COLLEGE OF ARTS AND SOCIAL SCIENCES

CENTER FOR CONFLICT MANAGEMENT

ASSESSING THE EFFECTIVENESS OF WASTEWATER MANAGEMENT ON THE ENVIRONMENTAL SECURITY:

A Case study of Kigali Special Economic Zone

A dissertation submitted to the University of Rwanda, in partial fulfillment of the requirement for the award of Master's Degree of Arts in Security Studies.

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Nyakinama, 15th May 2020

DECLARATION

I, Muragijimana Marie Claire, hereby declare that this thesis titled "*Assessing the Effectiveness of Wastewater Management on the Environmental Security*: *A Case Study of Kigali Special Economic Zone*" is my original work and to the best of my knowledge has not been presented to any other academic institution for any academic award except where due acknowledgement is made in this project.

Name Date

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DEDICATION

I dedicate this dissertation to my husband Mugiraneza Felix Kennedy, my daughter Ineza Masimbi Kaylee and my son Neza Rugwiro Kayden who have been patient during the period of my study. I further dedicate my dissertation to my father Ndenzaho Claver and my mother Mujawayezu Veneranda who sponsored my education and have shaped an eagerness spirit in me to learn more. Lastly, I dedicate this work to my sisters and brothers, who always give me courage to make a headway

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May God bless you All.

LIST OF ACRONYMS/ABBREVIATIONS

AIWW	: Amsterdam International Water Week
CoK	: City of Kigali
DEWATS	: Decentralized Wastewater Treatment System
EDPRS	: Economic Development and Poverty Reduction Strategy
EPA	: Environmental Impact Assessment
FGD	: Focused Group Discussion
IUWM	: Integrated Urban Water Management
IWA	: International Water Association
MDG	: Millennium Development Goals
MININFRA	: Ministry of Infrastructure
NBS	: Nature-Based Solutions
NPK	: Nitrogen, Phosphorus, And Potassium
REMA	: Rwanda Environment Management Authority
UN	: United Nations
WEFTEC	: Water Environment Federation Technical Exhibition and Conference
WERF	: Water Environment Research Foundation
WWAP	: World Assessment Program
WWTP	: Wastewater Water Treatment Plant

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ABSTRACT

The qualitative research study of assessing the effectiveness of wastewater management on the environmental security: a case study of Kigali Special Economic Zone was conducted with a view to finding the existing challenges and thereafter make viable recommendations. The increasing rate of wastewater being released in urban areas and blossoming industries world over and Rwanda in particular has led leaders to rethink on the rationale of making wastewater management a critical sector where government and urban resources are supposed to be channeled to in an endeavor destination. Some researchers have found a significant relationship between wastewater and environmental security others are still grappling with making a sharp distinction and are indeed finding both concepts in the same domain with no impact on each other.

The was done through a qualitative research design using the purposive sampling, 55 respondents from a cross section of people with knowledge on wastewater and whose daily attributes are related to wastewater management. Tools of data collection such as observation, focus group discussion and interview guide were adopted as the suitable tools of making this study appropriate and accurate. Three research questions were formulated to guide this study. The results of the wastewater management is not a new thing but policy makers have not multiplied their efforts to ensure that effective wastewater management is done well.

This study recommended among other things that Governments should ensure a central wastewater management is instituted in place to manage all wastewater related issues and it must be independent of authorities in charge of environment and solid waste and late regular environmental impact assessment should be done to inform policy makers of what is progressing well and what is inappropriate as far as handling the wastewater management is concerned.

CHAPTER ONE: GENERAL INTRODUCTION

1.0 Introduction of the study

This chapter is all about the introduction to the study, the problem statement, the objectives and the research questions, the rational and justification of the study, the scope and the structure of the study that make up the full chapter.

1.1. Background to the Study

The survival of human civilizations and settlements has been pegged on the way environment and water bionetworks are organized and preserved. They have further facilitated the fight against rain-fed agriculture, water transport, food security, treatment of water for human consumption and later facilitating habitations for biodiversity. It is noted that if this ugly development is not checked and environmental security is not guaranteed as well as constraining water resources, 45 percent of world total income and the biggest world population as well as global production shall be thrown in risky situation by 2050 and the biggest victims will be the poor or marginalized societies thereby intensifying the inequalities in the world. (UN REPORT, 2018:5).

