Wastewater management in developing countries: Bolivia case studies.

Conference Paper · July 2017

4 authors:

Claudia Cossio
University of San Simón

Jennifer R Mcconville
Swedish University of Agricultural Sciences

Sebastien Rauch
Chalmers University of Technology

Alvaro Rodolfo Mercado
University of San Simón

40th WEDC International Conference, Loughborough, UK, 2017

LOCAL ACTION WITH INTERNATIONAL COOPERATION TO IMPROVE AND SUSTAIN WATER, SANITATION AND HYGIENE SERVICES

Wastewater management in developing countries: Bolivia case studies

C. Cossio (Bolivia), J. McConville, S. Rauch & A. Mercado

PAPER 2776

Wastewater management in developing countries still is a challenge, especially in small towns. The aim of this study is to understand technical and social factors related to management. Thus, the context surrounding the performance of six treatment plants in rural areas of Cochabamba, Bolivia were investigated: three small treatment plants (2000-10000 p.e.; flow>5L/s) and three very small treatment plants (<2000 p.e.; flow<5L/s). Performance of the plants was measured based on the removal of TSS, BOD_5 and Fecal Coliforms. Management data was collected through semi-structured interviews with water association managers and users. Results found that inappropriate design and type of technology, lack of operational expertise and lack of financial resources were the main factors related to low performance. Moreover, lack of financial resources is linked to the awareness of users on the importance of having the service and willingness to pay for their adequate functioning.

Introduction

The UN Environment Programme estimates that 90% of wastewater produced in developing countries is discharged without any treatment into recipient waters (UNEP & UN-Habitat 2010). SDG6 aims at ensuring the availability and sustainable management of water and sanitation for all. Specific targets to be reached by 2030 include halving the proportion of untreated wastewater discharge into recipient waters and substantially increasing recycling and safe reuse globally. In Latin America most of the wastewater treatment plants (WWTPs) are small and present operational issues due to lack of available resources for an adequate management (Noyola et al. 2012). The population in small towns is rapidly growing around the world. Achieving the SDGs means that increasing efforts need to be made to improve wastewater services in small towns.

Several studies have looked at willingness to pay for water services because this is a common problem in developing countries, which impacts resources for management (Ceric & Vucijak 2011). Paying for sewage services and wastewater treatment is even a greater challenge. Therefore, the study intends to look at the aspects that impact adequate management of wastewater treatment in small towns. Specifically, the objectives are: (i) identify the technical and social aspects that affect the performance of the wastewater treatment plants, (ii) understand how the type of management structure impact on an adequate performance.

Methodology

Study area

The study has been performed in rural areas of Cochabamba, Bolivia where most of the wastewater services (sewage network and WWTPs) experience functional challenges. The technologies used at the WWTPs are presented in Table 1. WWTP1-3 are considered as small WWPTs, whereas WWTP4-6 are considered as very small WWPTs.

Methods to collect the information

1. **Monitoring,** the six WWTPs were monitored to determine their removal efficiencies.
2. **Semi-structured interviews**, based on literature review on the assessment of small WWTPs (Molinos-Senante et al. 2014).

Stakeholders

The study considers the following stakeholders:

1. **Water Association (WA),** organization in charge of the administration, operation and maintenance of the water and wastewater services. The Municipality implements the sewage network and the wastewater treatment plant with local or external funding and then transfers the facility to the local WA so they are in charge of the management.
2. **Users,** households, commercial institutions (shops, restaurants, homemade liquor establishments and slaughterhouses), schools and health centres.

Data analysis

1. **Sanitary inspections and influent and effluent analysis,** operational conditions were monitored and removal efficiencies were determined in the six WWTPs for TSS, BOD_5 and Fecal Coliforms (FC).
2. **SPSS,** answers from interviews will be processed in SPSS to address the objectives of the study.

