




### ASSESSING THE NATIONAL SANITATION POLICY IN RWANDA

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#### ABSTRACT

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Populated cities in Rwanda rely on decentralized wastewater management systems due to the absence of central sewerage systems and the limited finances for sanitation infrastructures. This paper studied the influence of the national sanitation policy and the best available technologies in addressing and reinforcing decentralized wastewater treatment practices in Kigali city such as on-site and off-site sanitation systems. Different sanitation and wastewater management related policies were reviewed with emphasis on densely populated cities. The paper highlighted the need for a sustainable sanitation policy focusing on the safe disposal of the wastewaters and the proper connection to protect the ecosystem and to improve the status of the sanitation services in Rwanda. It was also noted that policies cannot be implemented without a real intervention of the local authorities in monitoring, advising and putting practical guidelines for individuals and communities before and after constructing their treatment systems.

**Contribution/Originality:** This paper highlighted and reviewed the social and environmental problems related to the wastewater management practices in Kigali city, which has had negative impacts on human health and the ecosystem. The message to be delivered: Connecting every household to an improved sanitation system to meet the MDGs doesn't make any sense if the collected wastewaters were not treated and managed properly after the collection. Therefore, the paper reviewed and suggested some interventions to be included in the national sanitation policy of Rwanda trying to approach sustainable sanitation principles for the country sake before achieving any other global goals.

## 1. INTRODUCTION

This paper aims to identify some implementation gaps in the national sanitation policy of Rwanda in order to make it a sustainable policy. For this aim, the authors started the paper by background & literature review; introducing a case study of Kigali city and its wastewater related problems; reviewing different related research papers and sanitation policies regarding their effectiveness in addressing wastewater management and monitoring issues; proposing some policy interventions and finally summarizing the work done in the conclusions.

### 1.1. Background of Study and Literature Review

Wastewater management is considered one of the vital increasing problem worldwide due to the population increase, urbanization and industrialization [1]. Sanitation is needed to protect human health and the ecosystem,

and it is a must for sustainable development. However, poor sanitation and wastewater management practices in developing countries have contaminated the ecosystem and most of the fresh water sources leading to waterborne diseases [2].

Decentralized wastewater treatment systems are considered a good alternative in rural areas; however, local authorities should monitor and provide guidelines [3, 4]. In the 1990s, an international network of agencies and NGOs drew conclusions about the deficiencies of existing infrastructure development through the “decentralized wastewater treatment systems approach”. Decentralized wastewater treatment systems can be in two comprehensive categories; on-site and off-site sanitation systems. On-site decentralized sanitation systems involve wastewater management systems at individual or collective community levels, where off-site decentralized sanitation systems involve the treatment systems of faecal sludge collected from individual households before being reused or disposed into the environment. Decentralized wastewater treatment systems are designed to be an element of the comprehensive wastewater systems [5].

In most developed countries, wastewater management systems are well developed due to the effective management, collaborations of the institutions, appropriate policies and strategies. On the other hand, most developing countries has made investment in social infrastructures to wane the investment in the construction, operation, and management of wastewater treatment technologies. Consequently, the danger has led to unsafe water and poor sewage disposal. This tragic scenario was also richly captured by World Bank reports: “microbial diseases—costing billions of dollars in lost lives and unhealthy workers—are endemic in the poorest parts of most cities of the developing world. In these areas, water sources were contaminated, due to the poor sanitation facilities.

Most developing cities lack adequate wastewater management due to aging, absent or inadequate sewage infrastructure. According to the 4<sup>th</sup> World Water Development Report, only 20% of globally produced wastewater receives proper treatment [6]. Worldwide, wastewater treatment is failing and as a result, the majority of wastewaters, septage and faecal sludge are discharged into the environment without treatment spreading diseases and polluting the ecosystems [7]. Rwanda faces challenges regarding land use, water shortage, sludge management and climate change [7-9]. Despite the fact that Rwanda as a country had achieved the MDG targets on improved sanitation, it is easy to notice that there are unsafe and unsustainable decentralized wastewater treatment practices for both wastewater and faecal sludge before discharging into the environment.

