

Liquid Wastes Treatment and Disposal in Rwanda

Alice U^{1*}, Ming Y¹, Nestor U², Donath N³ and Narcisse N³

¹Department of Environmental and Natural Resources Protection Law, China

²Department of Chemical Physics, Ocean University of China, Shandong Sheng, China

³University of Science and Technology of China, Hefei Shi, China

Abstract

Rwanda country is located in east part of Africa, and its population is about 10 million. Because of the pressure on limited resources produced by growing number population day by day, nowadays Rwanda is facing serious issues related to the environmental protection. The government puts more effort in searching of new rules and strategies of how to sustain the environment. The core of this research is to review a comprehensive picture of liquid wastes and disposal in Rwanda and to make recommendations for their improvement. It is important to note that some Articles set by the good Government will be listed in this review paper. The first part of this work contains introduction, the second part covers specific issues and legal responses, In part three some recommendations are presented and the last section concludes this work.

Keywords: Rwanda; Liquid waste treatment; Environmental protection; Environment impact assessment

Introduction

To achieve the vision of 2020, the Government of Rwanda has put more efforts in waste management area. The rural and urban areas are to have sufficient sewerage and disposal systems by 2020. Each town is to be endowed with an adequate unit for treating solid wastes. Households will have mastered and be practicing measures of hygiene and waste disposal.

The foundation of Kigali city started in 1907 as a small colonial outpost initially it was supposed to be inhabited by at least 300,000 people and nowadays, Kigali is occupied by 1,132,683 citizens. Kigali City has never had any clear Master plan to reorganize the planning and resettlement. Since the colonial era, in spite of the rapid and ever increasing numbers of inhabitants. This has exerted strenuous pressure on the infrastructure which has resulted in many complex problems regarding settlement notably solid and liquid waste management. Sanitation and solid and liquid waste management in Kigali Municipality is a colossal challenge that is manifested. Waste management involves solid, liquid, and gaseous substances, with different methods and fields of expertise for each. Waste management practices differ for rural, small town, urban or industrial producers. Generally, there are 7 phases through which waste passes in the waste stream: Prevention/generation/Recycle, Reuse and Recover/collection/transport and export/treatment and disposal/contaminated sites and finally illegal dumping. In fact, waste policy and management system include all the stages in the waste stream [1,2].

Solid, hazardous and radioactive wastes are considered as the main kinds of wastes. Solid waste is often called non-hazardous waste. Waste in the form of powders, liquids, and gases is reported as hazardous regardless of its toxic properties because it needs special handling to avoid unwanted dispersal. Thus, all waste that is not included under the classification of hazardous may be classified into solid. Although not considered hazardous, solid waste can cause considerable harm and damage, and may lead to diseases and air pollution and the poisoning of water sources for people and animals. According to the origin of the Solid Waste (SW), we have SW which is the garbage that are produced by people in their homes and where they work. Usually, SW refers to what we throw away each day in our cities and towns such as old appliances, household garbage and just about anything you can think of that people throw away at home, schools, and businesses.

Kigali city has only one landfill located at North East of Kigali at Gasabo District, Nduba Hill at Muremure cell at 10 Km from Kigali Center. The dumpsite in Kigali receives about 400 tons per day of solid, not sorted waste or 140,000 tons per year. Even though, all waste collected in Kigali City are brought to Nduba landfill according to Kigali state of environment 2013, a big part of Kigali city doesn't have collection system [3].

Capital city (Kigali) being the source of the solid and liquid waste collected and transported and deposited to Nduba landfill, is also an overpopulated city compared to other cities of the country. This shows there is significant quantity of solid and liquid waste produced because of that increasing population and businesses. City of Kigali (CoK) is in charge of the management of solid liquid waste (SLW), of course collaborating with contracted private firms that collect solid and liquid waste and transport them at Nduba Landfill [4]. These companies are listed hereafter; COPED, COCEN, KPC General Services, CESCO Masaka, ROYAL Company Ltd., AGRUNI, Real Environmental Protection, UBUMWE Cleaning Services Ltd, INZIRA NZIZA CO Ltd, NEW LIFE NT& MV Ltd, BA HEZA General Services, ISUKU KINYINYA, UMURIMO MWIZA Ltd, KIGALI SEPTIC Services Ltd, INDATWA Gitega Cooperative, KANGUKA Business Company Ltd and HAKIZIMANA Babu.

