SEI Stockholm Environment Institute

Combining sewered and non-sewered sanitation in Montero, Bolivia

Scaling up sustainably

SEI report
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Key findings

- **The city of Montero, through the cooperative utility COSMOL, has successfully implemented on-site sanitation services for part of its population, in parallel to sewer-based services. However, additional solutions, capacity development and strengthening of governance systems are needed to allow for increased sustainability, for both the sewered and non-sewered sanitation services in the city.**
- **Technical improvements are still needed in wastewater and excreta management and treatment, to reduce health and environmental impacts. However, optimizing the existing sanitation systems could increase environmental, health and hygiene sustainability.**
- **Urine-diverting dry toilets (UDDTs) have the potential to reduce environmental impact the most, once optimized and if urine and faeces are collected and treated for reuse.**
- **Local farmers have expressed demand for sanitation reuse products, as long as low price and quality can be guaranteed.**
- **From a household perspective, demand exists for high levels of service and maintenance by providers, no matter the type of system, to ensure simple maintenance by users. But the sanitation system still needs to be affordable, match cleanliness expectations, and remain free of odours, mosquitos and rodents.**
- **Upscaling on-site sanitation systems depends strongly on the support of the public institutions and resources available, including legal, economic and technical resources, as well as having a long-term vision.**

Montero is one of the few municipalities in Bolivia with a service provider that acknowledges the advantages of mixed sanitation systems to achieve citywide access to sanitation. The city's water and sanitation utility, COSMOL, is run as an independent cooperative, and it currently manages both centralized and decentralized systems. Together with different non-profit and citizen organizations (e.g. UNICEF Bolivia and Aguatuya), COSMOL has been working on the implementation and promotion of sustainable sanitation and on-site sanitation projects.

The COSMOL centralized system has sewer connections and wastewater treatment in a pond system, to which 36% of Montero's population is connected. The utility also manages collection services and treatment of faeces from urine-diverting dry toilets (UDDTs) for about 1% of the population. The majority – nearly two-thirds – of the city's residents use septic tanks or other on-site systems, and COSMOL also receives some of the collected faecal sludge that currently is discharged into the treatment ponds, while the rest is managed by private operators.

Efforts by the city government, COSMOL and other partners to improve access to safely managed sanitation services have increased over the past few years. However, the city and its sewerage infrastructure are facing escalating pressures from population growth and an increased frequency of both droughts and floods. In addition, none of the existing sanitation systems in Montero are environmentally sustainable when it comes to release of nutrients and organic matter to the environment.

Solving these issues requires more than technological understanding on the part of WASH practitioners, service providers and policymakers. All stakeholders need to consider user preferences, product demand, governance settings, and the overall feasibility and sustainability of the proposed sanitation technologies. This understanding will facilitate scaling up alternative sanitation solutions that are sustainable in the long term.

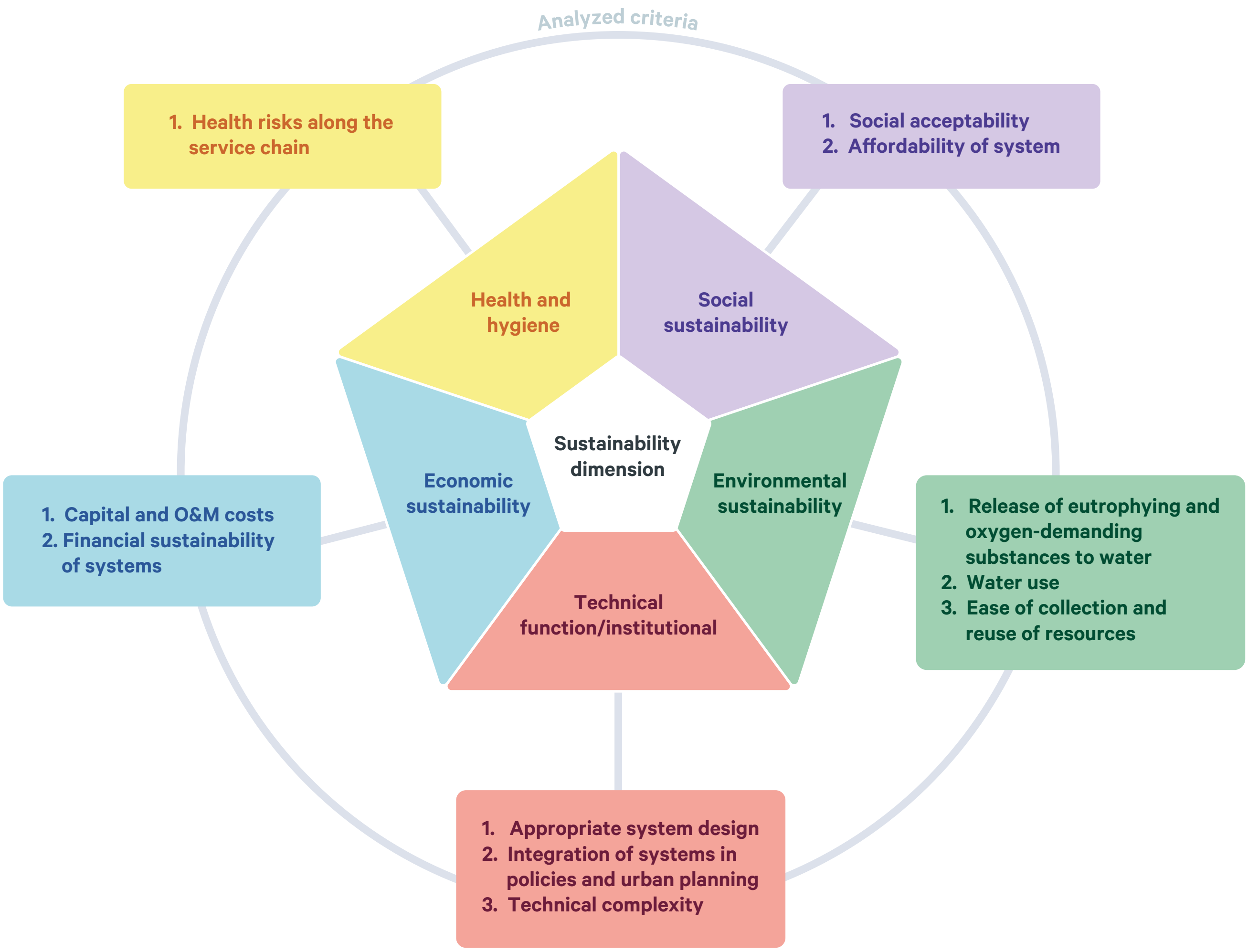
To explore these challenges, four studies were designed and carried out in Montero as a joint effort between the Stockholm Environment Institute (SEI), Research Institutes of Sweden (RISE), Aguatuya, and the Institute of Economic and Social Research José Ortíz Mercado of the Autonomous University Gabriel René Moreno (UAGRM), with support from UNICEF Bolivia and COSMOL. Below are the key findings that address these aspects from all four studies, followed by descriptions and recommendations from each individual case study and a final discussion for all.

