LUND UNIVERSITY

Improving Faecal Sludge Management System for Sustainable Sanitation, Rwanda

Kazora, Amos Shyaka; Bizuhoraho, Theobald; Mourad, Khaldoon A

Published in:
SciFed Biotech & Bioengineering Journal

2018

Document Version:
Publisher's PDF, also known as Version of record

Link to publication

Citation for published version (APA):
Kazora, A. S., Bizuhoraho, T., & Mourad, K. A. (2018). Improving Faecal Sludge Management System for Sustainable Sanitation, Rwanda. *SciFed Biotech & Bioengineering Journal*, *1*(1), 1-10. Article 1.

Total number of authors:
3

Creative Commons License:
CC BY

General rights
Unless other specific re-use rights are stated the following general rights apply:
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.
• Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
• You may not further distribute the material or use it for any profit-making activity or commercial gain
• You may freely distribute the URL identifying the publication in the public portal

Read more about Creative commons licenses: https://creativecommons.org/licenses/

Take down policy
If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

LUND UNIVERSITY

PO Box 117
221 00 Lund
+46 46-222 00 00

Download date: 10. Oct. 2026

SCIFED Publishers

Khaldoon A. Mourad, SF Biotechnol Bioeng J, 2018, 1:1

SciFed Biotech & Bioengineering Journal

Research Article Open Access

Improving Faecal Sludge Management System for Sustainable Sanitation, Rwanda

[1]Amos Shyaka Kazora, [1]Theobald Bizuhoraho, [2*]Khaldoon A. Mourad

[1]Pan African University Institute of Water and Energy Sciences Including Climate Change, Tlemcen, Algeria. B.P. 119 Pôle Chetouane, Tlemcen 13000, Algeria.
[2]Center for Middle Eastern Studies, Lund University, Lund University, Box 201, SE-221 00 Lund, Sweden.*

Abstract

The lack of faecal sludge treatment, inadequate policies and specified regulations on faecal sludge management as well as institutional framework arrangements are the global challenges that face sustainable sanitation in developing countries. The use of on-site sanitation systems is a possible option for the fast-growing cities including Kigali city due to the absence of sewer networks. Using on-site sanitation system needs a well-improved faecal sludge management system to achieve sustainable sanitation. Unfortunately, the conditions for faecal sludge management (FSM) system in Kigali city are poor and do not guarantee sustainable sanitation. Therefore, there is a need for a clear involvement of institutions and specific policy and regulations on FSM. This paper aims to provide an informed sanitation policy and institutional restructurings for improving FSM system in Kigali city. It emphasizes on assessing the faecal sludge management operations while analysing their institutional framework hence suggesting the improved off-site individual sanitation management policy for intensifying access to sustainable sanitation in Kigali city. The paper revealed that faecal sludge management in Kigali is a complex issue as there is no clear role and responsibilities of the institutions in charge for the faecal sludge management, which is a real threat facing human health and environment. A faecal sludge management is needed to achieve sustainable sanitation in Kigali city.

Keywords

Sewer system; On-site sanitation; Institutions; Policy

1. Introduction

1.1 Background

Land and water use affect soil and water resources in Rwanda [1-3]. Faecal sludge management in most of emerging cities is becoming a great issue to focus on for providing sustainable sanitation [4]. Meanwhile, the available faecal sludge technology and management operations are quite inefficient, most of the faecal sludge and other wastes are discharged into the environment without treatment, hence causing great threats to water resources, public health and the ecosystem [5].

Faecal sludge is defined as all liquid and semi liquid of pits and vaults accumulating in on-site installations of public and private latrines or toilets, aqua privies and septic tanks [6]. The management of faecal sludge in developing countries in which Rwanda belongs, is confronted by lack of appropriate faecal sludge treatment, high number of populations living in slums that are dominated by use of traditional pit latrines, inadequate policies, regulations and institutions on faecal sludge management [7].

***Corresponding author:** Khaldoon A. Mourad, Center for Middle Eastern Studies, Lund University, Lund University, Box 201, SE-221 00 Lund, Sweden. E-mail: Khaldoon.Mourad@cme.lu.se

Received March 05, 2018; **Accepted** September 25, 2018; **Published**

Citation: Kazora A.S, Bizuhoraho T, Mourad K.A (2018) Improving Faecal Sludge Management System for Sustainable Sanitation, Rwanda. SF Biotechnol Bioeng J 1:1.

Copyright: © 2018 Khaldoon A. Mourad. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

In most developed countries, faecal sludge management is well developed due to the effective management, collaborations of the institutions and appropriate policies. In Europe, for instance, the faecal sludge management is developed due to clear legislative, policies and citizens commitment. In accordance with European Union, Directive 86/278/EEC, the treated faecal sludge should have a limited amount of heavy metals before being used in Agriculture or being discharged into the environment [8]. This helped to process the sludge aiming at minimization its adverse effects, full stabilization and hygiene using thermal hydrolysis, anaerobic digestion or fluidized bed furnace [9]. On the hand, a study made in Kathmandu valley in Nepal, showed that over 70% of the household's recharged their waste directly into the sewer line as a way of removing their waste, while 30% of the population used latrines and septic tank for management of faecal sludge [10].