Regulations and guidelines made by MINIRENA-REMA, RURA, CoK and MININFRA govern waste management and are followed while complying with the environmental laws. CoK has to monitor and follow all processes regarding the MSLW.

The inadequacies in liquid waste treatments systems can lead to deterioration of the environmental quality as well as the water borne diseases such as diarrhea, cholera and so on. Liquid waste management

*Corresponding author: Uwajambo Alice, Department of Environmental and Natural Resources Protection Law, China, Tel: +8615656576310; E-mail: uwajamboalice@gmail.com

Received June 22, 2017; Accepted August 11, 2017; Published August 14, 2017

Citation: Alice U, Ming Y, Nestor U, Donath N, Narcisse N (2017) Liquid Wastes Treatment and Disposal in Rwanda. J Pollut Eff Cont 5: 197. doi: 10.4176/2375-4397.1000197

Copyright: © 2017 Alice U, et al. 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.

is increasingly becoming one of the major social and environmental challenges in most of developing countries including Rwanda. Some of the factors are rapid population growth, urbanization and increased demand towards industrial development and limited resources to cater for the growing quantity and pollutants of liquid waste generated [2].

Some evidences explaining the poor management of liquid wastes as well as solid wastes in Rwanda were reported in 2016 by the office of the Auditor General of State Finances, Rwanda after visiting one of the dumping sites called Nduba located around the capital city KIGALI. Those evidences are the following:

Inappropriate solid and liquid waste disposal

The system of collection in pits does not give a fair and sustainable solution as many pits are required to accommodate that liquid waste. At the time of the audit (April 2016), 3 pits were already full and they were digging a fourth one. These pits are located on the top of the hill and if it rains heavily, they are likely to overflow and spread into the neighborhood and contaminate water and crops [3-6]. This leads to spread of disease to the neighboring population.

Lack of sustainable management system for solid and liquid waste

For the liquid waste (sewage), there is no system to receive and treat the sewage emptied from septic tanks from different parts of the City. They are deposited into pits at Nduba site and as of today they have become like small lakes (ponds) of sewage. Disposal methods used at Nduba still expose City of Kigali to the environmental and health hazards.

Even though liquid wastes are considered as environmental pollutants, many literatures indicated that they can contribute to the development of the country if managed in sustainable manner in terms of heat generation by utilizing the calorific energy value of the sludge or, by utilizing useful constituents such as carbon and nutrients (example: agriculture use or extracting useful constituents from the sludge (example: extraction of phosphorus). Lack of clear and specific legal and institutional regulations or framework on solid and liquid waste management to serve as a back bone of the entire management of the said wastes which could have resulted in proper management of the same. Rwanda has no clear and specific Act or law to deal with solid and liquid wastes, and for many years those wastes were just treated as nothing of a great importance and as such, were always damped in pits and small holes, some found within residential homes and or areas. Institutions also were paying less attention on the issue and this increased the problem and decreased the awareness on the society about how to manage and prevent solid and liquid wastes pollution, and on the effects of mismanagement of the same.

Specific Issues and Legal Response

Considering the need of having regulatory tools so as to improve the delivery of sanitation services in terms of liquid waste management at large, RURA (Rwanda Utilities Regulatory Agency) has developed the guidelines which are the directives for the minimum requirement for liquid wastes treatment and disposal or management generally. These directives are giving or providing some potential guidelines in terms of the following:

Transportation issues

The directives provides for the companies, cooperatives or individual who want to engage in the business of managing liquid wastes

to fulfill the requirement that the vehicles, tanks or tankers employed to transport hazardous waste shall not be employed to transport liquid domestic waste as they state clearly under Article 5 and article 6 of the which require these persons and or organizations to have vehicles to transport the wastes collected. The ownership of the vehicle(s) is not of much importance as it can be owned by any responsible individual or even rent it from someone else. If it is a rented vehicle, should show the renting contract for at least one year. This requirement is approved during the registration of being recognized by RURA and during the application for the permit before starting the business [7,8].