The Sustainable Development Goals SDGs, Goal 6 goes beyond drinking water by addressing the quality and sustainability of water sources thereby ensuring sustainable management of water and sanitation for all [10]. However, there is a significant lack of the needed knowledge on decentralized wastewater treatment systems and there is a vital need for good implementation strategies based on wastewater management policies that can ensure the sustainability of the wastewater treatment systems [1].

## 1.2. Study Area

Kigali city, Figure 1, is one of the fast-growing cities in Africa with population of over 1.3 million inhabitants [11]. The city consists of three districts, Nyarugenge, Kicukiro and Gasabo districts in a total area of 730 km<sup>2</sup>.

Kigali city (CK) is dominated by slums that were built in the prior years before the establishment of Kigali city master plan in 2006. The estimated daily solid waste production from Kigali is more than 400 tons [12, 13] dominated by food wastes. The solid and liquid wastes from Kigali city are collected and dumped together into a communal dumping site at Nduba in Gasabo District [13]. In addition, households produce 3,240 m<sup>3</sup>/day of wastewater, 50% of which are discharged into the environment without any kind of treatment [14].

According to the thematic report utilities and amenities approved in March 2016 (EICV4), 81.6% of the improved sanitation in Rwanda uses pit latrines with solid slab due to the absence of sewage system/network in the country [15]. The high-altitude topography of the city has accelerated ground and surface water contamination

and has degraded the ecosystem. Moreover, the high standard of living and the limited finances from the government to develop different planned centralized sanitation projects have increased wastewater complexities.

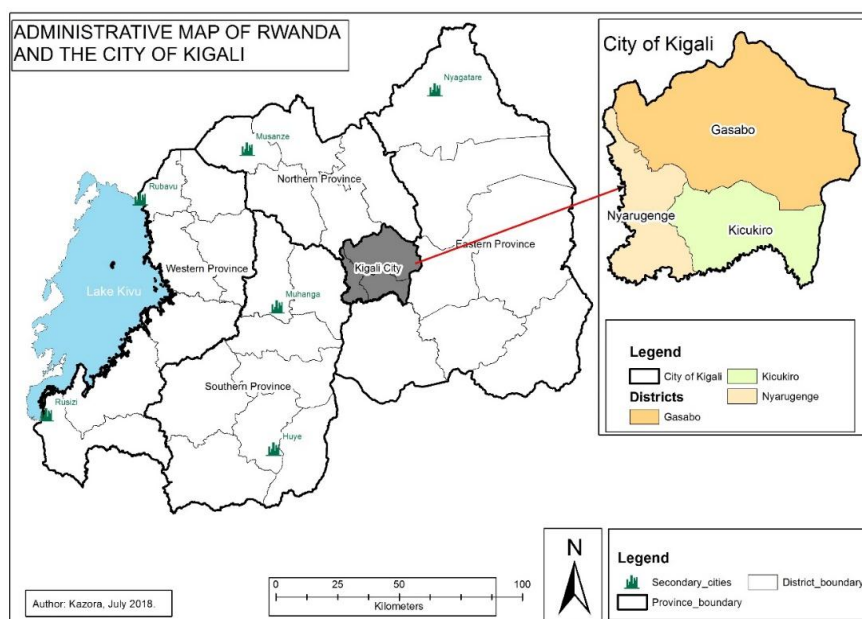


Figure-1. Administrative map of Rwanda, Kigali city [1].

### 1.3. Problem Statement

Inappropriate sludge management and disposal practices resulting from the absence of clear faecal sludge management (FSM) system has been identified as a problem in densely populated areas as it generates resilient environmental pollution and related health risks [16]. Urban wastewater management systems in developing countries increasingly show failures and significant lack of scientific knowledge in both technology selection and design of the most appropriate and sustainable wastewater treatment plants especially for the semi-centralized wastewater treatment systems. Moreover, the lack of sanitation infrastructures in fast growing cities and emerging urban and peri-urban areas has greatly increased the contamination of water sources [1].