In Addition, countries like Ghana, Burkina Faso and Kenya managed faecal sludge mostly using septic tanks and landfills [11]. However, if septic tanks and landfill are not well managed, they may cause negative impacts on groundwater resources and they may cause water borne diseases and pollute the environment. Faecal sludge should be managed and treated with incremental solutions that involve all stakeholders at all levels. Faecal sludge can be mixed, the residence time changed, and new investments may be made to provide new end products for resource recovery like compost, which can improve the socioeconomic activities such as agriculture and energy [12].

Therefore, to achieve the SDG 6, which is to ensure the availability and sustainable management of water and sanitation for all, by 2030 [4], we need to intensify the collaboration of the faecal sludge management institutions; improving the faecal sludge management operations services, which is mainly enhanced by specific regulations in relation to off-site individual sanitation policy as well as institutional framework for increasing access to sustainable sanitation.

1.2 Study Area

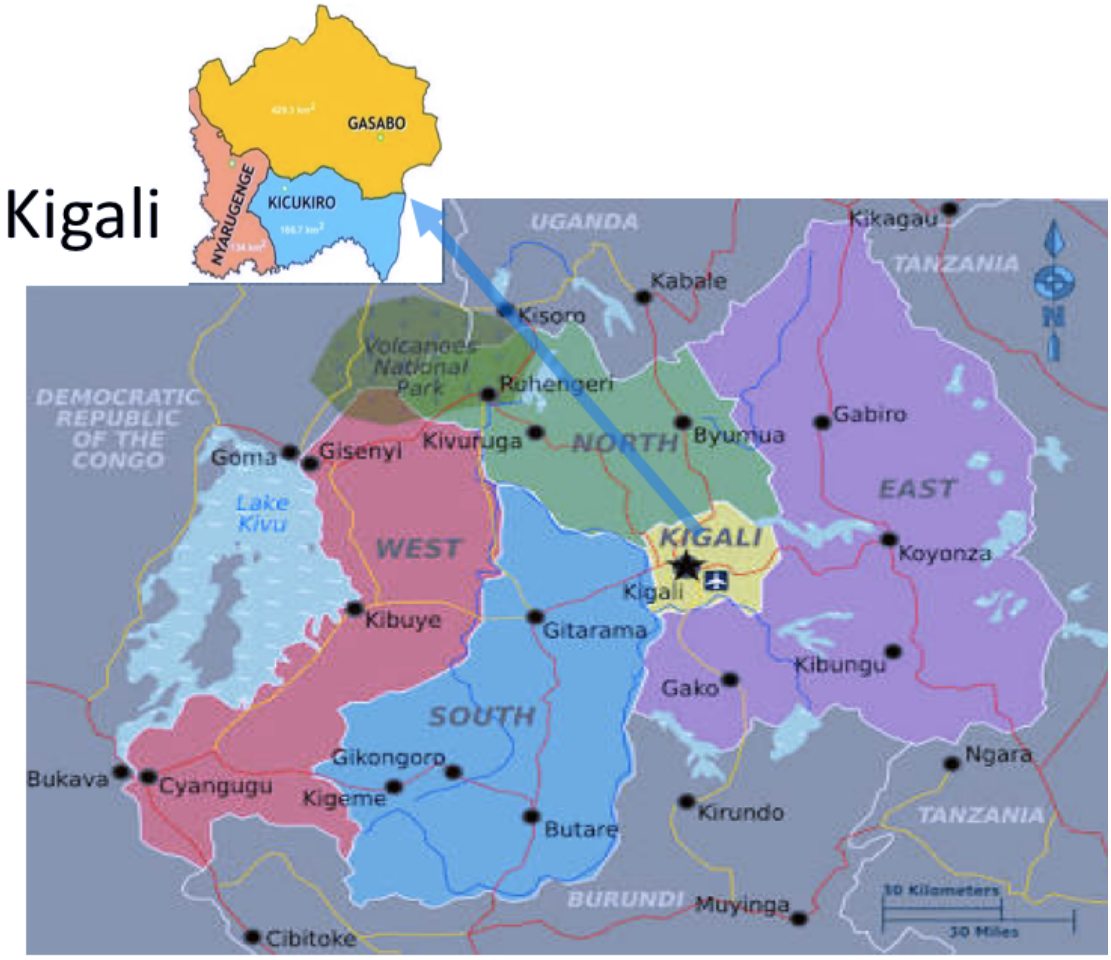
Kigali city is the capital and largest city of Rwanda that is located at the latitude of 1º 58'S and a longitude of 30º 07' E. [13]. Kigali city has three districts namely: Nyarugenge, Kicukiro and Gasabo, Figure 1. It is one of the most rapid urbanized cities counting over 1,223,000 inhabitants with a high population growth 4% living in an area of 730 km^2 [14]. The city is dominated by the slums that were built before the establishment of Kigali city master plan in 2006. The estimated daily waste production from Kigali is about 400 tons dominated by food waste that constitutes 68 % of all waste [15]. Solid and liquid wastes from Kigali city are collected and dumped together to one communal dumping site at Nduba in Gasabo District [15, 16]. The city produces 3,240 m^3/day of domestic wastewater, 60% of which are discharged into the environment without treatment [17], which cause water bon diseases and interfere negatively to the sustainable sanitation [18]. The main challenges of faecal sludge management in Kigali city are due to limited governmental focus in sanitation resulted from lack of finance and skilled staff in FSM [19]. Furthermore, there is no clear law or policy that involves local people in FSM; and limited number of private expert companies in faecal sludge management.