Case Study 1: Minor investments can boost sustainability of existing sanitation systems

A participatory multi-criteria sustainability assessment showed the strengths and weaknesses of existing sanitation services in the city of Montero (Kvarnström et al., in press). The assessment covered environmental, technical, institutional, economic, and health and hygiene aspects for the different systems considered in the city's sanitation planning. The results highlight where the different sanitation systems and approaches have improvement potential from a sustainability perspective in the Bolivian setting and clarify trade-offs between the different technical solutions for decision-makers.

Key sustainability assessment criteria were set (Figure 1) through a participatory process carried out in Montero with both national and local actors.

Figure 1. Co-created sustainability criteria.



Source: Adapted from Kvarnström et al., in press

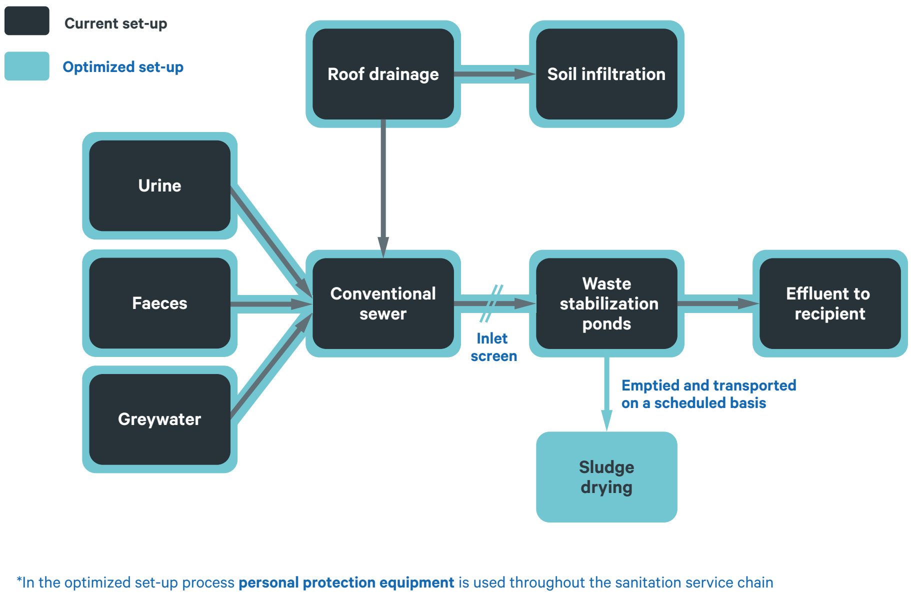
Based on the stakeholder-defined criteria, a small group of sanitation experts from Bolivia and Sweden developed indicators to allow for qualitative or quantitative assessments. The expert group assigned multiple indicators to all the criteria except one, to assess different elements of each specific criterion. The existing and the optimized system set-ups were fully assessed, which facilitated a full analysis of how sustainability changed with the proposed optimizations. Finally, the assessment result was validated by local and national actors in an online workshop.

The sustainability assessment covered four technical system configurations in their current set-up. Furthermore, optimizations for each system type were assessed. The four systems are briefly described below (see also Tilley et al., 2014, for definitions of systems and technologies).

System 1: Flush toilet connected to conventional gravity-fed sewerage and waste stabilization pond treatment

Household wastewater, including toilet discharge, is transported in a gravity-fed sewer system to the centralized treatment facility, or wastewater treatment plant (WWTP), with waste stabilization ponds (WSP) that follow anaerobic, facultative and maturation steps. For the potential optimization (Figure 2), roof drainage is diverted so that it infiltrates locally or is managed in a system separate from the sewerage; the WWTP is improved with an inlet screen, proper lagoon management and sludge treatment (drying); and personal protection equipment is used throughout the entire process.

Figure 2. System 1: flush toilet with traditional sewerage and waste pond treatment.

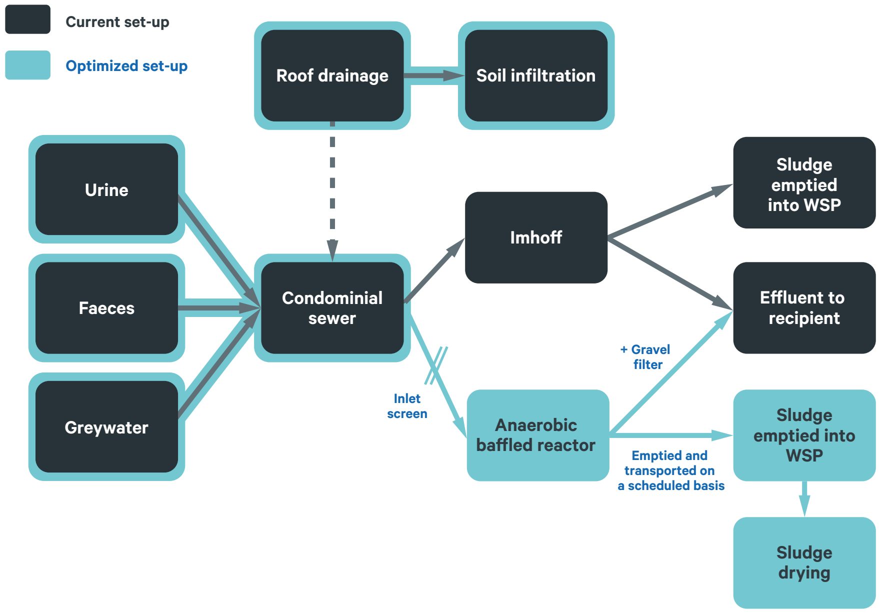


System 2: Flush toilet connected to simplified or “condominial” sewerage and anaerobic primary treatment

Household wastewater flows to a decentralized facility with a large-scale septic tank or an Imhoff tank, and the effluent is discharged into open channels. The sludge produced in the tanks is periodically collected and transported to the centralized WWTP and discharged at the inlet. The optimization considered (Figure 3) consists of the disconnection from roof drainage (if it exists), addition of inlet screens, replacement of the Imhoff/septic tank with an anaerobic baffled reactor, addition of a gravel filter, sludge treatment (drying) at the central WWTP, and the use of personal protection equipment.