In the City of Kigali, the safe sanitation systems don't cover all the city's people, while the few existing on-site collective systems (semi-centralized wastewater treatment plants) do not function appropriately as they were initially designed [17, 18]. The absence of sewage networks made the population of Kigali city dependent on septic tanks and pit latrines for facilities with 95% uses on-site sanitation systems, 80% of these are pit latrines [17]. However, that increased the problems related to poor sewage and wastewater disposal of the septic tanks and improved pit latrines because only 2% of the households in Kigali city used to empty the sludge from their pit latrines [19]. When the septic tanks or the improved pit latrines are full, they are emptied, and the sewage is just treated by the crude dumping at the Nduba Landfill site, which is exposed to the open environment without any further treatment [20]. The little percentage of the emptied sludge was not treated in a proper way rather it was just dumped in an open environment, dumpsite, that is called NDUBA, which receives about 400 tons per day of solid wastes and causes health and environmental problems in addition to displacement of the neighbourhood population [13]. Moreover, Bazimenyera and Gatete [21] studied the impacts of the household's wastewater systems on the environment in Kigali city and they found that soak pits are frequently used in slum settlement and planned housing as a system of wastewater disposal at 73.5% and 63.2%, respectively and the disposal of wastewater in the street in slum settlement and planned housing were at 22.1% and 36.8%, respectively. These soak pits, that allow the liquid wastes to slowly soak into the soil layers, (Figure 2) have led to fall down of some buildings and have increased groundwater contamination.

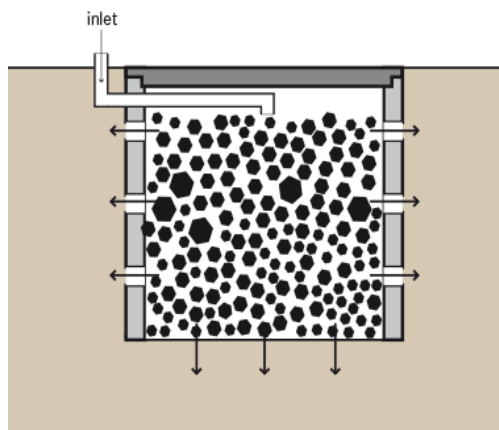


Figure-2. A schematic of a soak pit [22].

Therefore, wastewater management in the City of Kigali has become very crucial to ensure sustainable management of faecal sludge and the effluents generated from the on-site systems. Moreover, there is a need for a well-informed, effective, and sustainable sanitation policy that clearly addresses management, monitoring and treatment practices of such systems. Therefore, this paper reviews and evaluates the present national sanitation policy and proposes interventions to attain safe and sustainable wastewater treatment systems in the City of Kigali.

## 2. METHODS

This paper implicated both qualitative and quantitative data. The qualitative data used were from different related sanitation policies and research papers with respects to the gaps created by unfamiliar policies in addressing proper development and management of urban wastewater treatment systems. For the quantitative data, the present national sanitation policy and strategies (NSPS) of Rwanda that was launched in March 2017 were analysed and studied. The data were evaluated to come up with practical policy interventions in order to strengthen the existed policy in terms of effectiveness and sustainability. This study also encompasses secondary data where various research papers were reviewed focusing on the City of Kigali regarding sanitation systems and general urban wastewater management systems applied including their failures and challenges, in order to link the problems to the ruling sanitation policy. The primary data used included the collected data about individual onsite treatment system used as provided by Rwanda national Integrated Household Living Conditions Survey, EICV4 [15].

## 3. RESULTS AND DISCUSSION

### 3.1. Overview of Sanitation Status and Municipal Wastewater Treatment Systems

Rwanda as a country has achieved Millennium Development Goals particularly goal no. 7 article 3. The proportion of population using an improved sanitation facility was 83.4% in 2014, which was beyond the MDG target of 72.5%. The majority of Rwandese relies on the affordable on-site sanitation systems, 65% of which are proven to be improved sanitation facilities in accordance according to the international standards in the MDGs [23]. Installed flush toilets are rare in Rwanda as a country, which means water is mainly used for washing and cooking and then finally discharged into the surface, whereas excreta is discharged or managed openly in waterless latrines [23]. The proportion of households with access to improved sanitation in the City of Kigali increased from 83.3% in 2010-2011 to 93.2% in 2013-2014 with a significant improvement in all poorest quantiles based on EICV3 of 2012 and EICV4 of 2016 [15, 22]. No installed sewerage systems in the densely populated urban areas of Rwanda including Kigali city except, except for few developed sewerage systems constructed or installed by estate developers (Cluster of houses) for small communities of high-income household levels in Kigali city which are about 1,000 in total. In addition, there are some semi-centralized sewerage systems that were developed by business

owners in some public areas like hospitals, hotels, and governmental institutions based on governmental regulations [17, 23].