All cities without exception are grappling with challenges of wastewater management released from those cities leading to pollution of downstream water sources either internally or beyond the particular city territory thereby fermenting impending conflicts. Several examples exist like Rhine River in Europe and River Nile in Africa. Nutrients - nitrogen, phosphorus and potassium (NPK) - are known to cause serious eutrophication issues into water-bodies hence they deserve appropriate measures. Introduction of urban farming with its related fertilize application has also worsened problems. However much this agriculture provides nutrients in wastewater, insufficient importance has been placed on this option? There is inadequate complementarity between wastewater management and urban agriculture in spite of the desire to complement each other. However, synthetic (artificial) fertilizers culminate into surplus stream of nutrient inflow into urban areas. (Nhapi. I, and Gijze, J, 2005:1)

Purification of wastewater is somehow a new phenomenon despite the fact that drainage systems of water have tested time and it started with “night soil” packed in buckets or jars on the streets and laborers deflated them into “honey-wagon” tanks. In the end they found their way to villages

to support agriculture. This hard management of wastewater led to invention of drainage to direct water into water bodies which looked dangerous towards experts through spoiling rivers. The release of waste into water courses resulted into pollution and health problems for downstream users. (Amoety, P and Bani, R, 2016;1).

It is on record that supply of water, sanitation, treatment of wastewater, drainage of water and management of solid waste has been a requirement of different cities to be provided in secluded places as services to their populations and much legislation are enacted to support and guide these activities despite the failure of urban areas to differentiate qualities of water and their uses, thereby leading to diversion of certain water for uses that are not profitable to the population. On the other hand, there has never been a serious complementarity and nexus between freshwater, wastewater, flood control and storm water. (Bahri, A, 2012:35)

The common approach that would prompt efficiency, equity and sustainable environment would be IUWM (Integrated urban water management) whereby scarce and susceptible water resources are used optimally, and equity is ensuring that all people can access water in both quality and quantity regardless of the socioeconomic status and survival, and environmental sustainability requires proper management and protection of water resources and its related ecosystems to be suitable and accessible for future populations. Therefore, with the three not coming into friction, the issue of water management or wastewater management can be guaranteed. However, the three approaches of efficiency, equity and sustainability should complement each other instead of working in isolation and this can be maintained by enactment of different legislations although they cannot be enough without mindset change. Hence to ensure, water as a state property through authorized water economy, all institutions should have permits to deal with water management or wastewater management. That can guarantee monitoring and strict enforcement to check exploitation of unequal power relations. (Bahri, A, 2012:57).

City of Kigali (CoK) is charged through the department of works and infrastructures to collect, treat, manage mud and dispose wastewater. The department must ensure management of sewerage and sanitation, transportation of wastewater, water and electricity unit as well as open spaces unit.

As a result, ten wastewater treatment facilities have been put in place to manage wastewater disposal although a small percentage of wastewater is treated for big water consumers in areas of Nyarutarama, Gacuriro and social security fund estates of Kacyiru. The unmanaged wastewater is

liquidated into septic tanks, streams, wetlands, gullies which are dangerous for future human survival and environmental sustainability especially in areas of Kajevuba, Rwampara, Gatenga and Mulindi. (Mbateye, U, etal, 2010:3).

The communities that utilize river, lakes and ground water for drinking are facing challenges from water pollution. Contaminated water can affect the food they eat through irrigation and the aquatic life is endangered. The effects of contamination of wastewater from grain milling factory in special economic zone varies from loss of aesthetics to decrease in biological health, that is manifested in many ways like loss of species diversity in the ecosystem to specific human hazards. Grain milling hazards is not pronounced so much since a few chemicals are used and dry cleaning is the order of the day. Contemporary industries apply variety of physical, chemical and biological treatment ways to cause water quality of release to acceptable levels. Organic matters are majorly released from grain mills that may not cause pronounced hazards toward the health of humans and the environment when under appropriate management. This is due to the fact that organic wastes turn into decay thereby leading to unpleasant smells and diseases later. (EIA REPORT, 2009:36)

City of Kigali covers a territory of 73,100 hectares, but the program of managing wastewater is still emerging due to the realized demand. However, treating wastewater hasn't become rampant in accordance with the demands. This means that there is high risk to environment and health standards of human beings paused by untreated wastewater. Pit latrines are commonly used to discharge excreta in the city of Kigali. On the other hand, several institutions and individuals do it treatment of wastewater on their own such as hospitals, hotels, housing estates, prisons, banks and the effectiveness of their treatment is questionable. There is also insufficient information on domestic and industrial wastewater quality and quantity in the city of Kigali and Rwanda in general. This means that policy interventions by the city of Kigali on management of wastewater hit a snag as the quantity is not easy to come by. (Mbateye, U, et al, 2010:1).