The world is faced with problems related to poor faecal sludge management (FSM) systems due to the extensive increasing in population density and the increase of urbanized cities [4]. Urban faecal sludge management systems in developing countries have increasingly shown failures due to the lack of appropriate treatment of the faecal sludge, lack of sustainable sanitation infrastructures in fast growing cities, the increased number of the population using pit latrines and septic tanks that are connected to sewerage systems, inadequate policies, regulations and institutions that focus on faecal sludge management [7].

The City of Kigali is one of the fast-growing cities in Africa. However, there is no centralized sewerage system for carrying the liquid waste including the faecal sludge waste from individual households and office houses and no appropriate solid and liquid waste treatment which have led to a sanitation deficit [13]. Of all the households in Kigali city, 91.2% use pit latrines and 60% of the population lives in informal settlements (slum areas) with inadequate sanitation facilities due to the insufficient waste removal [20].

Lack of affordable emptying services and private operators in FSM services have resulted to self-exploration of means for emptying and discharging sludge into open channels. These effects were found after heavy rainfalls or during late night hours due to the lack of land for digging another pit latrine and the high costs of emptying services. This traditional method affects the health of people and pollutes the environment and downstream areas. In addition, the faecal sludge managed to be emptied

Figure 1: Administrative Map of Rwanda, Kigali city



from the pits or septic tanks are treated by open crude dumping in Nduba Landfill site. The disposed liquid waste including faecal sludge in dumpsite do not undergo further treatment but discharged direct into the environment which later affects human health and displacement due to the bad odours, the increase of insects, the pollution of both underground and receiving surface water sources due to leach ate substances hence destroying ecosystem and the degraded environment. The improvement of the FSM system in terms of effective sanitation policy, appropriate FSM technologies and institutional restructuring are needed for achieving sustainable sanitation in Kigali.

Therefore, this paper aims at providing institutional management framework policy to improve faecal sludge management systems to achieve sustainable sanitation system in Rwanda. The paper will assess the existing faecal sludge management system operations; analyse the faecal sludge management institutional framework for improvements; and propose an improved off-site individual sanitation management policy to achieve sustainable sanitation.

2. Overview of sanitation status and system

Rwanda as a country has achieved millennium development goals particularly goal 7 in its article 3 about the proportion of population using an improved sanitation facility. The proportion of households with access to improved sanitation in Kigali had increased from 83.3% in 2011 to 93.2% in 2014. The sanitation systems, whether on-site or off-site, were made of incomplete institutional frameworks and this resulted in poor accountability, informal private sector, and disagreements between stakeholders due to the threats to human health and environment.

There is no centralized sewerage, however there are some semi-centralized sewerage systems developed in some public areas like hospitals, hotels, government institutions and of course in some high-income households

developed by estate developers. These systems face functional problems due to poor management of infrastructures and irregular maintenance.

The population of Kigali city are largely dependent on septic tanks and pit latrines. 95% uses on-site sanitation systems, 80% of which are pit latrines [19]. However, only 2% of the households empties the sludge from their pit latrines [20]. The management process of the on-site sanitation system is under the role of the municipality but when it comes to FSM for individual on-site sanitation systems, the responsibility is mostly left to individual households and the informal private sector with less monitoring [19].

There is a lack in faecal sludge emptying operators [21]. The little percentage of the emptied sludge is not treated for proper disposal, it is dumped in the open environment or improper dumping site (Landfill), which causes health and environmental problems. The emptying operators are business oriented with specific target of interest. For example; Pivot Ltd, an energy company that produces renewable fuel from the city's faecal sludge with its factory constructed in 2015 at NDUBA dumping site, the company is only concerned about the solid portion of the faecal sludge to make briquettes where the remaining liquid portions and by-products of fuel production process are finally dumped in holes that eventually cause water pollutions. Another example is Rwanda Environment Care (REC) that was established in 2005, unfortunately, REC has never made any progress towards individual household's services, it focuses on public urine-diverting dry toilets (UDDT).