System 3: Flush toilet with household connection to an on-site septic tank with a soak pit, treatment of faecal sludge in treatment plant

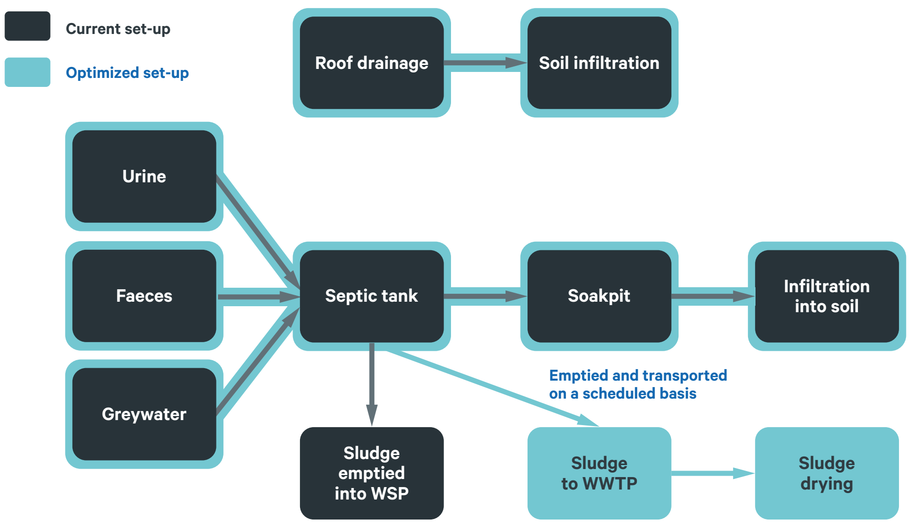
Figure 3. System 2 with condominial sewerage and anaerobic primary treatment.



*In the optimized set-up process **personal protection equipment** is used throughout the sanitation service chain

Greywater and flush-toilet discharge flow to on-site septic tanks, and the effluent feeds into a soak pit for disposal. The septic tanks are emptied of sludge by vacuum trucks, only once problems arise with the tanks. The collected sludge is discharged at the inlet of the central WWTP. The optimization (Figure 4) adds formal collection service (i.e. scheduled) and sludge treatment (drying) at the central WWTP, as well as use of personal protection equipment at all stages.

Figure 4. Flush toilet with on-site septic tank with a soak pit; faecal sludge transported to treatment plant.

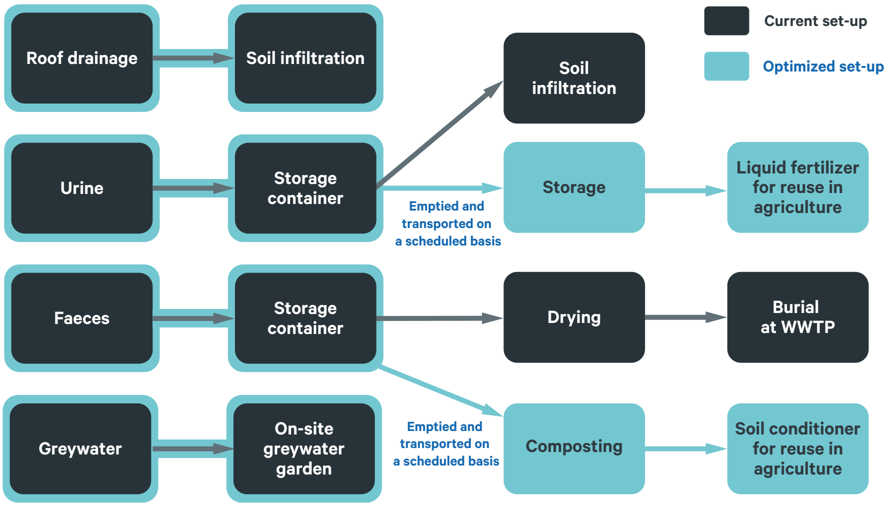


*In the optimized set-up process **personal protection equipment** is used throughout the sanitation service chain

System 4: UDDTs, local urine infiltration, local greywater treatment and treatment of faecal matter at treatment plant

The household excreta (urine and faeces) are collected in UDDTs. The urine is infiltrated on-site, while collected faeces are transported to the centralized treatment facility, for storage before being buried on-site. The greywater is managed at the household level, in a "greywater garden" or planted soil bed. The optimization (Figure 5) consists of collection and treatment of both urine and faeces at the treatment plant, plus the use of personal protection equipment.

Figure 5. System 4 uses UDDTs, local urine infiltration, local greywater treatment; faecal matter transported to treatment plant.



*In the optimized set-up process **personal protection equipment** is used throughout the sanitation service chain

The results of the assessment (Table 1) showed that all systems with their existing set-ups and management have significant sustainability challenges. For systems 2, 3 and 4 (i.e., condominial system, household septic tanks, and UDDTs), the key issue is environmental sustainability due to high levels of discharge of nutrients and organic matters (environmental sustainability). For System 1 (sewerage with centralized treatment), the major issues are household affordability, technical adaptability and economic sustainability.

What is promising is that all four systems show good improvement in sustainability with the considered optimizations, without major additional investments. When optimized, all four sanitation systems pose low risks to health and hygiene, and the optimizations result in less contaminated discharges. The systems' social sustainability, with regard to affordability and acceptability, does not change considerably, since optimization only adds minor additional costs for households (Figure 6).

Optimization increases technical and managerial complexities, which requires more capacity along the sanitation service chain. Due to increasing cost with optimization, a viable financial model must be established to ensure economic sustainability for all systems, but especially for the most expensive system, System 1. All systems are subsidized as they function today: the highest subsidy level is 48% for System 1 (centralized, sewered system), and the lowest, 9% for System 3.

All four systems could potentially benefit from further innovations, to address some of the sustainability challenges that persist even after they are optimized. For example, System 1 could improve significantly from an innovation that improves nutrient removal, e.g., an Up-flow Anaerobic Sludge Blanket (UASB) reactor step. For System 4, the main challenge is to manage the large volumes of urine that flow through the system, preferably through agricultural reuse. Hence, an innovation such as urine drying, which can reduce the urine volumes while keeping nutrients in the product, would be ideal for System 4.

Table 1. Summary table for the sustainability analysis of existing systems and optimized ones* for the context of Montero.

		System 1		System 2		System 3		System 4	
		Existing	Optimized	Existing	Optimized	Existing	Optimized	Existing	Optimized
Health and hygiene	Health and hygiene	2	4	3	4	3	4	4	4
Environmental sustainability	Total nitrogen release	3	4	2	3	1	3	1	5
	Total phosphorous release	2	3	1	1	1	1	1	4
	Biochemical oxygen demand (BOD_5) release	3	4	1	5	1	3	1	4
	Water use	3	3	3	3	3	3	5	5
	Separation of flow streams	2	2	3	3	4	4	5	5
Social sustainability	Social acceptability	5	5	5	5	3	4	4	4
	Household affordability	1	1	2	2	3	3	3	2
Technical and institutional sustainability	Appropriate system design	1	1	2	2	3	3	4	4
	Vulnerability to water scarcity	1	1	1	1	3	3	5	5
	Vulnerability to flooding	2	2	3	3	3	3	4	4
	Integration into urban planning	3	3	3	3	3	3	4	4
	Technical complexity	4	3	4	3	3	3	3	3
	Integration with other sectors	4	4	4	3	3	2	4	3
Economic sustainability	Financial sustainability	1	1	3	3	5	4	4	2