Results

Performance assessment of the six WWTPs

Key findings during the monitoring of the WWTPs were that low performance is linked to type of technology, especially regarding the tasks required for operation and maintenance. It is important that design of low-cost technologies take into account the level of expertise of operators in place, in order to ensure adequate operational conditions. Technologies that have been demonstrated issues with operation and maintenance should not be considered for implementation e.g. Imhoff tanks. As it can be seen in Table 1, removal efficiencies for WWTP1, 2, 4 and 5 are 0 in most of the cases. In all 4 case studies which include Imhoff tanks, the interviews with managers and operators showed that the tanks never were operated as theoretical design establishes. Operators were not trained to drag sludge using the pipes and valves installed in the Imhoff tank. Therefore, WWTP1 and WWTP2 were dependent on the Municipalities to use machinery to drag the sludge, whereas the smaller treatment plants: WWTP4 and WWTP5 clean the tanks manually or using pumps. This makes the operation and maintenance, of this type of technologies, inefficient, collapsing then in a shorter time and impacting the quality of the treated wastewater for next stages of treatment.

The situation in the smallest plant (WWTP6) is of particular interest because it has a connectivity issue. Originally the plant was designed and built for 80 users but actually only 8 households (10%) are connected to the system. The reasons that users gave for not connecting to the network were that they do not know how to do the connection or that they prefer to use an on-site septic pit. As a result of the over dimensioning, the effluent from WWTP6 is more contaminated and the treatment plant worsened.

Management structure

WA of small wastewater treatment plants (WWTP1-3) have a board of members in charge of the decisions regarding the water and wastewater services. They also have staff hired for the operation of these services, usually: administrative staff and technical staff (plumbers). In the case of the smaller plants (WWTP4-5) the board members of the WA are directly in charge of the administration and operation of the plants, this makes possible that users are more aware of the requirements of the sewage services and WWTPs to function properly. WA managers of the small WWTPs pointed out that low tariffs for sewage services prevent them to hire staff for the operation and maintenance of these services. Another critical issue is the lack of expertise even in the Municipalities regarding the operation of the technologies. Plumbers solve more often the issues of the sewage network.

Adequate operation and maintenance in the WWTPs can be ensured if tariffs are paid according to the actual costs to operate and maintain the plants, especially if the technology uses sophisticated equipment like pumps. Just one out of the six WWTPs that were investigated could afford the standard costs to operate and maintain the plants, the rest subsidize the wastewater service with water tariffs. However, not only financial resources are needed for an adequate performance but also the technical expertise on the management.

Table 1. Description of the six WWTPs and removal efficiencies in rainy (R) and dry (D) seasons for TSS, BOD$_5$ and FC.						
WWTP, technologies, p.e. and flow	**Removal of TSS [%]**		**Removal of BOD$_5$ [%]**		**Reduction of log units-FC [N°]**	
	R	D	R	D	R	D
WWTP1; pretreatment, Imhoff tank & Biofilter; 4 660 p.e.; 6.9 L/s	97	0	61	0	0	0
WWTP2; 2 Imhoff tanks (in parallel); 6155 p.e.; 6.3 L/s	0	0	0	0	1	0
WWTP3; pretreatment, 2 anaerobic ponds (in parallel), 2 facultative ponds (in parallel) & 4 maturation ponds (in parallel); 7000 p.e.; 14.2 L/s	81	88	80	62	1	1
WWTP4; Imhoff tank; 765 p.e.; 1.2 L/s	0	86	0	0	0	0
WWTP5; pretreatment, 2 Imhoff tanks (in parallel); 825 p.e.; 0.9 L/s	0	54	20	8	0	0
WWTP6; Septic tank & Biofilter; 40 p.e.; 0.14 L/s *	-	0	0	0.3	0	0

* Concentrations of selected parameters increased after the treatment. TSS increased from 34 to 72 mg/L in dry season (no data for rainy season); BOD$_5$ increased from 70 to 194 mg/L in rainy season; Log units of FC increased from 4 to 6 in rainy season and from 6 to 7 in dry season.

