specific provisions for FS services across the whole chain at a national level • They have had very limited active participation in the design of FSM policy	• Limited financial and human capacity • FSM considered a short- to medium term sanitation alternative
	Water Supply and Basic Sanitation Supervision and Societal Oversight Authority (AAPS)	• Regulate and monitor the provision of emptying, transport and treatment services • Approve tariffs and fees for emptying, transport and treatment of FS	• 14 out of 27 ERTLs are registered, but no official monitoring and enforcement of regulations has been implemented	• Limited capacity for monitoring and enforcement of regulatory framework
	National Tax Service (SNI)	• Registration and designation of tax identification number to water supply and sanitation service providers (EPSAs) and FS emptying and transport service providers (ERTLs)	• Small, family-businesses and informal firms do not provide receipts / proof of purchase to costumers to avoid taxes. There is limited monitoring from SNI to prevent this from occurring	• Limited financial and human capacity to carry out monitoring and enforcement
Departmental government	Santa Cruz Government	• Ensure the adequate provision of FS emptying, transport and treatment services (if municipal governments do not have the capacity)	• Limited involvement from the departmental government as FSM services seem to be adequately provided by the municipality	• Limited financial and human capacity • Prioritisation of other sectors
	Santa Cruz Environmental Authority	• Approval and classification of adequate practices and remedial actions with regards to FSM activities • Environmental monitoring of FS management and final disposal	• Assumes that all FS is discharged to SAGUAPAC treatment plants and disposed of correctly. • Limited monitoring of discharges of ERTLs	
Municipal government	Municipal Governments	• Ensure the adequate provision of FS emptying, transport and treatment services, directly or through public, communal or mixed service providers or cooperatives • Establish the fees for FS emptying, transport and treatment • Grant operating licenses to ERTLs	• On margin of coordination and service provision on behalf of EPSAs and ERTL, focusing exclusively on granting licenses and occasional environmental monitoring	• Allocation of responsibilities remains unclear • Reliance on other authorities to guarantee the adequate provision of FS services • No specific budget allocated for water and sanitation
	Water supply and sanitation service providers (EPSAs)	• Provide FS emptying, transport and treatment services directly or through a third party • Estimate and propose fees for FS emptying, transport and treatment services	• SAGUAPAC is the only service provider that is fully complying with all FS regulations • Not all EPSAs have records of the quantity of FS emptied and transported, limiting their ability to improve services	• Not all EPSAs have wastewater or sludge treatment plants to ensure ERTLs properly discharge FS • Limited financial resources to build new wastewater or sludge treatment plants
	FS emptying and transport service providers (ERTLs)	• Supply and provide FS emptying and transport services	• Not all FS collected is not transported and discharged to a SAGUAPAC treatment plant • Not all ERTLs operate in the formal market	• Family-based and small firms are informal • Subjected to EPSA capacity and contractual arrangements
Private sector	Households	• Ensure adequate FS containment and demand and use FS emptying and transport services	• There is limited knowledge about OSS standards and required maintenance	• Low-income households have a limited ability to pay for FS emptying and transport services • Limited knowledge of what happens with FS after it is collected
	Commercial establishments	• Ensure adequate FS containment and demand and use FS emptying and transport services	• Not all OSS facilities are adequately built	• Limited knowledge of what happens with FS after it is collected

2.3 *Service provision*

Even with several ERTLs, there is limited competition in this sector which means prices for emptying and transport remain high and unaffordable to the poorest households. The costs for containment is aligned with households' ability to pay, but it should be noted that the type of onsite sanitation (OSS) facilities built by the poorest are rarely deemed as effective containment or emptiable by motorised means. FSM services are generally good in Santa Cruz, but improvements could be made regarding discharge at faecal sludge (FS) treatment facilities. Ensuring that all FS emptied is transported to a treatment plant, and that ERTLs comply with all administrative and technical standards are seen as the main issues.