3. Present Institutional framework in FSM processes

None of the previous studies on Kigali FSM system has focused on the institutional framework arrangements to deliver the service but they tackled different constraints to the involved stakeholders in FSM [19]. Challenges and opportunities to achieve sustainable and modernized decentralized sanitation system in poor neighbourhoods and informal settlements of Kigali, Rwanda [20, 21]. Other studies show failures in management and improper disposal of liquid waste by using unsustainable solution for FSM that later spread related diseases in the neighbourhood [22, 23].

Regardless the fact that institutions involved in sanitation sector are recognized and well known, there is no defined formal institutional framework for FSM services delivery. The roles and responsibilities of those institutions in FSM are not defined, which gives chances to involving informal operators who are not inevitable by clearly defined responsibilities or legislation. Therefore, there is a need to openly assign FSM-related responsibilities and collaborations to the existing institutions to enhance FSM system. Table 1 below presents the institutions that govern sanitation sector in Kigali [19].

Different key partners are also identified in managing liquid waste together with solid waste but not the management of faecal sludge itself from individual household. The main waste management players are MININFRA, MINIRENA, WASAC, 3 districts of CoK, RURA, REMA and private operators that collect and transport solid and liquid waste to Nduba dumping site as described in Table 2 [23].

4. Policy and Regulations

FSM is included in the national sanitation policy directions, but the government participation in FSM services is imperfect [24]. The national sanitation policy gives rights to CoK to only provide emptying services to public institutions and then the rest of residents to be served by private operators. The policy defines the proper way of providing FSM services, which cannot be achieved without the involvement of the municipality [19]. Therefore, the municipality should fully participate in collection, emptying and transport services or open intervention of other existing local institutions in sanitation sector particularly FSM to ensure proper faecal sludge management services at household levels in terms of emptying, transport, treatment and sludge disposal.

In developing safe, well-regulated and affordable off-site sanitation services for densely populated areas, the national sanitation policy didn't provide any guidance about managing the off-site individual sanitation (FSM) services as it did for off-site collective sewerage. This contradicts to the statement in this policy under the part of individual vs. collective sanitation which states that "Individual & collective, and On-site& Off-site sanitation need to be carefully set" [25]. The policy clearly defines the management of the off-site individual sanitation as faecal sludge management collection by vacuum tankers and transportation to a faecal sludge treatment plant [25]. It is not fair to limit treatment technologies in the policy though its effective to only the faecal sludge treatment plants, but it should also be open to new technologies like safe and productive dumping sites for various purposes or

Table 1: Institutions that Govern Sanitation Sector in Kigali City and their Responsibilities

Institutions	Overall National Leading Institution
Ministry of Infrastructure (MININFRA)u	– Setting policies related to sanitation – lead the development of national sanitation law – Responsible for Sanitation infrastructure – Promote capacity development in the sanitation sector at the national level – National coordinator of sanitation activities
Regulatory Institutions	
Rwanda Environment Management Authority (REMA)	– Implementation body for environment-related policies – Monitor, inspect and ensure compliance with national environmental standards and regulations
Rwanda Utilities Regulatory Agency (RURA)	– Ensures that there are good conditions for fair competition in provision of services – Licensing – Legal enforcement
Sanitation Service Providing Institutions	
Water & Sanitation Corporation (WASAC) Ltd	National Co-ordination of the implementation of all technical aspects related to sanitation policy – Capacity development about technical aspects in sanitation – Compliance with national sanitation law and relevant regulations
Other public and private operators	– Provide sanitation services (FSM services included) – Compliance with national sanitation law and relevant regulations
Development partners/NGOs	– Capacity development support in sanitation sector – Compliance with national sanitation law and relevant regulations
Public Sanitation Infrastructure Managing Institutions	
Ministry of Local government/Local Leaders (MINALOC)	– Responsible to support the sanitation services provision activities and manage infrastructure related to sanitation services in their territory – Compliance with national sanitation law and relevant regulations
Sanitation services users	
Individual compounds/households, Community	– Participate in sanitation services provision activities – Compliance with national sanitation law and relevant regulations

Source: [24]

Table 2: Roles and Responsibilities of Key Players in the Management of Solid and Liquid Waste

No	Institution	Responsibilities
1	MININFRA (Ministry of Infrastructures)	Provides guidelines through its department in charge of water and sanitation, by providing guidance on how to improve sanitation.
2	Ministry of environment and natural resources (MINIRENA)	Responsible for making policy for management of waste including solid waste
3	WASAC (Water and Sanitation Corporation)	Provides some guidance on how to improve sanitation by effectively manage waste and it has crosscutting responsibilities with the CoK in the waste management.
4	Districts of Nyarugenge, Gasabo and Kicukiro	Ensure that solid waste are collected and dumped at Nduba site (Including public liquid waste)
5	Rwanda Utilities Regulatory Agency (RURA)	Regulate the management of waste, both liquid and solid waste
6	Rwanda Environment Management Authority (REMA)	Prepare guidelines related to management of waste including both liquid and solid waste
7	Private firms	Execute the contract of management of solid and liquid waste

Source: [23]

to any standard treatment facility.