*The optimization additions are shown in green in the list below:

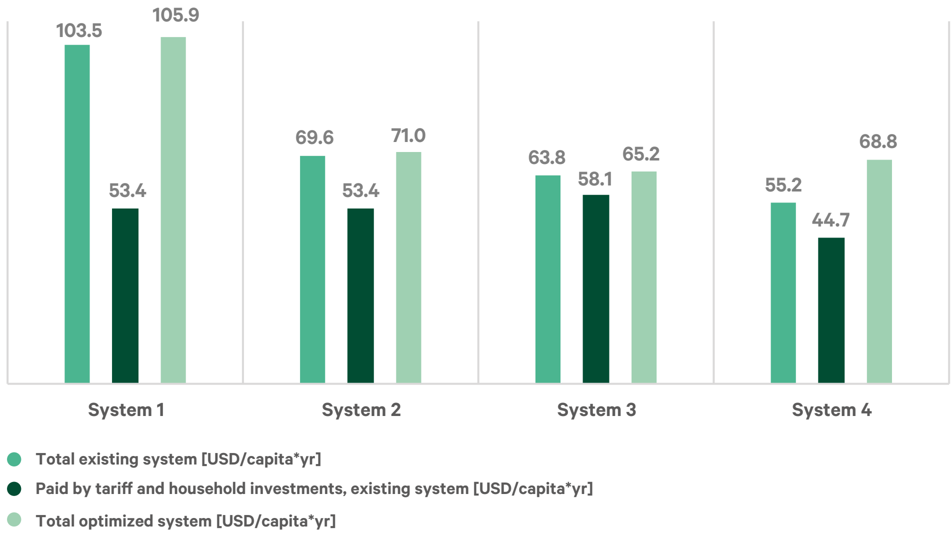
System 1: Flush toilet, conventional sewers and waste stabilization ponds + {Addition of inlet screen, proper management of lagoons and sludge and sludge treatment (drying) + disconnection of roof drainage from sewer pipes + personal protection equipment};

System 2: Flush toilet, condominial sewer system and primary anaerobic treatment with discharge to open channel + {Addition of inlet screen and gravel filter, sludge management at central plant (drying) + disconnection of roof drainage to condominial sewers + personal protection equipment};

System 3: Flush toilet, septic tanks + soak pits, vacuum emptying + {Formal collection service in place (e.g. scheduled), sludge treatment (drying) + PPE};

System 4: UDDTs, local grey water treatment + {Collection and treatment of urine and faeces) + PPE}.

Figure 6. Total sanitation costs (capital and operational expenditures) for the existing systems and the costs covered by tariffs and household investments for those. Total costs for the optimized systems are also shown.



Insights from sustainability assessment

- With limited additional investments and changes in operations and maintenance, it would be possible to improve the sustainability of all four system types examined here, especially from health and environment perspectives.

- The potential to reduce pollutant discharge, such as nutrients and organic matter, improves with optimized management for all systems, but outstandingly so for System 4.

- Some criteria are difficult to improve for Systems 1 and 2 with the suggested optimizations, due to inflexibility in their technical set-ups. Therefore, certain criteria, such as costs, adaptation to different population densities, and vulnerability for water scarcity, still score low for these system types in their optimized versions. At the same time, user acceptance for these systems is currently higher.

- Financial resources are unequally distributed between the different sanitation systems today; all system types should have access to the same financing mechanisms and subsidy levels as System 1, which has the highest subsidy level.

Case Study 2: Understanding users' preferences, needs and behaviour is crucial for upscaling on-site sanitation

A perception and acceptance survey carried out in the municipality of Montero identified the determinants of use, preferences and acceptance of existing sanitation systems (Andersson et al., 2021b). Understanding such user demand, needs and behaviours can facilitate the success of sanitation initiatives and investments.

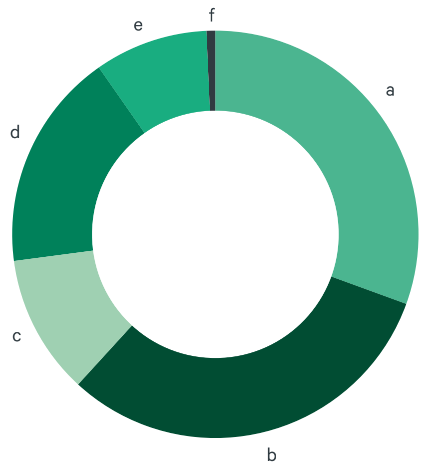
The study was conducted during February 2021. The research participants were adult members of a household in the city at the time of the study. Using convenience sampling, a total of 145 households were surveyed.

The quantitative survey was designed in Spanish by UAGRM and SEI researchers. The survey questionnaire was composed of both closed and open-ended questions divided into four sections. The first section collected information on the demographic characteristics of the target population, such as gender, marital status, education level, occupation, working status and income, as well as access to water, sanitation and hygiene facilities. This section also included the water insecurity scale with some additional questions on hygiene and sanitation.

The second section covered information about the perception of households' existing sanitation systems (positive aspects of the system, negative aspects, improvement of hygiene and health, etc.) and the evaluation of the conditions of the system (availability of doors, lighting, waste bins, etc.). The third section covered aspects of availability of information on sanitation and education campaigns by the municipality. The last section contained questions on the user's preference regarding their sanitation system (water use, disposal of faecal sludge, ease of maintenance), as well as their perception and knowledge of other existing sanitation systems in Montero. Before implementing the survey, the questionnaire went through a pilot stage, allowing the survey takers and other members of the team to build confidence and refine the survey instruments.

Of the 145 households in the study, most had toilets that were connected to the sewerage (31%) or to a septic tank (31%). The remaining households had toilets that were connected to a soak pit (17%), UDDTs (11%), or toilets that discharged to a body of water or field (9%). Only one household reported practicing open defecation (Figure 7).

Figure 7. Sanitation systems in surveyed households.



a	**Connected to sewerage**	**31%**
b	**Septic tank**	**31%**
c	**Urine-diverting dry toilet (UDDTs)**	**11%**
d	**Soak pit**	**17%**
e	**Open drainage**	**9%**
f	**Open defecation**	**1%**

Source: Andersson et al. (2021b)

The results of the survey revealed that three conditions mostly determined the extent to which a sanitation technology would be accepted by a household: the cost of the system, the absence of odours and vectors, and the ease of maintenance. While comfort of the sanitation system was not relevant, aesthetics was an important aspect for the users. Although most households surveyed reported considering making changes or improvements to their sanitation facility, such as expansion of the service or façade improvement, many of them indicated that they had not done so due to lack of financial resources.