A majority of financial resources are currently being directed towards the expansion of the sewerage network and the construction of new wastewater treatment plants. SAGUAPAC (Cooperativa de Servicios Públicos de Santa Cruz Ltda) are allocating limited resources to increase FS discharge capacity at treatment plants and the AAPS is working on improving regulatory mechanisms. As a result, services cannot be deemed equitable. Although the city has made significant investments in improving FSM services, they have mainly focused on the supply side. Recent initiatives aimed at increasing competitiveness across ERTLs may reduce emptying fees and allow for increased access to emptying services among the urban poor.

The main challenges in provision are related to planning and budgets, which have been focused on sewerage. Although FSM has been integrated into policy and legislation (Section 2.1) there is no investment planned hence no budget allocated. There is a lack of targets in FSM services, which is possibly due to it being seen as a short term solution. Additionally there is a lack of incentives for investment in FSM especially as they sector is relatively informal (i.e. operation of the ERTLs).

2.4 *Service Standards*

The norms, standards and regulations for FSM are set out in the Municipal Ordinance No. 031 (2011) and the AAPS regulations. Although the local environmental authority is in charge of defining the norms and standards for OSS facilities, data is not readily available.

Reporting on FSM is currently being undertaken for registered ERTLs, but there is no data for informal service providers. There is also a lack of monitoring on the effectiveness of the containment of FS and the frequency of maintenance of OSS facilities by households.

3 Service Outcomes

2012 Census data for Santa Cruz states that around 47% of the population was connected to sewerage, with a further 21% and 26% of facilities emptying into a septic tank or a lined pit respectively, and 6% of households having no sanitation facility (practising open defecation). The Municipalities of Porongo, Cotoca and El Torno have the highest proportions of households without a sanitation facility, at 26%, 21% and 21% respectively.

Table 2: Sanitation coverage by municipalities in Santa Cruz

(National Census 2012, in World Bank 2016)

Type of containment	Municipalities (%)						Total
	Santa Cruz de la Sierra	Cotoca	Porongo	La Guardia	El Torno	Warnes	
Sewerage	53%	17%	12%	2%	21%	21%	**47%**
Septic tank	21%	16%	21%	38%	10%	22%	**21%**
Lined pit	23%	46%	40%	52%	48%	40%	**26%**
Into lake	0%	0%	0%	0%	0%	0%	**0%**
No facility / OD	3%	21%	26%	8%	21%	17%	**6%**

In the World Bank Study, a citywide household survey was deemed as being unrepresentative of Santa Cruz as a whole, so the data from the Census (2012) was used as a reference to estimate the proportions of different types of sanitation and containment technologies used in 2015. This data, found in Table 3, was used to generate the SFD matrix (Table 6).

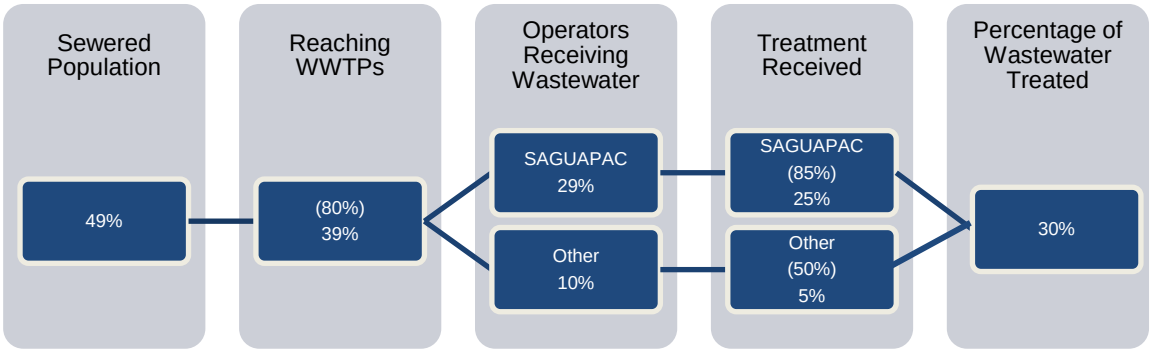
Table 3: Type of sanitation facility / containment (World Bank, 2016)

Sanitation and containment type	City-wide
Sewerage	49%
Flush to septic tank and soakaway	35%
Flush to septic tank (other)	6%
Flush to cement-lined pit	3%
Latrine to unlined pit	1%
No facility / OD	5%