When it comes to a cooperation framework for improving household sanitation and behaviour change, the policy highlights government institutions to be involved in inter-sectoral program of promoting household sanitation and hygiene, developing, evaluation and support of adequate technical sanitation solutions to be used whereas, the management part of faecal sludge produced at household has been left behind [25]. The policy should fully indicate an improved household sanitation and behaviour change that comprises of not only promoting programs of household sanitation and hygiene, developing, evaluation and support of adequate technical sanitation solutions but also an FSM framework with respective institutions in charge.

Regarding the laws on FSM system, Rwanda Utilities Regulatory Authority (RURA) is the only independent government authority in the whole country that develops rules and regulations to be followed in all sectors as well as water and sanitation for different drivers. When it comes to sanitation services, RURA has to ensure effective regulations consisting of regulatory tools necessary for sanitation service provision by licensing and analysing reports from sanitation service providers.

Currently, RURA has no regulations for FSM services but has put in place regulations regarding the produced sludge from decentralized wastewater treatment plants installations and operations [26]. Where the FSM services exists, the authority doesn't even use the regulations for decentralized wastewater treatment services to regulate FSM services hence no regulations nor licensees to the existing FSM service operators [19].

The authority provides guidelines (excluding collection rules) for liquid waste treatment and disposal on specific issues and their legal responses like transportation, treatment, discharge standards, disposal, inspection, reporting, and penalty issues. But these mentioned issues in relation to the improved individual FSM are not considered good conditions for the FSM service providers as it can't be completely applied for sustainable sanitation [27].

For example; when it comes to the transport issue, the regulations try to make sure that the liquid waste are transported in a manner that doesn't detriment the environment and this could be applied in FSM service. It is worse when it comes to the treatment side, the authority provides regulations about the treatment of liquid wastes, discharge standards, as an obligation to only public services like commercial buildings, prisons, hospitals, hotels, and schools plus populations and industries before liquid wastes are being disposed into the environment. But, these treatment directives leave behind the treatment of faecal sludge that will be transported from the individual households which mean that these treatment guidelines can't help faecal sludge treatment, which poses threats to the health of people and the environment.

5. Improving Faecal Sludge Management System (FSM)

5.1 Adjusting the National Sanitation Policy and Strategies of 2016

In the scope and policy definitions of the national sanitation of 2016, the definition of sanitation services for individual off-site sanitation management should be changed and not limited, in order to create room for advanced technologies in the sector, Table 3;

Table 3: Definition of Sanitation Services

Management	Individual Sanitation	Proposed Individual sanitation definition
On-site sanitation	Sanitation facilities at household level (latrines, septic tanks, infiltration pits)	-
Off-site sanitation	Faecal sludge management (collection by vacuum tankers and transportation to a faecal sludge treatment plant)	Faecal sludge management (collection by vacuum tankers from licensed operator and transportation to a standard sanitation treatment facility preferably faecal sludge treatment plant and finally disposed in a manner that mitigates water pollution)

In the sub-article of establishing a cooperation framework for a comprehensive inter-sectoral program to promote improved household sanitation and behaviour change under objective 1, raise and sustain household sanitation coverage to 100% by 2020. The policy should indicate all government institutions and their responsibilities and should include housing related authority as follow:

- A firm, permanent framework of cooperation will be established to coordinate the involvement of the different government institutions involved in sanitation and hygiene promotion – the MoH, MININFRA, WASAC, RHA, Ministry of Local Government (MINALOC), MINEDUC and the districts.

- MoH, with the involvement of MINALOC, will continue to lead the individual sanitation and hygiene promotion at the community level, through its national Community-Based Environmental Health Promotion Programme (CBEHPP).

- WASAC will be responsible for the development, evaluation and support of adequate technical sanitation solutions.

- As sanitation and hygiene components are lagging behind, they shall continue to be incorporated in each water supply project.

- Kigali districts in association with RHA will be responsible of the safe collection of faecal sludge from individual households, assist in gathering the information and data on waste production at household level.

- MINEDUC will contribute in research related alternative technologies for improving productive individual off-site sanitation management systems.

- The policy should also define the off-site individual sanitation as follows: Off-site individual faecal sludge management services shall be confined to all areas where there are no sewer networks and approved to be for domestic or commercial services or any other service that officially allowed for setting up buildings/ fulfils construction requirements.

- The second statement of this sub-article may state that: Adequate institutional interfaces and regulations provided by RURA are to be developed.