The access to improved sanitation in Rwanda is highlighted in Rwanda EICV4 Thematic report utilities and amenities approved in March 2016 are presented in Table 1 [15].

**Table-1. Access to Improved Sanitation**

EICV4	% Improved sanitation	% improved but not shared	Flush toilet	Pit latrine with solid slab	Pit latrine without solid slab	No toilet facility
			% improved sanitation		% unimproved sanitation	
Rwanda	83.4	63.5	1.8	81.6	13.5	3.2

Source: NISR [15].

### 3.2. Preface on Rwanda National Sanitation Policy and Strategies of 2016

The national sanitation policy was been developed to ensure the appropriate implementation of sanitation activities in order to make sure that the access to sanitation services will be extended in a safe and sustainable manner. It is clearly specified that the access to sustainable services will be achieved through the creation of sanitation services centres and activities at district levels that provide technology and expertise in sanitation sub-sector and work on improving services for operation and maintenance of the sanitation amenities.

Though the government considered both national and international flagships for community development and committed to cooperate to achieve the sustainable development goals of 2030 (SDGs). The separate sanitation policy document was developed in the context of avoiding the situations where the sanitation sub-sector was abandoned or just seen as an accompaniment to water supply by providing controlling principles for all aspects of sanitation including liquid wastes, solid wastes, hygiene, industrial waste, health-care waste, nuclear waste, and e-waste. All these inspirations and needs could be based on developing national sanitation policy and strategies (NSPS) from the existed national water supply policy and strategies (NWSPS) to ensure meeting safe and sustainable wastewater treatment systems. However, this might bring uncertainties about whether the entirely developed NSPS will address the effective management and operation of wastewater treatment systems (WWTS's) either for individuals or for small communities in the densely populated municipalities specifically Kigali city.

### 3.3. Review and Evaluation of Rwanda National Sanitation Policy

The national sanitation policy of 2016 has seven parts. However, this paper evaluated four of them that address safe and sustainable municipal wastewater treatment systems (WWTS's). These intervened four parts were: policy scope and definitions, addressed sanitation sub-sector issues and concerns, policy principles, and policy directions. For example, the policy directions part had some implementation gaps precisely in its objectives and some sub-objectives. These gaps have been addressed and some modifications have been suggested in this paper.

#### 3.3.1. Policy Scope and Definitions

The policy describes the meanings of ten concepts that impacted the design of strategies and policy including "Coverage and access to safe sanitation", which addresses how sustainable WWTSs, whether for household or community, must operate. The definition goes beyond the sanitation indicators for coverage and access to safe basic sanitation (ability to get and use affordable services) in reflection of the country's flagships (EDPRS 2 & VISION 2020) but also clarifies the need for safety conditions of both on- or off-site treatment and disposal of sludge and wastewater at household and community levels. These systems should have sufficient affordable services and resource-oriented solutions in compliance with the environmental standards.

The policy delimited this definition as a practical tool for monitoring purpose to follow the sustainable development goals (SDGs).

### 3.3.2. Addressed Sanitation Sub-Sector Issues and Concerns

Lack of safe improved sanitary amenities, inadequate provision of excreta disposal services and management of liquid waste are among the key issues that were highlighted by the sanitation policy to hinder the sustainable development in terms of economic development and poverty reduction. However, the policy safeguards sustainable and affordable access to safe sanitation for all Rwandans in its vision as a contribution to address the highlighted issues including environmental protection.