There are a total of 13 wastewater treatment plants in SCMA (H, Paniagua, GIZ Santa Cruz, 20th September). Six are operated by SAGUAPAC, seven by other peri-urban water cooperatives, and one additional plant is under construction (SCMA (H, Paniagua, GIZ Santa Cruz, 20th September). The wastewater treatment plants (WWTP) are predominately waste stabilization pond systems (Libhaber & Orozco-Jaramillo, 2012). Only one of the plants, Parque Industrial operated by SAGUAPAC, accepts FS (SCMA (H, Paniagua, GIZ Santa Cruz, 20th September). The SAGUAPAC WWTPs are thought to be treating a majority of the sewerage in the city (approximately 75%) and these plants are known to be functioning at 85% efficiency (SCMA (H, Paniagua, GIZ Santa Cruz, 20th September). As no data is available for the other WWPTs, it is assumed that they are functioning at 50% efficiency. The World Bank Study stated that 100% of the waste entering the sewers reaches a wastewater treatment plant and that 50% of that waste gets treated. This study however assumes conservatively that 80% of the waste entering the sewer reaches one of the wastewater treatment plants, allowing for 20% losses due to sewer leakage. The total

amount of the populations' wastewater that is treated is therefore 30% (Figure 1). This data was used to generate the SFD Matrix (Table 6).

Figure 1: Total of wastewater treated as a percentage of the population's excreta



3.1 *Categories of origin*

This report and the SFD are based on an *in-depth* World Bank study that focussed on household-level faecal sludge management. It does not consider non-household generated faecal sludge, such as from schools. Schools were identified in the other city studies[1] as a potential significant contributor to faecal sludge flow across the city. To include the flow of excreta from schools, a better knowledge of the use of school and home sanitation facilities is required, so usage could be split between locations and technology types.

3.2 *Shared or communal toilets*

Shared sanitation is defined by the Joint Monitoring Programme as a sanitation facility shared by two or more households. Data on sharing was not available in the 2012 Census and the World Bank Study only researched this in non-sewered areas. They found the average number of households per sanitation facility in non-sewered areas was 1.2. So it can be assumed that very few households in Santa Cruz as a whole use share sanitation facilities.

3.3 *Emptying technologies for onsite sanitation*

SCMA has an established FS emptying market which is over 25 years old. There are currently 27 registered FS emptying and transport service providers (ERTLs). ERTLs are subcontracted by one of the ten utilities or cooperatives (EPSAs) that currently provide water supply and sanitation (WSS) services in Santa Cruz. Through this subcontract, ERTLs agree on a fee rate to use the EPSAs' treatment facilities for FS discharge after emptying. However, only SAGUAPAC, the main WSS cooperative has an adequate wastewater treatment facility. SAGUAPAC currently has contracts with 14 of the 27 ERTLs, meaning that all other FS collected is treated inadequately or dumped illegally to the surrounding environment. WSP(2016) estimates that approximately 24,000 m^3 of FS are illegally dumped every year in SCMA.

[1] See reports for Kumasi, Nakuru, Niamey and Kisumu http://sfd.susana.org/

Tariffs for emptying services have been reported by households to be high (i.e. US$ 68). Demand for emptying pits and septic tanks was found to be driven by the need for corrective (e.g. pit overflowing) rather than preventive measures (e.g. regular desludging). Poorly built infrastructure reduces the demand for FS emptying and transport services, as few pits or tanks are reported to fill up. Households that rely on traditional latrines, also have a tendency to build a new pit once the one in use fills up, rather than emptying them. The World Bank Study explored if different types of sanitation systems were emptied in non-sewered areas (Table 4) and this data was used to generate the SFD Matrix (Table 6).

Table 4: Action after pit or tank filled up – non-sewered areas (World Bank, 2016)

	Emptied	Not emptied	No. of households
Flush to septic tank and soakaway	30%	70%	219
Flush to septic tank	24%	76%	38
Flush to cement-lined pit	17%	83%	63
Total	**27%**	**73%**	**320**

The World Bank Study found that 95% of those who had their sanitation systems emptied in non-sewered areas had it done by vacuum tanker (motorised means), while 5% of systems were emptied by family members. From the data in Table 4, the percentage of each system that was emptied by vacuum tanker (95%) and the amount collected by SAGUAPAC (52%) was calculated (Table 5). This was then used to generate a proxy for the amount of faecal sludge delivered to treatment. This was due to SAGUAPAC owning and operating the only wastewater treatment plants in SCMA, and it is known there is a high level of illegal dumping of faecal sludge in the city.