The above background indicates a dire need for research on the topic of wastewater management and its linkage with environmental security of Rwanda. As noted above, Rwanda is still in the phase of development of capacity to manage both solid and water waste and the development of industries and urbanization in general causes severe environmental problems that threaten the existence of humans and acceptable ecological standards. Therefore, the researcher is motivated to undertake the study to assess the impact of effectiveness of wastewater management to

environmental security in an endeavor to come up with findings that can help to guide the entire process of waste management.

1.2. Problem Statement

The operationalization of wastewater management program is still affected by several hindrances and drawbacks in City of Kigali as confirmed by the city leadership who affirmed that the city's policies must ensure that the city wastewater infrastructures are planned and managed well during its development phase. (Mbateye, U, et al, 2010:3).

Accordingly, the city developed a master plan that sought to upgrade waste management and it was endorsed by the several stakeholders. The master plan is based on 3Es namely economic development; ecology and environment and equity and basic needs. Furthermore, the willingness of political leaders, coupled with commitment and legal frameworks shall ensure the achievement of the said master plan. Interestingly, there are shortcomings associated with capital investment to facilitate the entire process of both solid and wastewater management which have resulted into untreated liquid and solid waste not to be managed appropriately in accordance with ecologically acceptable areas thereby leading to debilitating repercussions to environment, human beings and biodiversity. (REMA, 2011:46)

Inadequate management of wastewater pause a concern for both environmental health and the protection of water resources. It is inseparable from associated development sectors, the provision of adequate WSS services is therefore a core element of development strategies and indicators, including Rwanda's Vision 2020 and EDPRS 2 as well as the international Millennium Development Goals (MDG). (MININFRA, 2013:8).

The environment security is one aspect of human security it is to be given a consideration it deserves. However, it is not an easy task as it creates a false sense that through technology and organizational transformations, safety can be the outcome and people forget about environmental threats. It is also ironical to conclude that environmental threats can be combatted just like similar threats through military ways. Experts of environment underscore that such threats associated with environment can be movement of people and contest concerning environmental resources. They are however, not solved by military ways but can be checked by technological development and other operations conducted in a military way top-down management order. Therefore, environmental security doesn't necessarily be narrowed on national protectionism against

immigration but some military type missiles earmarked to combat ozone hole. (Halle, M,1998:13). Therefore, since separation of environmental adverse consequences from security threats is difficult, it is important to analyze how ineffective wastewater management impact on security of an area or the country. Wastewater management if done in a good way probably the environment will be safeguarded, therefore the question to be asked can be how ineffective wastewater management impact on security?

It is against this background that the researcher intends to make an assessment on the ineffectiveness of wastewater management and its related security problems in City of Kigali more especially in the mushrooming and blossoming industries in the Kigali Economic Zone hence the question is "How would ineffective wastewater management impact on the environmental security?"

1.3. Objectives of the Study

This study shall be based on three main objectives and they include:

a. To determine the link between wastewater management and the environmental security.

b. To investigate the security problems that can be caused by ineffective wastewater management.

c. To analyze the environmentally friendly strategies that can be used in industrial wastewater management.

1.4. Research questions

The following research questions shall guide this study:

1. What is the relationship between wastewater management and environmental security?
2. Are there security problems associated with ineffective wastewater management?
3. Are there wastewater management strategies that are environmentally friendly?

1.5. Justification and rationale of the study

The justification for the research is derived from the fact that Rwanda has not taken much visible wastewater management strategies which is already a security and health danger especially in the Special Economic Zones of in City of Kigali that have been gazette for manufacturing industries.

The increasing level of seasonal changes and harsh climatic conditions need thorough research on its sources so that leaders can prescribe lasting and sustainable solutions.

The rationale of conducting this research study will be to inform policy interventions on what efficient ways of ensuring that wastewater doesn't turn into a health and security hazard through the mitigation measures that are supposed to be put into practice to ensure that dangers of wastewater are managed in the most suitable way.