User perception

Results of the surveys performed to users regarding the perception they have on the functionality of the sewage network (Figure 1) shows that 100% of users of the WWTP5 and WWTP6 say the sewage is working well in the first case because they fulfill communal tasks and have regulations in order to use and maintain the sewage network properly. WWTP6 has few users so the pipe is over dimensioned and generally do not have issues rather that very little flow reaches the WWTP. WWTP4 is again a particular case regarding the maintenance of the service because half of the population that lives near to the plant experiences flooding due to clogs; on the other hand the population that live upstream answered that the sewage network works well since they do not have problems but cause the issues downstream with their non-proper usage of the sewage network. Small WWTPs in general affirms sewage works well because staff of the WA are in charge of solving the problems when they arise.

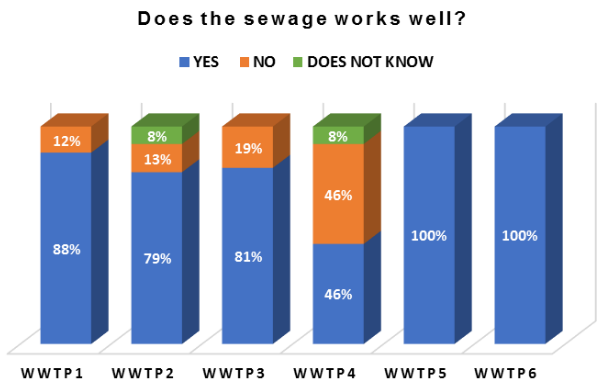

Figure 1. User perception of sewage services

Other results of the surveys show that 34% or 39 respondents (13 from small WWTPs & 26 from very small WWTPs) out of 114 users, affirmed that they have been in the WWTPs and 89% or 36 users (12 from small WWTPs & 24 from small WWTPs) out of 39 affirmed that if the WA improves the service they are willing to pay a higher tariff. 62% of users from small WWTPs and 59% from very small WWTPs complain about the smells due to low performance of WWTPs.

Users of very small WWTPs in comparison to users of small WWTPs showed a higher level of awareness on the importance of an adequate wastewater management and also willingness to pay for the wastewater services.

Conclusions

Type of technology, lack of operational expertise and lack of financial resources were the main factors related to low performance in the WWTPs. Lack of financial resources corresponds to what users are willing to pay for the service and how relevant they consider it. Answers from users and interviews with the managers of the WWTPs suggest that miscommunication is the main cause for lack of awareness from users and their willingness to pay an adequate tariff for the wastewater service. Additionally, social acceptance is connected to smells from low performance of the WWTPs. Very small WWTPs with a community based management, shows to be more efficient due to higher involvement of users, rather than Small WWTPs which functions with a more complex structure. Subsequently a strategy that takes into account this upgrade between both types of systems has to be implemented in order to achieve a sustainable wastewater management.

Acknowledgements

The authors would like to acknowledge financial support from the Swedish International Development Cooperation Agency (SIDA) and the technical support from the Centro de Aguas y Saneamiento Ambiental (CASA) in Bolivia.

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Contact details

Engr. Claudia Cossio is a PhD candidate at Chalmers University of Technology, with particular interests in wastewater treatment in developing countries, sustainability and reuse of resources. Dr. Jennifer McConville is a researcher at Swedish University of Agricultural Sciences, with a specific interest in processes of planning and decision-making with regards to urban sanitation and wastewater management. Sebastien Rauch is a professor in Urban Environments and Systems at the Department of Civil and Environmental Engineering, Chalmers University of Technology. Engr. Alvaro Mercado is a researcher on processes of wastewater and water treatment at the Centro de Aguas y Saneamiento Ambiental, Universidad Mayor de San Simón.

Claudia Cossio
Water Environment Technology
Department of Architecture and Civil Engineering
Chalmers University of Technology
412 96 Gothenburg, Sweden.
Tel: +46721562340
Email: claudia.cossio@chalmers.se

Jennifer McConville
Email: Jennifer.mcconville@slu.se

Sebastien Rauch
Email: sebastien.rauch@chalmers.se

Alvaro Mercado
Email: alvaromercado.g@fcyt.umss.edu.bo