Table 5: Percentage of population's toilets in non-sewered areas that are emptied by vacuum tanker (and SAGUAPAC as a sub-set)

	Emptied (%)	Emptied by vacuum tanker (%)	Emptied by SAGUAPAC (%)	Treated (%)
Flush to septic tank and soakaway	30	29	15	13
Flush to septic tank	24	23	12	10
Flush to cement-lined pit	17	16	8	7
Total	**71**	**68**	**45**	**30**

The assumptions in this report vary from that of the World Bank Report, as it uses raw data for the percentage of the systems emptied (Table 5) and considers that 33% of the emptied waste is delivered to the wastewater treatment plant[2]. For this study it was estimated that 52% of faecal sludge reaches a WWTP as only the sludge emptied by SAGUAPAC is discharged at their plant. The efficiency of their plant is taken to be 85%, as explained in Section 3.

3.4 *Drinking water supplies in the city*

2012 Census data states that around 97% of households use piped water for drinking (92% from water piped into the dwelling and 5% at public taps), while the remaining 3% rely on wells (protected and unprotected), rainwater or springs, and other unimproved water sources. Water supply and sewerage services in Santa Cruz are provided by 10 different cooperatives. SAGUAPAC is the main and largest service provider.

3.5 *Risk to groundwater*

In terms of identifying the risk to groundwater from sanitation sources, for generating the SFD no information could be found on the main rock type in the unsaturated zone. Conservatively, it has been assumed to be to sandstone and limestone fractured rocks . The depth to the stabilised water table has been assumed to be more than 10 meters (Morris et al., 2003). It is also assumed that less than 25% of sanitation facilities are within 10 metres of a groundwater source, or uphill of groundwater sources. Groundwater is the major drinking water source for the city from boreholes, so it is stated that more than 25% of the population gain its water from this source. This water is then treated and distributed via piped networks, so it is assumed that there is a low risk of pollution to people's current source of drinking water sources.

[2] The only containment facilities that are formally emptied are septic tanks, septic tanks with soakaways and cement-lined pits. Among households with these types of facilities, the household survey suggests that only 27% are emptied. Secondary data about the total number of discharges at the SAGUAPAC treatment plant shows that there were 15,974 discharges in 2014, of which 80% correspond to domestic FS. Assuming that each discharge is the equivalent of 1.5 households, then 19,169 households were served in 2014. This is equal to 33% of households having their FS effectively transported and treated.

4 SFD Matrix

The data from Section 3 has been collated in Table 6 as the basis for generating the accompanying SFD. Due to the margins of error associated with the data collected, only streams which represent 1% of the population or more are shown in the SFD. The tool has the ability to take into account the flow of infiltrate from soakaways and pit latrines, but as this stream was deemed to be safely managed, it has been disregarded. This was done to reflect the sanitation service chain more accurately in terms of faecal sludge movement.

The assumptions on emptying can be found in Section 3.3, while the assumptions about the treatment efficiency are found in Section 3. The resulting SFD (Appendix 1) shows 70% of the excreta as being safely managed, which is significantly different to the World Bank study where 28% of excreta are considered as effectively managed. This is due to the different ways each study defines effectively or safety managed. In this report, “safely managed” is related to the risk of faecal contamination from sanitation systems entering the drinking water supply and being consumed by the population. This risk is assumed to be low due to high usage of the piped water supply throughout the city. The World Bank study is more conservative, as effectively managed is related to broader environmental risks. The difference in these definitions has led to the onsite sanitation systems which are not emptied being classified significantly differently. In the World Bank study these systems are seen as being ineffectively managed as they are causing environmental contamination, whereas in this study they are seen as being safely managed due to the low risk of this contamination affecting the water consumed by the population.