These findings suggest that even though users of on-site sanitation technology systems (septic tanks, UDDTs and soak pits) consider them be low cost and easy to implement, they consider that the presence of odours and mosquitos is a major problem. This problem may lead users to conceive of this technology as a transition option, until they can acquire a sewerage-based system. On the positive side, users of on-site sanitation technologies highlighted as benefits of these systems the low use of water consumption and reduced environmental impact. In addition, users of UDDTs did not perceive the management of excreta as a negative aspect or burden, which is most often the case with the users of on-site sanitation systems (Cookey et al., 2020). This could be linked to the work that COSMOL has been undertaking for the collection and final disposal of the faecal sludge.

Most people in the area prefer sewage-based technologies because they are easy to maintain and do not produce odours. However, the high cost of these technologies limits their implementation. The UDDTs have the lowest implementation and maintenance cost and could be a more feasible economical solution. However, these technologies first must be accepted by the users, to avoid the perception of being only transitory solutions.

Lack of knowledge or awareness of on-site sanitation technologies plays a significant role in user preference. The survey showed that participants had limited information about different on-site sanitation technologies other than the ones that they owned: many had never used different options or had never heard of them.

Insights from users' preference of sanitation systems

- Despite being low cost and sustainable, UDDTs have the lowest implementation and are seen as only transitory solutions.
- Ease of maintenance, low prices and absence of odours or mosquitos and rodents are the most important aspects for people in the area to implement on-site sanitation technologies.
- People need more information about the different options of on-site sanitation technologies to make them more acceptable. Education and introductory workshops, social media campaigns and physical exhibitions of the technologies in public areas of the municipality could help fill this gap.
- Long-term support from COSMOL for the users of the existing on-site sanitation technologies is needed to ensure sustainability of these systems.

Case Study 3: Farmers express demand for sanitation reuse products

The municipality of Montero and supporting organizations have ambitious plans to “close the loop” on nutrients, by facilitating reuse of sanitation waste in agriculture or for other uses. Still, crucial technical and infrastructural development remains necessary to enable the production of marketable reuse products.

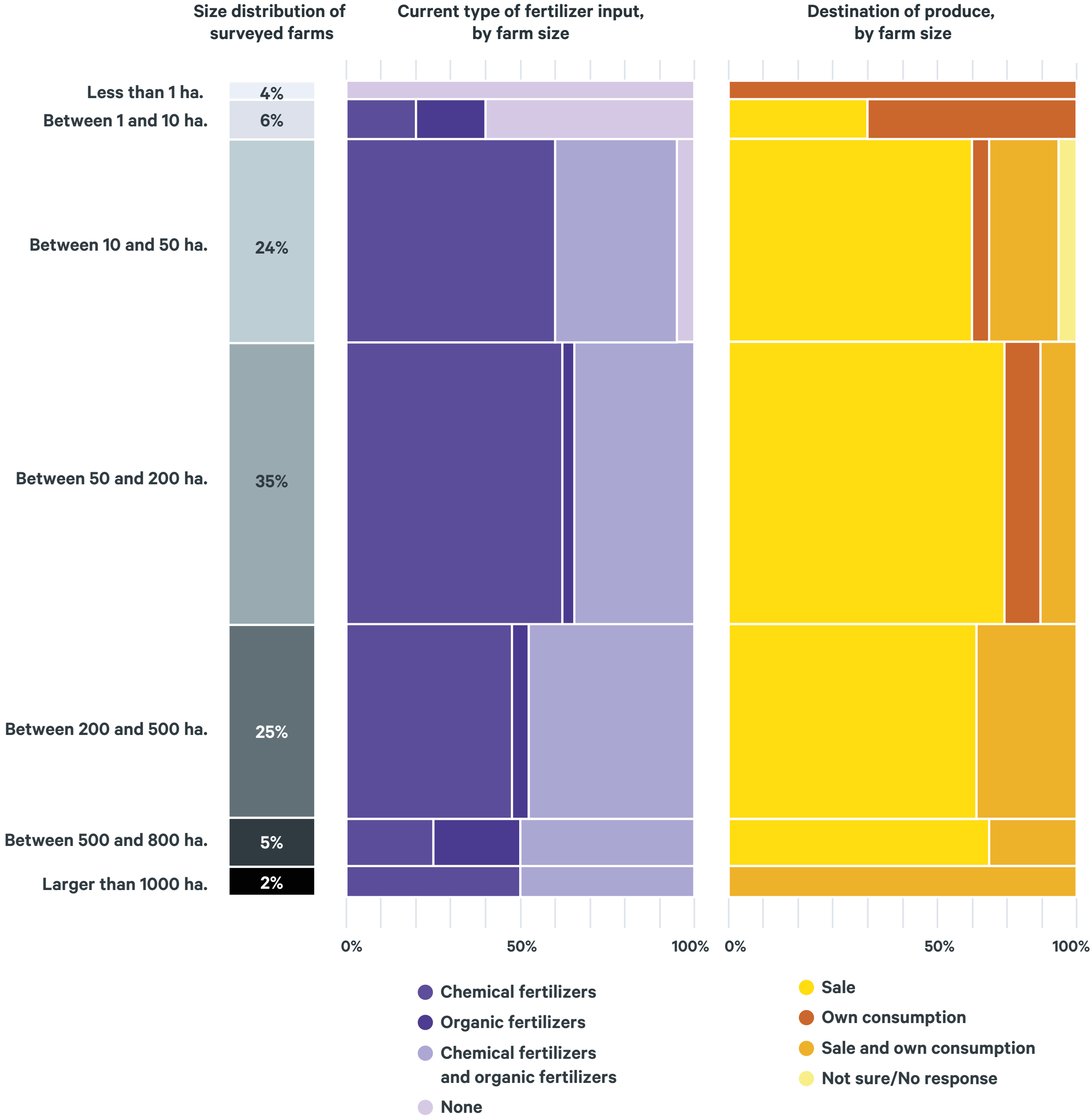
In parallel with these plans, a dialogue must be initiated to explore the demand and potential markets for different reuse products. As an initial exploration step, a survey was carried out that showed broad and promising interest among the farming community in Montero municipality.

The “farmers’ demand” survey had eight sections, covering general farm characteristics; land rights; agricultural activities; current fertilizer and irrigation use; demand and purchasing power for inputs; knowledge of regulations; perception and acceptance of reuse of sanitation sub-products; and knowledge or perception of environmental and health impacts. The survey was carried out February–March 2021, with a total of 84 surveyed farms in Montero municipality, defined by farm size (small and medium, according to Bolivian classification; Andersson et al., 2021a).

The farms in Montero are diverse, covering less than 1 hectare (ha) to over 1000 ha. More than 50% of the farms grow sugar cane and soy; rice and corn are other common crops in the area. Small-sized farms commonly produce crops only for their own consumption.