The guidelines regarding transportation of liquid wastes is also clearly stated to meet the safety challenges as without them the liquid wastes collected could be transported unsafely by using any kind of vehicles, tanks or tankers which can even cause some accidents by spreading the wastes anywhere in the road. On this particular issue, it is very important to focus on the standards for vehicles and other devices used in liquid waste collection and transportation. The directives continue to cement that any vehicle or device used in liquid waste collection and transportation including septic waste collection shall comply with the following requirements which are: Wasted contained control requirement which requires all liquid wastes to be contained in controlled area such as a portable tank, sound and leak free requirement which requires all the containment devices to be of structurally sound and leak free, the requirement on the fact that all the containment devices must be of sufficient quantity or volume to completely contain the liquid wastes generated, and the requirement which requires all the containment areas or devices not to be located where accidental release of contained liquid can threaten health or safety or discharge to water bodies, channels, or storm drains.

By making these directives, RURA can be sure that liquid wastes are being transported in the manner which can't cause any risk to the environment and its surrounding living organisms including Flora and Fauna.

Treatment issues

The treatment process can lead to many issues if no attention is paid to considering that all variety of liquid wastes are collected from different place so their compositions are also different, reason why rural has established the obligation of treatment of liquid waste under article 11 which states that "The treatment of liquid waste is the obligation of all other parties that may perform activities that degrade the environment and those are: Industries, commercial buildings, prisons, hospitals, hotels, schools, population, slaughter houses, garages and etc." and again that "The treated wastewater shall comply with effluent standards as illustrated in article 19 and article 20 of these Directives". Treatment and separation of liquid wastes is very rare, the guidelines mentioned here above can help in one way but also sometimes can't work properly because of many reasons like the lack of economic capacity for some institutions such as schools, small private hospitals,... the other reason is the lack of awareness by the people who are may be the owners of the commercial buildings or the garages and so on, treatment of liquid wastes is not a necessary and emergency case for them because they can even discharge these wastes in the public canals which are normally designed for carrying rain water from homes, they don't care about whether the liquid wastes can harm the environment as well as human beings around them. Accordingly we can't say that is totally impossible to implement this guideline, whatever how much peoples are poor or careless, the source of failing is in the monitoring institution who could know how to implement the enacted provision according to the living standards of the people or provide some facilities which can

motivate them for the treatment of liquid wastes because sometimes the challenge can be the lack of knowledge about how to treat the liquid wastes or about how worst and dangerous that these wastes are and their impacts to the environment and human beings. For this provision to be effective, RURA should impose these institutions listed above (industries, hospitals, garages,.....) to have a person or team of persons who are in charge of controlling and reporting regularly how the liquid wastes are being managed and if there are some challenges that they are facing, they can include them in their report, so with that the flow of information can make possible and easier the activities of treating liquid wastes [9].

Discharge standards issues

Discharge issue is on various dimensions whereas; article 18 is categorically dealing with the discharge of domestic and industrial liquid waste to sanitary sewers, and it states that “No person shall discharge or deposit or cause or permit the discharge or deposit of matter of a kind listed below into or in land drainage works, private branch drains or connections to any sanitary sewer or combined sewer”. The article further continues to state that “Without limiting the generality of the foregoing, any of the following: solid or viscous substances in quantities or of such size as to be capable of causing obstruction to the flow in a sewer, including but not limited to ashes, bones, cinders, sand, mud, straw, shavings, metal, glass, rags, feathers, tar, plastics, wood, ungrounded garbage, animal guts or tissues, paunch manure, and whole blood; sewage that may cause an offensive odour to emanate from a sewage works, and without limiting the generality of the foregoing, sewage containing hydrogen sulphide, carbon disulphide, other reduced sulphur compounds, amines or ammonia in such quantity that may cause an offensive odour; water other than storm water that has originated from a source separate from the water distribution system of the municipality; sewage or uncontaminated water at a temperature greater than 65 degrees Celsius; sewage containing dyes or coloring materials which pass through sewage works and discolor the sewage works effluent; and the following materials or sewage containing any of the following in any amount: fuels, ignitable waste, pesticides [10].