Table 6: Data used to draw the SFD

SFD terminology level 1	World Bank 2016	SFD terminology level 2	%	Emptied	% emptied	% delivered to treatment	% Treated
Offsite sanitation	Sewerage	No onsite containment discharged to centralised combined sewer	49	N/A	N/A	80	76*
Onsite sanitation	Flush to septic tank and soakaway	Septic tank connected to a soak pit	35	Motorised emptying	29	52	85
	Flush to septic tank Flush to cement lined pit	Fully lined tank with no outlet no overflow	10	Motorised emptying	20	52	85
	Latrine to Unlined Pit	Pit never emptied, abandoned when full and covered in soil	1	Not emptied	N/A	N/A	N/A
Open defecation	No Facility/ OD	Open defecation	5	N/A	N/A	N/A	N/A

*75% is treated at an efficiency of 85% and 25% is treated to an efficiency of 50%

5 Stakeholder Engagement

The primary stakeholder in this process was the World Bank Water and Sanitation Program (WSP) who is the collaborating partner in this study. A majority of the data in this report unless stated otherwise comes from:

The World Bank WSP 2016 Report: Fecal Sludge Management: Diagnostics for Service Delivery in Urban Areas, Case study report – Fecal sludge management in Santa Cruz, Bolivia.

The World Bank study was based on a household survey, transect walks, observations, key informant interviews and focus group discussions. It also incorporated a review of the enabling environment for FSM. It should be noted that no other stakeholders were involved in the production of this report, as the World Bank had consulted with major stakeholder during their research.

6 Prospects for uptake and use of this study

The detailed World Bank WSP 2016 Report, *Fecal Sludge Management: Diagnostics for Service Delivery in Urban Areas, Case study report – Fecal sludge management in Santa Cruz*, Bolivia is being used with city-level stakeholders, to inform plans for improving urban sanitation in Santa Cruz. This report will be available externally on http://sfd.susana.org/ and enables external organisations to gain an overview of the current situation in Santa Cruz.

Acknowledgements

A majority of the data in this report unless stated otherwise is from the World Bank WSP report *Fecal sludge management: Diagnostics for service delivery in urban areas, case study report – Fecal sludge management in Santa Cruz, Bolivia*. That report was prepared by WEDC and Oxford Policy Management Ltd for the World Bank. This report is compiled as a part of the SFD Promotion Initiative project funded by the Bill and Melinda Gates Foundation.

References

Libhaber M. & Orozco-Jaramillo A. 2012. Sustainable Treatment and Reuse of Municipal Wastewater: For Decision Makers and Practicing Engineers. IWA Publishing, London, United Kingdom.

Magnus, H. C. 2012. Propuesta para la gestión de lodos fecales en zonas periurbanas de Bolivia - Informe Final.

Magnus, H. C. 2015. The political economy of faecal sludge management in the city of Santa Cruz de la Sierra.

Morris, B L, Lawrence, A R L, Chilton, P J C, Adams, B, Calow R C and Klinck, B A. 2003. Groundwater and its Susceptibility to Degradation: A Global Assessment of the Problem and

Options for Management. Early Warning and Assessment Report Series, RS. 03-3. United Nations Environment Programme, Nairobi, Kenya.

Rivera, J. 2010. Los Servicios De Limpieza De Cámaras Sépticas, Recolección Y Disposición Final De Lodos Fecales En Zonas Periurbanas De La Ciudad De Santa Cruz (Bolivia). Water And Sanitation Program (WSP).

Wikipedia 2016. Santa Cruz de la Sierra.

https://en.wikipedia.org/wiki/Santa_Cruz_de_la_Sierra#cite_note-5 Last accessed 6/9/2016

Water and Sanitation Program (WSP). 2016. Bolivia: Strengthening Institutional Capacity to Improve Wastewater Management in Peri-Urban Areas - Technical Assistance P132278.

World Bank. 2016. Fecal sludge management: Diagnostics for service delivery in urban areas, case study report – Fecal sludge management in Santa Cruz, Bolivia. http://documents.worldbank.org/curated/en/764701468343909340/Fecal-sludge-management-tools-case-study-in-Santa-Cruz-Bolivia last accessed 21/9/2016

Appendix 1: SFD