1.6. Scope and delimitations of the study

The scope of the study is limited on the scope of the topic under study namely assessment of effectiveness of wastewater management on the environmental security especially in the Kigali Special Economic Zone of Gasabo District. Since the time was not sufficient, the data to be based were for five years namely 2013-2019. The Government through implementations of Millennium and sustainable development goals safe water is given attention through ministry of water and natural resources and related statutory organizations during that period.

This study is delimited to City of Kigali Special Economic zone the case study. This area was chosen due to the upcoming industries in the area gazette by the state and other activities that are a source of wastewater.

1.7. Study Significance

This study may be significant in the following ways:

It will create a clear understanding to the researcher on different ideas about wastewater management which will help the researcher in future in the career to critically analyse the practices in wastewater management field for a helpful recommendation on how to improve the environmental security.

To the community, this study is used to create awareness and other scholars about the issue of wastewater management and how to mitigate its dangers if there are gaps in effective management.

The study may help policy makers' especially local Government authorities to address the dangers of ineffective wastewater management.

1.8. Organization of the study

This study is organised in five chapters namely: chapter one which discusses the general introduction comprising the background of the study, the statement of the problem, the research questions, and objectives, significance of the study, rationale of the study, the scope and organization of the study. The second chapter handles the literature review which will divulge the important concepts and the theoretical framework to guide the research and facilitate the researcher understand well the views of different scholars. The third chapter discusses the methodology that was applied for this study, tools of data collection, research design and how data collected to be analyzed. However, the fourth chapter focuses on the data presentation, analysis and interpretation of findings so that the researcher contributes to the body of knowledge. Finally, the last chapter summarises and conclude the findings in reference to the objectives of the study and thereafter suggest some recommendations

CHAPTER TWO: LITERATURE RIVIEW

2.0. Introduction

This chapter analyses views and opinions of different scholars and give special preference to definitions of different concepts that are associated with this study. It will also discuss on different dimensions and indicators that are important for the analysis of wastewater management and environmental security. Moreover, it looks at the use of secondary data from desktop research on all associated information that will be put together in reference to the research questions that are set in chapter one.

2.1. Wastewater management concept and environmental related concept

This subtitle entails wastewater management concept and the environmental related concept which the researcher feels are important for the study and are linked so that the reader gets to know them very well.

2.1.1. Wastewater

It can represent a consequence of several uses of water. They include greywater which is domestic and normally refers to used water from showering, kitchen, laundry. Second type of wastewater is black water which refers water from toilet and other type is stormwater which is unharvested water that flow in open space. On top of that, industrial wastewater and wastewater from agriculture activities where companies apply water in many of their activities including processes, production, and cleaning or rinsing of parts. Following the usage of water, it transforms into wastewater stream, until it reaches wastewater treatment plant. However, on any visit to a plant of treatment as a first time, one may be confused by the perceptions they held before because the treatment facility is a complex one since it is earmarked to produce high quality end product. (Cheremisinoff, N, P, 2001:2).

2.1.2 Wastewater Management

Wastewater management can be termed as a process of handling or decontamination of wastewater with a view to decreasing its contaminants in appropriate levels and to be safe for release into the environment. This has two forms namely the centralized and the decentralized wastewater treatment plants. Centralized wastewater systems are used in various countries whereby large-scale systems are designed to collect wastewater from variety of users for decontamination in specified facilities. The decentralized deals with wastewater from household level, users from small areas or within the surroundings which generate same type of wastewater. The selection of the two forms depends on several factors although having both centralized or decentralized is important to achieve effective wastewater management instead of considering sewerage to be a duty of urban sanitation department. (Singh, P, B, etal, 2015:22-23).

2.3. Water resources conservation towards the environmental protection/security

Ecosystems and their inhabitants, including humans, are water users. Water-related ecosystems include wetlands, rivers, aquifers and lakes, and sustain a high level of biodiversity and life. They are vital for providing benefits and services such as drinking water, water for food and energy, humidity, habitats for aquatic life, and natural solutions for water purification and climate resilience. They contribute to addressing competing demands, mitigating risks and promoting stability and trust-building measures, if they are managed well. They are therefore essential for sustainable development, peace, security and human well-being. Water-related ecosystems are increasingly under threat, as the demand grows for fresh water for agriculture, energy and human settlements. They endure effects from pollution, infrastructure development and resource extraction. Degrading ecosystems can also lead to conflict, displacement and migration.