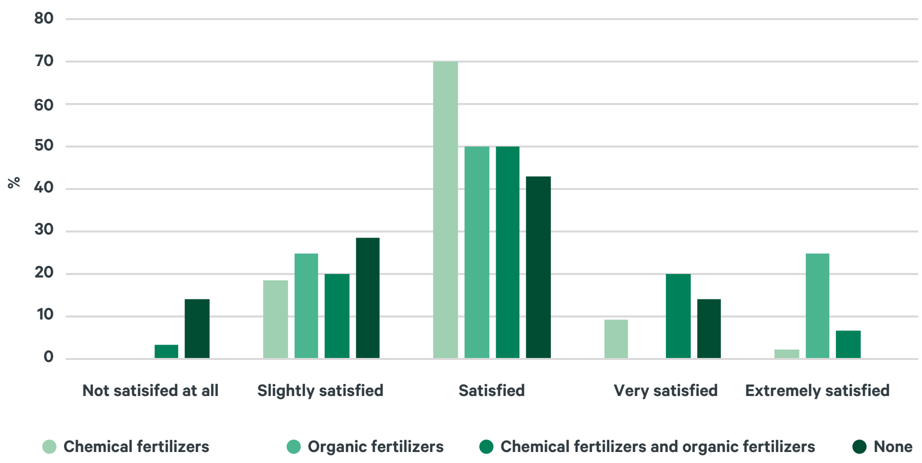
Half of the farmers in the study use only chemical fertilizers in their crop production, while around a third use a mix of chemical and organic fertilizers (Figure 8). Still, 8% of the farms do not use any fertilizer input at all, mainly due to lack of economic resources, especially for small-scale farms. Interestingly, the farmers who stated that they are applying a combination of both chemical and organic-based fertilizers also expressed having the best yields (Figure 9). Most of the farms use rain as their main water source, while a limited number of farms have irrigated crop production, predominantly using deep groundwater wells.

Figure 8. Type or fertilizer and destination of product by farm size.



Source: Andersson et al. (2021a)

Figure 9. Level of satisfaction by type of fertilizer input.

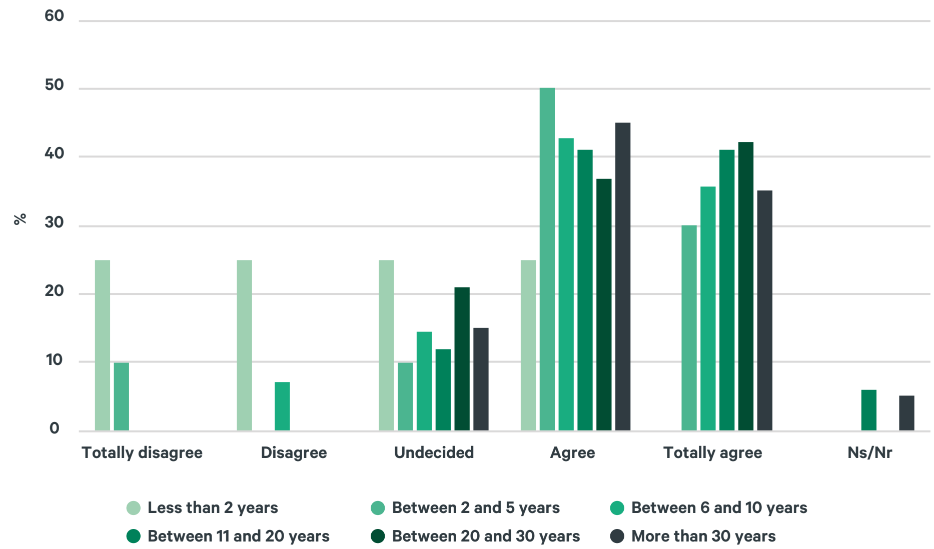


Source: Andersson et al. (2021a)

Important considerations that farmers rank the highest when acquiring fertilizer products are: 1) nutrient content (i.e. NPK), 2) price, 3) whether they are environmentally sound, and 4) organic content.

Most of the farmers interviewed expressed interest in applying fertilizers derived from sanitation waste streams. The farmers with strongest acceptance had more extensive experience, while the group of farmers with fewer years of farm practice were more sceptical towards applying reuse products from sanitation waste (Figure 10).

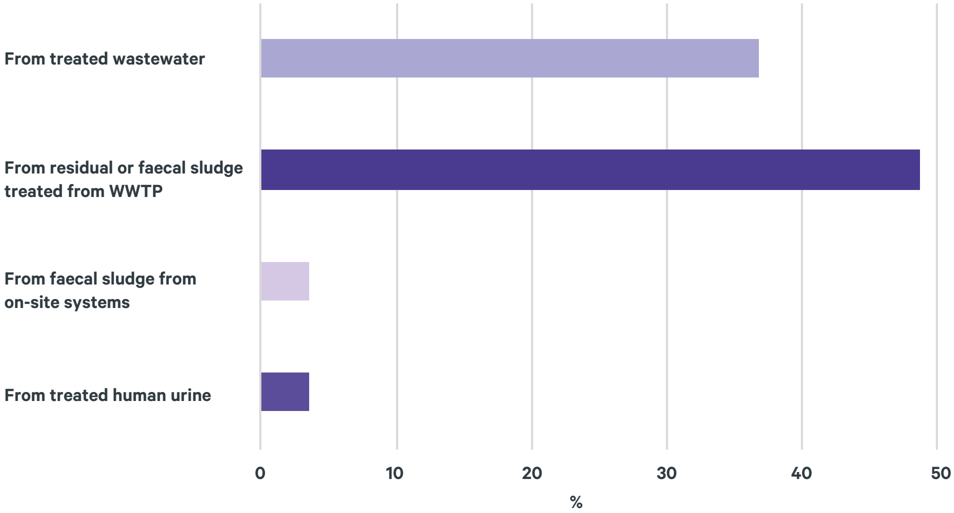
Figure 10. Acceptance of fertilizers by farmers' experience, as indicated by length of career.



Source: Andersson et al. (2021a)

The type of reuse product that interested the farmers most was treated sludge from the WWTP, followed by wastewater as an irrigation source (Figure 11).

Figure 11. Willingness to use by-products from sanitation systems.



Source: Andersson et al. (2021a)

Only a few farmers expressed interest in reusing treated urine or faecal sludge from on-site systems. This may be due to lack of knowledge about the potential advantages of reusing these specific by-products, considering that only 40% of the surveyed farmers were aware of the benefits of reusing sanitation waste as fertilizer in crop production (Figure 12).

Figure 12. Farmers' awareness of possible health impacts and benefits of using by-products from sanitation systems.

42% of the surveyed farmers are aware of the benefits of reusing sanitation waste as fertilizer in crop production

79% of the surveyed farmers are not concerned for the negative health or environmental impact for the use of by-products derived from the sanitation systems

81% of the surveyed farmers are not concerned for the negative impact on the sales of produce for the use of by-products derived from the sanitation systems

Source: Andersson et al. (2021a)

Similarly, the answers showed farmers have very few health or environmental concerns when it comes to reusing sanitation waste. This result is of course positive for acceptance, at the same time that it indicates a need for raising awareness about the potential risks in the handling and applying of fertilizers from sanitation by-products, due to the possible presence of pathogens and other contaminants. Another promising result is the low concern farmers have for the negative impact on sales of crops grown with these reuse products.