### 3.3.3. Sanitation Policy Principles

The principles demonstrate the roles of government in managing the wastewater for small communities as to invest and operate or delegate collective sanitation services and facilities as well as sanitation institutional, sewerage systems, and treatment plants for wastewater are concerned.

The policy involves 13 principles, for example, “*water and sanitation hygiene services*”, and “*water resources and environmental protection*” illustrate the suitability for sludge and wastewater collection, treatment and disposal that shall be managed to maximize public health and to reduce environmental impacts while ensuring water resources safety.

### 3.4. Policy Interventions and Proposed Changes

Different justifications that create difficulties and confusions in organizing the sanitation sector in the sanitation policy were identified under this part, especially those complications that seemed to reduce the political will and the sense of engagement responsibility in developing and management of safe, reliable, improved and sustainable wastewater treatment systems.

Objective 7.1 of the current policy: The objective mentions the promotion approaches for improving individual behaviour change to attain household sanitation coverage by enhancing the need for sanitation using mutual measures. It also provides the essence for developing capacities of private sector as one of the strategies to develop and demonstrate number of individual sanitation technologies for improved sanitation. However, according to the sanitation sub-sector status in Rwanda that has been highlighted in this national policy; a great number of populations are dependent on improved on-site sanitation systems.

In addition, the introductory statements under this objective 7.1 itself declares that on-site systems “*will remain the sanitary solution*” for the majority of households in Rwanda to reach the general coverage objective while showing a need for availability and design of modern individual sanitation. Furthermore, one of the addressed key issues and concerns in this policy is the lack of safe improved sanitary amenities.

In this regard, faecal sludge management (FSM) practices such as collection and treatment efficiency, benefit-cost proportional, and social satisfaction must be fully and clearly developed with their responsible indicators. Therefore, all these factors specified by the policy and different researches provides inspirations to change the stated objective for enhancing safe and sustainable individual sanitation as follows.

Proposed objective 7.1: Raise and sustain safe and sustainable household sanitation coverage to 100 per cent by 2020. Further interventions have also been suggested not only from the main objective 7.1 but also from its sub objectives,

In regard to how the objective 7.1.1 of the current sanitation policy has been stated and detailed, there is a need to describe under this policy objective how the faecal sludge will be managed to intensify sustainable individual sanitation. It is in this regard that off-site individual sanitation (Faecal sludge management) can be considered as part of sub-objective (As objective 7.1.5) such as;

Proposed Objective 7.1.5: Provide safe and affordable well controlled off-site individual sanitation services for densely populated areas.

Off-site individual services must be restricted for areas with no sewerage systems to meet environmental standards for protection of human health and the environment.

The off-site individual services associates with infrastructure components (Preferably faecal sludge treatment plants) and service functions which comprises of sludge collection, transport, and treatment for proper sludge management and disposal in environmentally friendly manner to avoid increased risks of public health and water resources.

Objective 7.3: The objective 7.3 of sanitation policy gives insights on safely off-site sanitation services to be developed for densely populated areas. However, it leaves behind the fact that the city as a whole is densely populated and inhabited by different income community levels who can even afford different sewerage technology systems. From its point view, the objective demonstrates that such sewerage systems are developed in all areas specified which is not the reality but rather developed in some specific small communities within the city.

Proposed Objective 7.3: “Develop safe, well-regulated and affordable off-site sanitation services for small communities within the densely populated areas”. Further modifications have been also identified under the same above reviewed objective 7.3 of the present sanitation policy, this objective describes the services to be provided for off-site sanitation including off-site collection infrastructure elements as well as service functions.

When man looks at the main intention for development of this objective 7.3, it specifically favours and benefits off-site collective services than off-site individual services especially in its first paragraph that gives insights on conditions to be based on for a community to be given off-site collective sewerage services.

So, the second paragraph tried to bring-in off-site individual sanitation in a situation that makes it recognized as an add-on to off-site collective sanitation services and this can lead to negligence of providing such individual off-site service functions.