5.2 Institutional restructuring

For achieving sustainable sanitation, institutional empowerment is needed to assure funding from the government for FSM services. Funds allocation for FSM services will allow for developing and performing new internal strategies. The paper proposes developing a new unit within two different existing government institutions related to sanitation and housing, that means one more unit to be added in WASAC Ltd (Water and Sanitation Corporation Ltd, Figure 2) and another in RHA (Rwanda Housing Authority) as follow;

Within WASAC structure, there is a directorate for urban water and sanitation serves (UWSS, Figure 3).This study proposes to create faecal sludge management (FSM) unit under sewerage operations services management and this unit will be responsible for supporting the development of technical sanitation solutions to manage faecal sludge at household level in the areas where sewer networks do not exist; and ensuring suitable and acceptable treatment of other faecal sludge that are transported from household before being discharged into the environment.

For RHA Structure, Figure 4, the paper proposes to create a unit called Urban Household Sanitation Services (UHSS) under the Construction and Legislation Division with the following responsibilities;

- Prepare the guidelines and standards for waste management;

- Provide the assistance and follow up the master plan;

- Involving stakeholders and getting funds for improving the sanitation;

- Coordinating all activities related waste management and sanitation;

- Ensure the collaboration with other institutions; and

- Gather all data about waste production.

6. Conclusions

The adjustment of national sanitation policy and institutional reforms alone are not enough to improve FSM system to strengthen sustainable sanitation, but specific regulations, laws, legal guidelines and management of FSM services are needed to provide appropriate directives to get sustainable individual FSM services. The proposed adjustments in this paper can be a start point for further

Figure 2: Organizational Structure for Water and Sanitation Corporation Ltd, WASAC Ltd.

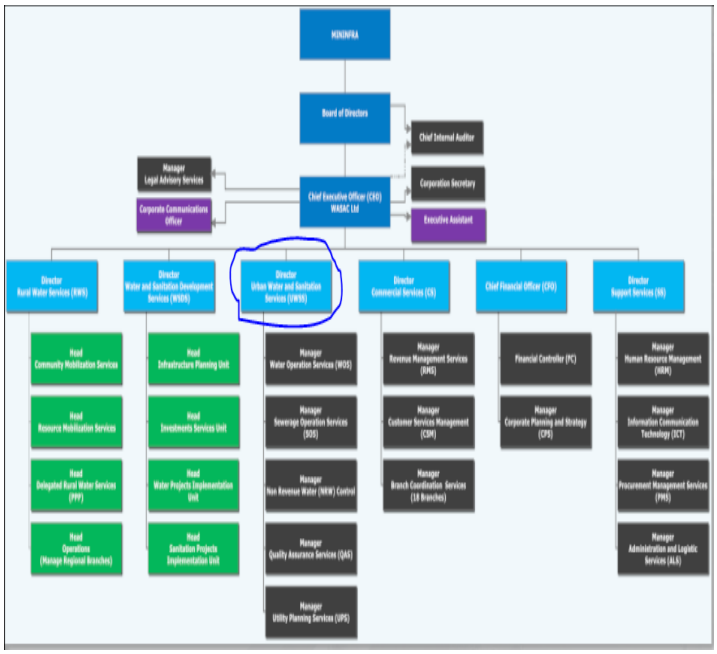


Figure 3: Urban Water and Sanitation Services (UWSS) Structure, WASAC Ltd.