To further increase acceptance, the surveyed farmers proposed implementing reuse demonstration projects (e.g., field trials), information sharing, and awareness and training campaigns (Figure 13).

Figure 13. Farmers' proposed measures to increase acceptance for reuse of by-products from sanitation systems.

Top three proposed measures to increase acceptance for reuse

Demonstrations	48%
Information	24%
Awareness	10%

Source: Andersson et al. (2021a)

Insights from farmers' demand for sanitation reuse products

- Most farmers in Montero municipality have a positive response to the idea of using fertilizers derived from sanitation waste. Considering current practices, these alternative fertilizers could fill a real gap, e.g., for farmers who cannot afford conventional fertilizers or where farmers lack access to organic-based fertilizers, where the reuse of sanitation waste could boost crop yield.

- Also promising are farmers' low levels of concern for negative impacts on health and the environment for reuse of sanitation by-products, but these show the strong need for awareness raising and the need to generate guidance and standards for fertilizer handling and application in crop production. This can facilitate positive uptake and support safe reuse – minimizing risks for both farm workers and other actors in the food chain, including consumers.

- Technologies should be identified and implemented that ensure a high quality of fertilizers derived from sanitation systems, both in the content of nutrients and organic matter, as well as biosafety parameters. To establish quality criteria, dialogues between the sanitation sector and the food production sector must be established. Nationally and locally, regulations and standards should be put in place that promote the safe reuse of waste from sanitation systems.

- As suggested by the surveyed farmers, awareness raising and information sharing campaigns should be complemented by agricultural field trials to demonstrate and provide first-hand experience of the positive impact this reuse can have on crop yields.

- Farmers were unconcerned by impacts on sales of their products grown with reused sanitation-based fertilizers, and this finding needs to be complemented by perspectives from other key food market actors. A feasibility study on market, financial and logistics models should be implemented for the production of crops with fertilizer based on sanitation waste. Such a study needs to address acceptance by retailers, end-consumers and other key actors in the "agri-food chain".

Case Study 4: Assessing Montero's governance capacity for upscaling on-site sanitation systems

Despite interest in upscaling current on-site sanitation systems, the pace and scale of implementation is still lagging in Montero municipality, which suggests the existence of gaps in governance capacity. These aspects include level of awareness and knowledge, suitable policies, institutional and regulatory frameworks, and finance structures.

A governance assessment of the city is crucial, in which the barriers and enabling factors that influence the upscaling of alternative sanitation systems can be identified, to achieve long-term sustainability of the sanitation in the city. The identification is necessary of actors who have a key role in the governance of these systems and their main functions, as well as the connections among them. This study maps scores Montero's governance capacity (Andersson et al., 2021c).

In addition to COSMOL, the public water and sanitation utility, the main organizations that are or have been engaged in this work are the local learning institute INCADE (Instituto de Capacitación para el Desarrollo); Etta Projects; the national non-profit organizations Aguatuya and Sumaj Huasi, UNICEF Bolivia. These organizations work on the implementation and promotion of sustainable sanitation projects at local and regional level. At the citizen level, neighbourhood associations and a civil committee have served as a communication channel between citizens and public institutions, and these have been important in training users about on-site sanitation. Other important actors that influence the governance of sanitation in Montero are the private companies that collect the sludge from septic tanks.

The tool used to assess the capacity of Montero to govern the upscaling of the on-site sanitation systems was the governance capacity framework (GCF). The GCF is an empirical indicator-based diagnostic approach developed for assessing factors that influence environmental governance in urban contexts (Koop et al., 2017). It consists of 27 indicators that are scored from the most limiting factors (--) to the most enabling ones (++); see Figure 14.

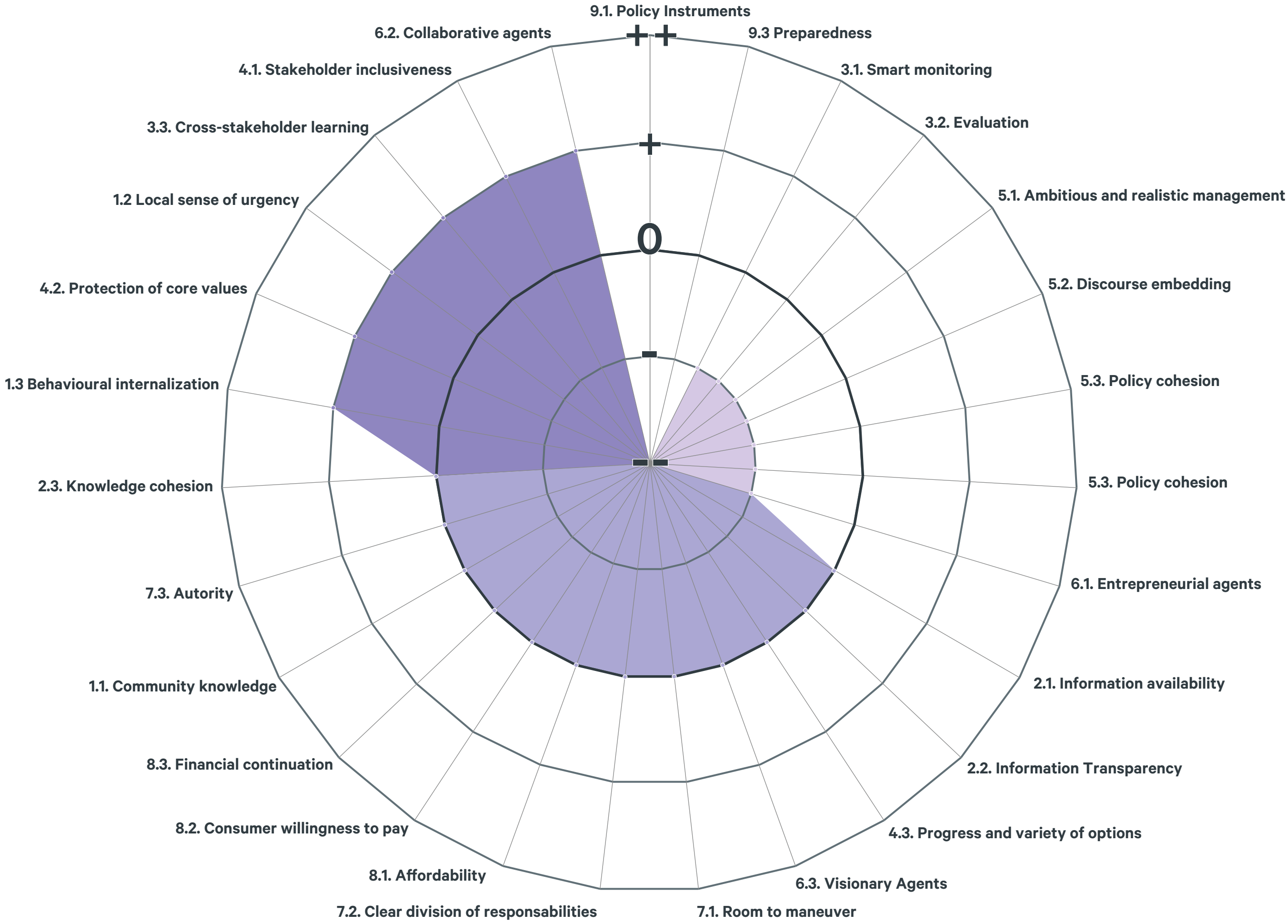
The scores were generated with the information collected from a desk study and interviews with stakeholders. The desk study included peer-reviewed studies on sanitation as well as local, regional, and national regulatory documents and projects on sanitation in Santa Cruz, Montero and Bolivia. For the interviews, stakeholders with different roles in the governance system of Montero were mapped and categorized according to these roles: regional and local public authorities, COSMOL, private companies that worked on sanitation or resource recovery, boards of neighbourhood associations, users of on-site sanitation, etc. From the stakeholders mapped, 30 interviewees were selected through a combination of purposive and snowball sampling, to ensure that each of the 27 GCF indicators could be discussed by at least three or four different interviewees.