It is in that context that the off-site individual sanitation (faecal sludge management) services have been proposed to be fully addressed under objective 7.1 and this brought up a suggestion to change and ignore off-site individual related services in objective 7.3 and 7.3.1 as proposed below;

Proposed 2nd Paragraph of objective 7.3: “Off-site collective sanitation services combine infrastructure elements (e.g., sewerage systems, treatment plants) as well as service functions that involve public and private actors and different sectors (infrastructure, environmental health and environment) following the developed adequate institutional interfaces and regulations”.

Proposed objective 7.3.1: “Establish an effective regulatory and institutional framework for collective sewerage”.

Last but not least, to facilitate the appropriate disposal and reuse of the wastewaters for various purposes including among others environmental sustainability and public health safety, the safe developed off-site infrastructures particularly treatment plants need to be managed and monitored for their treated wastewater at each plant unit.

The objective 7.3 does not provide a clarification on how treatment infrastructures will be monitored in a safe and affordable manner. Considering also the best use of wastewater management, the objective situates a gap in the policy hence a need to create additional sub-objective that may be named objective 7.3.2 and then others follow as proposed below;

Proposed objective 7.3.2: Implement improved management and monitoring system programs for collective sewerage systems.

The sustainability of decentralized wastewater treatment plant systems subjects to technology selection and operation monitoring programs of the plant for its treated wastewater.

Adequate management and monitoring programs for any collective sewerage systems of any community size must be regulated at each wastewater treatment unit to ensure the effective (Active and real time) control the public

health and environmental risks while taking advantage on the flexibilities of manageability and competence of the systems [24].

#### 4. CONCLUSION

Rwanda as a country has ambitious targets with good strategies to sustain the improved access of both household and collective sanitation coverage, and this has been proven by achieving the MDG no 7 of 2015. However, it doesn't make sense to have 100% coverage of improved sanitation facilities that are not sustainable and safe for public health and environment because in return, whether directly or indirectly, these facilities and poor practices of wastewater and excreta disposal will generate both health and environmental costs hence limitations in economic development and poverty reductions. Therefore, the sustainability of municipal wastewater treatment systems (WWTS's) in populated areas of developing countries like Kigali city, requires sustainable sanitation policy focusing on different wastewater management practices including storm water management among others. This can be achieved based on the comprehensive development and management aspects of both on-site and off-site sanitation systems by sustainable regulations and the use of best available technology. In this regard, local authorities should play its roles in advising, monitoring and giving guidelines for such kind of systems.

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#### REFERENCES

- [1] O. B. Akpor, "Wastewater effluent discharge: Effects and treatment processes," presented at the 3rd International Conference on Chemical, Biological and Environmental Engineering IPCBEE, IACSIT Press, Singapore, 2011.
- [2] UNESCAP, "United Nations economic and social commission for asia and the pacific," Joint Programme. Policy Guidance Manual on Wastewater Management with a Special Emphasis on Decentralized Wastewater Treatment Systems. Bangkok2015.
- [3] K. A. Mourad, J. C. Berndtsson, and R. Berndtsson, "Potential fresh water saving using greywater in toilet flushing in Syria," *Journal of Environmental Management*, vol. 92, pp. 2447-2453, 2011. Available at: <https://doi.org/10.1016/j.jenvman.2011.05.004>.
- [4] K. A. Mourad, "Marginal and virtual water for sustainable water resources management in Syria," Academic Thesis Submitted in Partial Fulfilment of the Requirements for the Degree of Doctor of Philosophy (Ph.D. Engineering, Lund University), 2012.
- [5] B. Gutterer, L. Sasse, T. Panzerbieter, and T. Reckerzügel, "WEDC, loughborough University, UK in association with BORDA, Germany. Decentralized Wastewater Treatment Systems (Decentralized Wastewater Treatment Systems) and Sanitation in Developing Countries. Available from: [https://wedc-knowledge.lboro.ac.uk/resources/books/DEWATS\\_-\\_Chapter\\_01.pdf](https://wedc-knowledge.lboro.ac.uk/resources/books/DEWATS_-_Chapter_01.pdf)," 2009.
- [6] UNESCO, "Managing water under uncertainty and risk, United Nations educational, scientific and cultural organization," The United Nations World Water Development Report 4, Paris2012.
- [7] A. S. Kazora, T. Bizuhoraho, and K. A. Mourad, "Improving faecal sludge management system for sustainable sanitation, Rwanda," *SciFed Biotech & Bioengineering Journal*, vol. 1, pp. 1-10, 2018.
- [8] J. Aboniyo and K. A. Mourad, "Role of community based organization in transferring climate change information in Rwanda," *Research Journal of Environmental Sciences*, vol. 11, pp. 156-169, 2017. Available at: <https://doi.org/10.3923/rjes.2017.156.169>.
- [9] T. Bizuhoraho, A. Kayiranga, and N. Manirakiza, "The effect of land use systems on soil properties; A case study from Rwanda," *Sustainable Agriculture Research*, vol. 7, pp. 30-40, 2018. Available at: <https://doi.org/10.5539/sar.v7n2p30>.