Water quality is diminishing as pollution from pathogens, organic matter, nutrients and salinity increase due to lack of properly managed sanitation, and industrial and agricultural run-off. Land and freshwater ecosystems are totally interdependent. Land-based ecosystems depend on freshwater resources in sufficient quantity and quality; in turn, activities on land, including land use, influence water availability and quality for people, industry and ecosystems. Poor water quality degrades freshwater habitats and coastal areas and can affect fishers, thus influencing both biodiversity and food security.

Interest is growing in nature-based solutions (NBSs), which use or mimic natural processes to increase water availability (e.g. soil moisture retention and groundwater recharge), improve water quality (e.g. natural and constructed wetlands and riparian buffer strips), and reduce water-related risks by restoring flood plains and constructing decentralized water retention systems such as green roofs.

Agriculture is both a leading cause and a victim of water pollution. Agricultural water withdrawals are consumed by crops, but some water is returned to water bodies, resulting in pollution. The lack of water treatment from domestic and industrial sources also makes agriculture a victim, as polluted water contaminates crops and transmits disease to consumers and the people involved in food production and processing.

Much of the pollution affecting oceans and coastal zones comes from human activities and poorly managed land-use practices. This also applies to solid waste dumped at or near coastal areas, which eventually ends up in the sea. Reducing pollution and minimizing dumping of hazardous materials into upstream ecosystems will benefit marine environments and reduce the impact on coastal ecosystems.

Furthermore, climate change has a significant impact on freshwater systems and their management. Most effects due to climate change will be experienced through changes in the hydrological cycle, such as overall water availability, water quality and frequency of extreme weather events such as floods and droughts. Water-related hazards account for a large part of disaster and its impact. (UN REPORT, 2018:21)

2.4. Wastewater management systems

Various techniques for wastewater management techniques are used and present different challenges on the aspect of financial implication but also inadequate environmental protection. However, one method of wastewater management that various scholars is Decentralized Wastewater Treatment System. The primary benefits of DEWATS are improved livelihoods: DEWATS will improve the quality of livelihoods in poor urban settlements, especially for women and children; Public health safeguarded: By protecting drinking water sources, DEWATS treatment options will reduce the pollution load of groundwater and surface water sources such as rivers; Time efficient: Less than 12 months are required for planning and implementing DEWATS; Sustainability through informed choice: Communities choose DEWATS system and components

they prefer; Professional design and workmanship: Technical options promoted are tested and subjected to rigid quality control; Cost efficiency: The investment as well as operation & maintenance costs of technical CBS options are low; Strengthened capacities through training and capacity building: Stakeholders are trained and assisted to plan, implement and manage DEWATS independently or in management; Replication: Trained local facilitators and urban planners ensure future DEWATS replications and scaling up within the target cities. (Singh, P, B, et al, 2015:26)

2.4.1 Challenges in wastewater management systems

The sewer or wastewater collection system is designed so that it flows to a centralized treatment location. The collection system is comprised of smaller sewers with a diameter of about four inches. As more homes and companies are connected along the system, the pipes become larger in diameter. Where gravity systems are not practical, pumping stations are often included to lift the wastewater. Methods for wastewater treatment changes over the time and new technologies evolve. Some sewer piping was actually installed long time back. Materials of construction and methods of construction have changed significantly over the years. Many systems experience problems during wet weather periods with inflow and infiltration. This is commonly referred to as "I&I." Wet weather operating periods typically occur when the snow melts in the spring and/or during heavy rainstorms. Water resulting from snowmelt or storms should flow into a storm water system and not into the sanitary sewer system. Unfortunately, this isn't always the case. (Cheremisinoff, N, P, 2001:3)

2.5. Dangers of ineffective wastewater management

A big portion of wastewater is disposed with a minimum and without any untreated at all. Urban wastewater becomes particularly hazardous when mixed with untreated industrial waste, a common practice in many parts of the developing countries. (Bahri, A, 2012:20)
In most cities of sub-Saharan Africa, grey water can be reused without treatment for some purposes and it is channeled into drains, where it mixes with highly polluted storm water, solid wastes, and excreta from open defecation before entering natural water bodies and even groundwater. (Jiménez et al., 2010).