On the other hand, article 19 is talking on tolerance limits of discharged domestic wastewater. It states among other things that these tolerance limits are applied to the physical, chemical and microbiological domestic wastewater discharged from households, business buildings, institutions etc. as it has been elaborated hereunder (Table 1) [11].

However, these data have been set as the discharge standards but there is no technical or scientific method established to test whether the standards are matching as required or whether they are below or exceeding the standards and it is impossible to prove the scientific results without doing laboratory tests, so the standards given are meaningless about controlling the discharge standards of liquid wastes in Rwanda if they can't be proved. The inefficient of these two guidelines (art. 18 and art. 19) is not only about the lack of specification of the scientific methods to be used but also they are not updated. According to their source, it shows that they were published in 1992 and until today they are still in use without being updated [3,4].

Likewise, article 20 is also talking on tolerance limits of discharged industrial wastewater, and it states inter alia that these limits are applied to the physical, chemical and microbiological wastewater that results from industrial processes and manufacturing (Tables 2-4) [12,13].

Like for articles 18 and art. 19, here article 20 was also talking about discharge standards and their related data were mentioned but RURA didn't say anything about either national laboratory or institutional

Parameter	limits
TDS mg/l	≤1500
TSS mg/l	≤50
pH	5.0-9.0
Total Nitrogen mg/l	≤30
Nitrite mg/l	≤2
Ammonium mg/l	≤5
Total phosphorus	≤5
Temperature variation of treated water compare to ambient temperature of water	≤3
BOD5 mg/l	≤50
COD mg/l	≤400
Coli forms number/100ml	≤400
Oil and Grease mg/l	≤10
Chlorine mg/l	≤2
Sulfate mg/l	≤500
Color TCU	50
Turbidity NTU	30

Table 1: Tolerance limits of discharged domestic wastewater [11].

Physical and microbiological requirements		
Determinants	Units	Upper limit and ranges
Temperature increase	°C	3 (variation)
pH	-	6.0-9.0
Dissolved oxygen (min)	%sat	60
BOD5 (max)	mg/l à 20°C	50
COD (max)	mg/l	250
Oil and Grease	Mg/l	10
Colour	TCU	50
Turbidity	NTU	30
Total Dissolved Solids (TDS)	mg/l	2000
Total Suspended Solids (TSS)	mg/l	50
Faecal coliform	Counts/100 ml	1000
Coliforms	Number/100 ml	400

Table 2: Tolerance limits of discharged industrial wastewater (Physical and microbiological requirements) [12].

Chemical requirements-Micro determinants	
Determinants in mg/l	Upper limit and ranges
Free and saline ammonia (as N)	50
Ortho phosphate (as P) or soluble phosphate	1.5
Phenol	2
Calcium as Ca	500
Chloride as Cl	600
Chlorine residual	1
Fluoride as F	1.5
Potassium as K	100
Sodium as Na	400
Sulphate as SO ₄	400
Sulphide	1.0
Zinc as Zn	5.0

Table 3: Tolerance limits of discharged industrial wastewater (Chemical requirements-Macro determinants) [13].

laboratories which can be used to prove the measures called discharge standards. Unlike for the two previous, this provisions is supposed to be very stringent with clear specification because it is concerned to the discharge standards of the liquid from industries and we all know that industrial wastes are much and highly dangerous.

Usually discharge standards are established to control the extent to which industries must reduce to the minimum the quantity of wastes

Chemical requirements-Micro determinants	
Determinants in mg/l, unless otherwise stated	Upper limit and ranges
Arsenic as A	0.01
Benzine mg/l	0.00
Boron as B	0.5
Cadmium as cd	0.01
Chromium total (Cr)	0.05
Chromium as Cr (total)	0.5
Cobalt as Co	1
Copper as Cu	3
Cyanide as CN	0.1
Iron as Fe	3.5
Lead as Pb	0.1
Manganese as Mn	0.1
Mercury as Hg (total)	0.002
Nickel as Ni	2
Selenium as S	0.02

Table 4: Tolerance limits of discharged industrial wastewater (Chemical requirements-Micro determinants).

they produce. Rwanda as a developing country with fewer industries should not deny the discharge standards issues because even these fewer industries if not well controlled, they can put a whole country in danger by their wastes either liquids or solids.