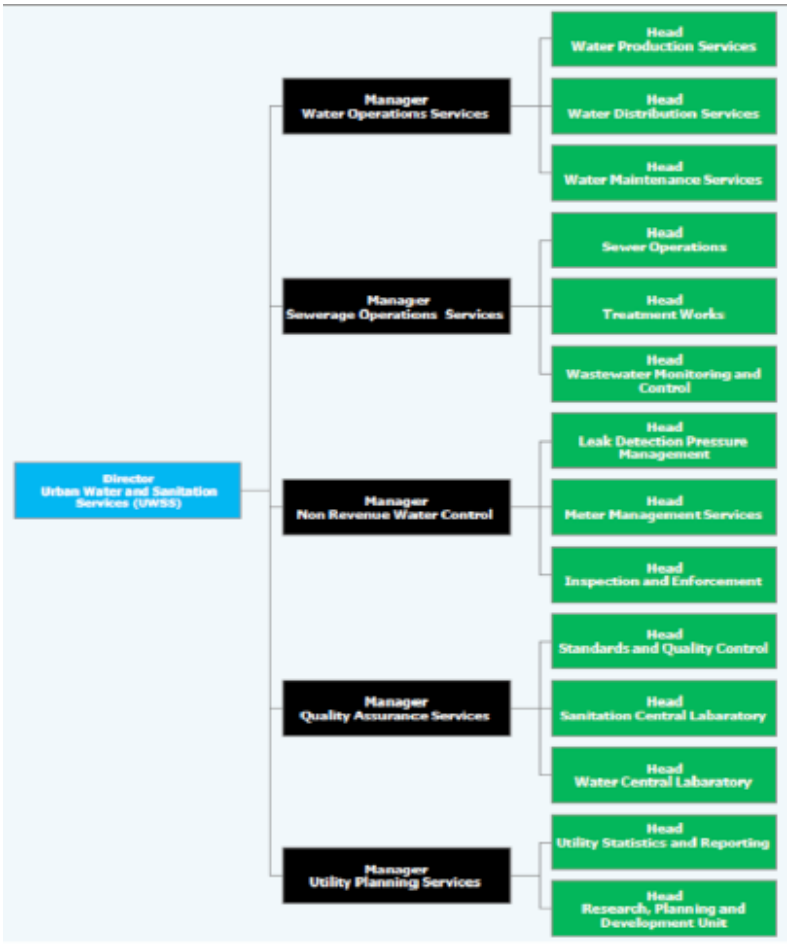
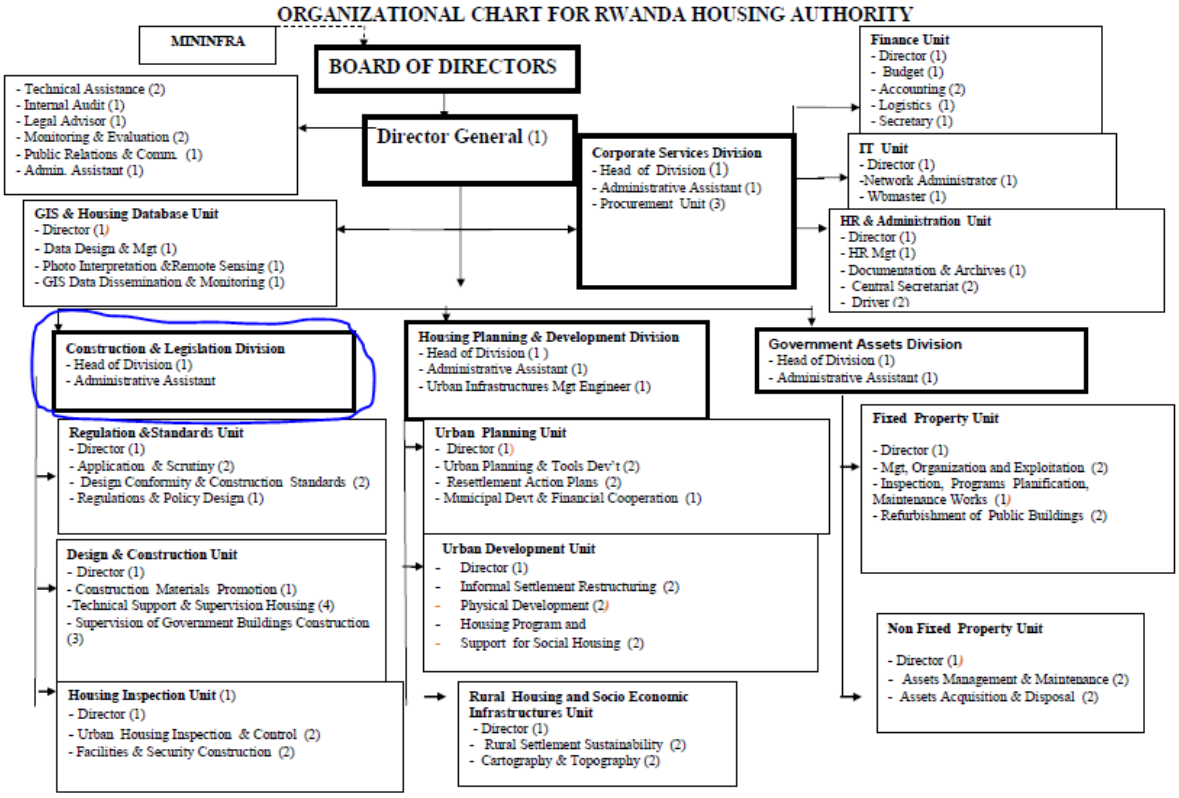


Figure 4: Organizational Structure for Rwanda Housing Authority, RH



studies and improvements. Therefore, there is much need for regulations on faecal sludge management (FSM) systems to ensure adequate access to improved sanitation services for the human well-being and the ecosystem.

Reference

1. Aboniyo J, Umulisa D, Bizimana A, Kwisanga JMP, et al. (2017) National Water Resources Management Authority for A Sustainable Water Use in Rwanda. Sustainable Resources Management Journal 2:3, 01-15.

2. Aboniyo J, Mourad KA (2017) Role of Community Based Organization in Transferring Climate Change Information in Rwanda. Re. J Environ Sci 11:4, 156-169.