Each of the 27 indicators has a predefined question and a scoring guide that is used to link all the information collected to a relevant score that depicts the level of governance capacity for that particular indicator. In this way, scores were assigned to all the indicators.

According to the governance assessment, Montero has moderate capacity to upscale its on-site sanitation systems (Figure 14). The municipality's main enablers are awareness and a sense of urgency about implementing these systems, stakeholder engagement, and willingness to collaborate. Its main barriers are lack of policy instruments, low levels of monitoring and evaluation, and short-term vision within policy-making processes. Many other factors appear to be neutral with regards to upscaling sanitation, which implies that they need to be reinforced to improve the governance system.

Organizations such as INCADE, Etta Projects, Aguatuya and Sumaj Huasi have a good level of knowledge about sustainable on-site sanitation. They are aware of the environmental and health benefits, and they recognise that these systems have a lot of value because they provide a sustainable alternative to centralised systems and dignify the lives of people.

Figure 14. GCF results from Montero show a moderate governance capacity for upscaling sanitation systems. The 27 indicators arranged clockwise according to scores, from very limiting (- -) to very encouraging (++).



Source: Andersson et al. (2021c)

In Montero, COSMOL is the institution that shows a higher sense of urgency to upscale on-site sanitation and in that way increase the number of people that have proper access to sanitation. The utility also raises citizen awareness through campaigns and by providing technical information in trainings for users. However, to increase the impact in the city of the organizations mentioned above and COSMOL, the municipality needs to increase its collaboration with these entities.

Montero residents who already have on-site sanitation systems lack practical knowledge about health and environmental benefits and risks, as well as proper operation and maintenance of the systems. Regarding technical knowledge, users have more information about managing septic tanks than about UDDTs. Also, the population has little knowledge of how to obtain organic fertiliser from dry toilet waste and septic tank sludge. Except for the international platform SuSanA (Sustainable Sanitation Alliance), no existing platform shares knowledge in a horizontal way among different stakeholder groups.

Policy instruments are lacking at the national and local level for regulating the operation and maintenance of on-site sanitation systems. From a legal point of view, having access to on-site sanitation systems is still not considered equal to sewer systems, which makes it difficult to get public investments or tax money for their upscaling. Therefore, most of the initial funding comes from international organizations such as UNICEF, the Swedish development agency Sida, and Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ).

Despite cooperative development of Montero's local water and sanitation plan (Plan Municipal de Agua y Saneamiento) with different interested parties and highlighting the importance of mixed sanitation systems, the plan is still not properly used and implemented in practice. Regular monitoring, follow-up and assessment of results of on-site sanitations projects are limited because COSMOL is the only institution that carries out these activities, and more support from the government is needed.

Furthermore, short-term vision seems to prevail within the local decision-making processes and is the common approach for sanitation in the city, which is reflected in temporary public investments and in the lack of actions plans and infrastructure that prepare the city to deal with emergency situations. This is also reflected in the political arena, where politicians hardly ever consider sanitation systems as part of their political discourse or campaigns.

Political instruments and policies are also missing that would promote the reuse of the subproducts of on-site sanitation systems, for example, as fertilizers.

Insights from governance capacity to scale sustainable sanitation

- Awareness and a sense of urgency about implementing on-site sanitation systems are identified as the main enablers for the upscaling of on-site sanitation technologies, as well as willingness to collaborate, for Montero's public utility COSMOL and other organizations, such as INCADE, Etta Projects, and Aguatuya, and among Montero's users of the existing on-site sanitation.

- However, local public authorities still need to increase their awareness about the health and environmental benefits of these systems and to show higher sense of urgency about their implementation.

- The creation of a cross-stakeholder platform that facilitates horizontal collaboration and strengthens existing knowledge about on-site sanitation systems could help raise awareness about different sanitation technologies.

- The collaboration between local public authorities and COSMOL needs to be strengthened. This could be achieved through the creation of a committee composed of local authorities and COSMOL technical project officers who would oversee the issues arising through discussion forums and roundtables.

- The upscaling of on-site sanitation systems depends strongly on the creation of new policy instruments and the establishment of a long-term policy strategy that increases public investments in on-site sanitation technologies. In this regard, local authorities need to prioritize the allocation of resources to the implementation of on-site sanitation systems and set national and local regulations to control the operation and maintenance of on-site sanitation systems.

Discussion

Despite the successful implementation of on-site sanitation in Montero, we suggest additional solutions to scale the sustainability of the sanitation systems based on the case studies above.

The cooperative utility COSMOL has been successful. The city itself requires capacity development and strengthening of governance systems according to case study 4. COSMOL also needs to work more closely with other actors for technical improvements as well as acceptance along the whole sanitation value chain.

Optimizing existing sanitation systems will lead to benefits in wastewater and excreta management and treatment, to reduce health and environmental impacts. However, while some steps are easy to undertake others are costly and will require policy support and investments.

The UDDTs have the potential to reduce environmental impact the most and have capacity to provide secondary services in the form of farming fertilizer. Local farmers would use these sanitation reuse products at the right price and quality. Further work needs to be done to persuade farmers to do this and to see if consumers will also accept these products.

Our case studies show that households, demand good services no matter the type of system. They want simple maintenance, affordability, and cleanliness and health safety.

Households also consider sewage systems to be most desirable. However, we think that upscaling the UDDTs and other hybrid alternatives could also be made possible with the right messaging and investments from the municipality. That requires having a long-term vision for upscaling on-site sanitation systems using legal, economic, and technical resources.

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