Disposal issues

The last and very important stage in the wastes management process is their disposal which must be done in environmentally sound manner. As we have already discussed before in Rwanda, management of liquid wastes is in the hands of private companies, but also the government developed the guidelines about how disposal activities should be done (art. 13). This article states that “Any liquid waste, especially from hospitals, dispensaries and clinics, industries and any other dangerous liquid waste, must be collected, treated and changed in a manner that does not degrade the environment in order to prevent, eliminate or reduce their adverse effects on human health, natural resources, flora and fauna and on the nature of the environment” and again some exception is about the disposal of domestic liquid wastes as stated that “Domestic Liquid waste is not usually an extreme environmental hazard unless discharged in a manner where it can impact surface water or shallow groundwater. With proper application, domestic liquid waste can be a resource (fertilizer, source of moisture) rather than becoming a pollutant. Domestic liquid waste should be disposed of properly following the appropriate standards for effluent disposal. Even though the guidelines have been established but the problem is still happening like in the case of Nduba dumping site mentioned before in this paper, so the government has much to do about controlling the disposal process in order to be sure that the companies or individuals are complying with this guideline. The other challenge which can be the main source of disposal issues is that the companies, cooperatives or individuals in charge of liquid wastes management must find by themselves the place where to create the dumping site, so it could be better if the government takes this responsibility of choosing the places to be reserved for creating dumping sites [14].

Inspection issues

Inspection system can be a big issue and can lead to many challenges if not well organized. In the management of liquid wastes in Rwanda, article 29 has been provided as it states that “The regulatory authority has the right to inspect the service provision by the licensee at any time during working hours and he/she has to cooperate with inspectors and

provide all relevant documents as requested”. This guideline is not quite effective like here said that “The inspector has to cooperate with the licensee” it could specify that “The inspection will be done by visiting the dumping sites” because having all documents for the licensee, it doesn’t implicate that the activities are being done perfectly. Regular inspection is one of the good way to evaluate whether the laws or regulations are effective to solve the problem or if not it can be a source of information to know where is the weakness, then according to that the policy makers can either change the implementation strategies or revise the laws [15].

Reporting issues

Based on the article 28 of these directives, it talk about reporting for the licensee engaged in the liquid wastes management as it states that the licensee should submit to the regulatory authority an annual report highlighting technical aspects as well as the financial statements. The service provider shall follow the reporting format provided by the regulatory authority and the annual report must be submitted not later than 31 March of each year. Accordingly, reporting which is done once per year couldn’t give true information, it is only to prove whether the documents are fulfilling the requirements or not, which is helpless for solving the problem. For the activity like waste management, Reporting should be done regularly with the purpose for RURA to evaluate whether liquid wastes management activities are being done in effective way which is relevant with the environmental protection [6].

Penalty issues

Actually, penalties are not established with the purpose of doing business for the government or giving trouble to the people, their purpose is like a preventive mechanism. If the punishment or a fine is too much low (flexible), the people won’t be afraid of being punished so it can’t work for preventing the mistakes or solving the problem. Considering the penalties established by RURA under the article 24, it states that “Discharge of liquid waste that may have harmful effects on the environment (not in compliance with effluent disposal standards) is punished by one of the following [10,16,17]:

1. Suspension of his or her activities from 3 to 6 months and/ or to pay a fine ranging from one million (1,000,000) to ten million (10,000,000) Rwandan francs, or Closure of his or her business.
2. Anyone who transports, dumps or treats without authorization, any liquid waste that is subject to prior authorization provided for by these directives is punished by a fine ranging from five hundred thousand Rwandan francs (500,000) to two millions (2,000,000) Rwandan francs.
3. Anyone who pollutes inland water masses by dumping, spilling or depositing chemicals of any nature that may cause or increase water pollution is punished by a fine ranging from two million (2,000,000) to five million (5,000,000) Rwandan francs.
4. Any person who deposits, pours sewage in an unapproved place, is punished by a fine ranging from fifty thousand (50,000) to five hundred thousand (500,000) Rwandan francs.