- [10] UN, The Sustainable Development Goals Report, United Nations Report 2016.
- [11] National Institute of Statistics Rwanda, "Republic of Rwanda, Integrated Household Living Conditions Survey (EICV3), Thematic Report - Utilities and Amenities," 2012.
- [12] A. S. Kazora and K. A. Mourad, "Assessing the sustainability of decentralized wastewater treatment systems in Rwanda," *Sustainability*, vol. 10, pp. 1-15, 2018. Available at: <https://doi.org/10.3390/su10124617>.
- [13] U. Alice, Y. Ming, U. Nestor, N. Donath, and N. Narcisse, "Liquid wastes treatment and disposal in Rwanda," *Journal of Pollution Effects & Control*, vol. 5, pp. 1-5, 2017. Available at: <https://doi.org/10.4172/2375-4397.1000197>.
- [14] M. F. A. Umuhoza, I. Nhapi, U. G. Wali, and N. Banadda, "Assessment of wastewater management practices in Kigali City, Rwanda," *The Open Environmental & Biological Monitoring Journal*, vol. 3, pp. 21-28, 2010.
- [15] NISR, "National institute of statistics Rwanda (NISR)," Republic of Rwanda, Integrated Household Living Conditions Survey (EICV4, Integral Survey on Household Living Conditions) Thematic Report - Utilities and Amenities, March 2016.
- [16] HPCIDBC, "Status and strategy for faecal sludge management in the Kathmandu Valley," High Powered Committee for Integrated Development of the Bagmati Civilization, Kathmandu, Nepal 2011.
- [17] J. B. Akumuntu, U. Wehnb, M. Mulenga, and D. Brdjanovic, "Enabling the sustainable Faecal Sludge management service delivery chain—a case study of dense settlements in Kigali, Rwanda," *International Journal of Hygiene and Environmental Health*, vol. 220, pp. 960-973, 2017. Available at: <https://doi.org/10.1016/j.ijheh.2017.05.001>.
- [18] WASAC, *Report on sanitation status in Rwanda*. Kigali Rwanda: Water and Sanitation Corporation Ltd, 2017.
- [19] A. Tsinda, P. Abbott, S. Pedley, K. Charles, J. Adogo, K. Okurut, and J. Chenoweth, "Challenges to achieving sustainable sanitation in informal settlements of Kigali, Rwanda," *International Journal of Environmental Research and Public Health*, vol. 10, pp. 6939-6954, 2013. Available at: <https://doi.org/10.3390/ijerph10126939>.
- [20] OAG, *Performance audit report on management of solid and liquid (sewage) waste in city of Kigali*. Rwanda: Office of the Auditor General of State Finances, 2016.
- [21] J. D. Bazimenyera and C. Gatete, "Impact of households' wastewater management on the environment," *East African Journal of Science and Technology*, vol. 6, pp. 64-73, 2016.
- [22] NISR, *National sanitation policy, ministry of environment*. Islamabad, Pakistan: Government of the Islamic Republic of Pakistan, 2016.
- [23] MININFRA, *National sanitation policy and strategies (NSPS)*. Kigali: Republic of Rwanda, Ministry of Infrastructures (MININFRA), 2016.
- [24] Jordan WWMS Policy, *Decentralized wastewater management policy*. Jordan: Ministry of Water and Irrigation, 2016.

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