3. Bizuhoraho T, Kayiranga A, Manirakiza N, et al. (2018) The Effect of Land Use Systems on Soil Properties; A case study from Rwanda. Sustainable Agriculture Research 7:2, 30-40.

4. UN (2015) Transforming our world: the 2030 agenda for sustainable development sustainable development. United Nations: New York, USA.

5. Ingallinella AM, Sanguinetti G, Koottatep T, et al. (2002) The challenge of faecal sludge management in urban areas-strategies, regulations and treatment options. IWA Publishing 46: 285-294

6. Strauss M, Montangero A (2002) FS Management-Review of Practices, Problems and Initiatives.

7. M Mbéguéré, JB Gning, PH Dodane, et al. (2010) Social economic profile and profitability of faecal sludge emptying companies.

8. Inglezakis1 VJ, Zorpas AA, Karagianides A, et al. (2011) European Union legislation on sewage sludge management.

9. Mininni G, BlanchF AR, Lucena S, et al. (2015) EU policy on sewage sludge utilization and perspectives on new approaches of sludge management. Environmental Science and Pollution Research. 22: 10, 7361-7374

10. UN-Habitat (2010) Faecal sludge management. High Powered Committee for Integrated Development of the Baghmati Civilization: Nepal.

11. Anthony Mensah (2006) Faecal Sludge Management in Kumasi-Perspective as seen by the Municipality. First International Symposium/Workshop on Faecal Sludge Management (FSM) Policy. Dakar Senegal.

12. Magalie Bassan (2015) Institutional Frameworks for Faecal Sludge Management. J Water Sanit Hyg Dev; UN-IHE.

13. GoR (2013) Kigali city Development plan 2013-2018. Government of Rwanda (GoR) Kigali city. Kigali Rwanda.

14. National Institute of Statistics of Rwanda (NISR) (2012) Ministry of Finance and Economic Planning (MINECOFIN) Rwanda. Fourth Rwanda Population and Housing Census. Thematic Report: Population Projections.

15. Kahigana Innocent (2011) Selection and implementation of an optimal system to handle garbage in Kigali, Rwanda. Master Thesis in Sustainable Development: Examensarbete Hållbar Utveckling 17.

16. Josephine Isugi, Dongjie Niu (2016) Research on Landfill and Composting Guidelines in Kigali City, Rwanda Based on China's Experience. International Proceedings of Chemical, Biological and Environmental Engineering Volume 94 of IPCBEE (2016) DOI: 10.7763/IPCBEE. 2016. V94. 10

17. Umuhoza et al. (2010) Assessment of Wastewater Management Practices in Kigali City, Rwanda. Open Environ Biol Monit J, 3: 21-28. 21

18. Striebig Bradley A, Appel Philip, et al. (2007) Decentralized Waste Treatment and Energy Recovery in Kigali, Rwanda. Nolt-Helms, Cyntia: Gonzaga University.

19. Jean Baptiste Akumuntu UtaWehnb, Martin Mulenga, et al. (2017) Enabling the sustainable Faecal Sludge Management service delivery chain-a case study of dense settlements in Kigali, Rwanda. Int J Hyg Environ Health 220: 960-973.

20. Tsinda A, Pamela A, Steve P, et al. (2013). Challenges to achieving sustainable sanitation in informal settlements of Kigali, Rwanda. Int J Environ Res Public Health 10: 6939-6954.

21. Sano JC (2007) Urban Environmental Infrastructure in Kigali City, Rwanda. Challenges and Opportunities for Modernized Decentralized Sanitation Systems in Poor Neighborhoods. MSc thesis, Wageningen University, Wageningen.

22. Alice U, Ming Y, Nestor U, et al. (2017) Liquid Wastes Treatment and Disposal in Rwanda. J Pollut Eff Cont 5: 197.

23. OAG (2016) Performance audit report on management of solid and liquid (sewage) waste in city of Kigali Office of the Auditor General of State Finances (OAG), Rwanda.

24. MININFRA (2010) National Policy & Strategy for Water Supply and Sanitation Services. Ministry of Infrastructure, Republic of Rwanda.

25. MININFRA (2016) National Sanitation Policy and Strategies (NSPS). Republic of Rwanda, Ministry of infrastructures (MININFRA). December, Kigali.

26. RURA (2012) Regulations on Decentralized Wastewater Treatment Systems, 8 June. Regulatory Board, Rwanda Utilities Regulatory Agency, Republic of Rwanda, Serial Number 008/SAN/RURA/2012.

27. Alice U, Ming Y, Nestor U, et al. (2017). Liquid Wastes Treatment and Disposal in Rwanda. J Pollut Eff Cont 5: 197.

Citation: Kazora A.S, Bizuhoraho T, Mourad K.A (2018) Improving Faecal Sludge Management System for Sustainable Sanitation, Rwanda. SF Biotechnol Bioeng J 1:1.