Here, Rwandan franc is approximately equal to 700 U.S dollars. So 50,000 Rwandan francs is approximately 71.4 U.S dollars. In reality, these fines are too much flexible comparing to the mistakes or the impacts that these mistakes can pose to the environment and its surroundings and if it comes about their role as preventive mechanism, they can be a source of increasing pollution other than prevention.

Recommendations

All recommendations mentioned here are focusing on the on the gaps or weaknesses of these guidelines. RURA should revise these guidelines in such away:

1. Transpiration means can be updated; it means they could impose the use of advanced technology for transporting liquid wastes other than using vehicles.

2. The technology about treatment of liquid wastes should be specific and the monitoring system should be improved in different institutions.

3. Discharge standards must be based on the scientific data. It should be an obligation for the industries to have laboratories which can be used to prove whether their discharge standards are proportional to those required.

4. The government should be responsible for deciding where to create dumping sites, and also should start to use some liquid wastes as a sources of income, for example to use them as a source of energy like biogas from domestic wastes, use them as fertilizers.

5. The inspection and reporting should be done regularly, so RURA must have a team of persons who are responsible of doing inspection and provide the reports.

6. The penalties should be increased to the extent of being a preventive mechanism.

7. The polluter pay principle should be applied in order to minimize the quantity of waste generated.

Conclusion

Although, making an appropriate law and choosing advanced technology is not an easy task, but it could reduce the risk of future problems and failures. Liquid waste treatment and disposal practices should be site specific, accounting for social, cultural, environmental and economic conditions in the target area. Some of the guidelines regulating liquid wastes management are well and clearly developed but their effectiveness is determined by good implementation and enforcement. The gaps mentioned also ought to be bridged by urgently

formulating an effective law and consolidating the institutional arrangements as a framework for addressing the challenges facing the sub-sector.

References

1. Ann-Sofie I, Arne B (2012) Institution building with limited resources: establishing a supreme audit institution in Rwanda. *World Dev* 40: 1870-1881.
2. Rwanda BI (2008) Rwanda utilities regulatory agency.
3. Kigali R (2013) Rwanda Environment Management Authority (REMA).
4. Tsinda A, Abbott P, Pedley S, Charles K, Adogo J, et al. (2013) Challenges to achieving sustainable sanitation in informal settlements of Kigali, Rwanda. *Int J Environ Res Public Health* 10: 6939-6954.
5. Uwimpuhwe M, Reddy P, Barratt G, Bux F (2013) The impact of hygiene and localised treatment on the quality of drinking water in Masaka, Rwanda. *J Environ Sci Health Part A* 49: 434-440.
6. Bazimenyera JDD, Qiang F, Ntakirutimana T (2012) Assessment of the characteristics of Nyanza landfill leachate, Rwanda. *Advance Mater Res* 599: 618-621.
7. Marara M (2011) The importance of context in delivering effective EIA: case studies from East Africa. *Environ Impa Assess Rev* 31: 286-296.
8. Kabera T (2017) Environmental impact assessment in higher education institutions in East Africa: the case of Rwanda. *Environ Sci Pollut Res* 24: 7852-7864.
9. Alice J (2015) Preliminary Terms of Reference (TOR) and Environmental Impact Assessment (EIA) of geothermal exploration drilling in Bugarama, Rwanda, pp: 675-696.
10. Sano JC (2007) Urban environmental infrastructure in Kigali City Rwanda. Challenges and opportunities for modernised decentralised sanitation systems in poor neighbourhoods. Wageningen University, Wageningen, The Netherlands.
11. WHO (2006) Guidelines for wastewater reuse.
12. WHO/UNEP Environmental Program (1998) Technical Report.
13. EPA Manual (1992) Wastewater treatment/ Disposal for small communities.
14. Akumuntu JB, Wehn U, Mulenga M, Brdjanovic D (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.
15. Vergara SE, Tchobanoglous G (2012) Municipal solid waste and the environment: A global perspective. *Ann Rev Environ Resour* 37: 277-309.
16. Musabe T (2002) Environmental management in Rwanda: have the national conservation plans worked? *Organisation for social science in Eastern and Southern Africa (OSSREA)* 3: 27.
17. Ekane N (2013) Sanitation policy and practice in Rwanda: tackling the disconnect. SEI policy brief, Stockholm, Sweden.