Inadequate wastewater treatment is a major risk for human security worldwide particularly developing countries in Africa. In Europe, the flow of nutrients into coastal waters is reducing

productivity and creating anoxic dead zones (Corcoran et al., 2010). Microbial pollution, caused by exposure to animal wastes, inappropriate wastewater disposal and inadequate sanitation facilities, is the most important contaminant affecting human health. Indeed, achieving the sanitation target of the Millennium Development Goals is proving a greater challenge than expected and universal sewerage is alleged to be an unattainable goal, even in the long term. (Bahri, A, 2012:21).

2.6. Environmental Security

Environmental security reflects on the capacities of people, communities and countries to handle environmental risks, changes or conflicts or limited natural resources. Climate change is one of the threats to environmental security that is of concern to the world. The harmful activities of man emit CO2 emissions that have a bad consequence on regional and global climatic and environmental threats which consequently impacts on agricultural production and food security in general. This is detrimental as it can cause ethnic clashes, civil disobedience and political problems. Consequently, environmental security is viewed as natural environment tampered by human beings to offset their needs for survival purposes.

Linking nature, environment and safety of humans has attracted tremendous research and publications in the past few years however, it is a new concern for international environmental policy. Interestingly environment has been viewed as more transnational of transnational issues and hence its security in the perspective of peace, national security and human rights is now the main focus. For the next 100 years, a third of global land cover shall face transformation and the world is likely to encounter debilitating consequences concerning consumption, ecosystem services, restoration, conservation and management.

Environmental security is a priority of national security consisting of the dynamics and interrelatedness among natural resource base, the social fabric of the countries and as a driver of global economic activities and stability. Although environment is seen to impact on peace, conflict, destabilization and human insecurity in a different way but the debate about their nexus is still a subject of further debate in comparison with other security and conflict variables, however, much indications point to the phenomenon that environment facilitates the emergency of instability, conflict and unrest. (Myers, N, 2004:1)

Moreover, pollution, climate change, conflicts, water-related disasters and demographic shifts are putting unprecedented pressure on water resources in many regions of the world. More information on these complex linkages will improve the performance of decision makers. However, political acceptability to regulate pollution and decision implementation are two of the main barriers for tackling the water pollution challenge, in addition to the problem of gaps in data. The evidence available to inform decision-making will always be uncertain, as demonstrated by the emergence of new pollutants and the identification of diffuse pollution sources. Action must be taken at some point. (UN REPORT, 2018:68)

2.7 Environmental Issues Related to Wastewater Treatment Plants Concept

Wastewater treatment systems have been designed to minimize the environmental impacts of discharging untreated wastewater in natural aquatic systems. Different wastewater treatment options have different performance characteristics and also different direct impacts in the environment. For instance, some systems have a higher energy usage, some use materials which have a high embodied energy (e.g. steel and cement), others occupy a greater expanse of land. If minimization of environmental impacts is one of the main functions of wastewater treatment systems then they should be designed so that their total impact on the environment is reduced (Dixon et al., 2003).

At any wastewater treatment plant (WWTP) there is an incoming wastewater flow; this flow is treated before it is allowed to be returned to the environment, lakes, or streams. Wastewater treatment plants operate at a critical point of the water cycle, helping nature defend water from excessive pollution. Most treatment plants have primary treatment (physical removal of floatable and settleable solids) and secondary treatment (the biological removal of dissolved solids). Some other treatment plants have tertiary treatment option. The purpose of tertiary treatment is to provide a final treatment stage to raise the effluent quality before it is discharged to the receiving environment (sea, river, lake, ground, etc.). More than one treatment process may be used at any treatment plant.

2.7.1. Human Health aspect

Wastewater treatment plant present various negative effect to human health include emissions such as: cancer-causing emissions, inducing climate change, ozone layer depletion, organic and inorganic substances causing respiratory effects. (Murray and Lopez, 1996; Aramaki et al., 2006. Among the emissions with significant effect to human health; CO2 emissions caused the highest damage. Large CO2 emissions are produced during cement manufacturing and electricity production for WWTPs. Choosing the most appropriate type of wastewater treatment system that can provide the most co-benefits is site specific, and countries need to build capacity to assess this. Reuse of water needs to take into account the whole river basin, as wastewater from one part of a basin may well be the source of supply for others downstream. A coordinated and pragmatic policy environment bringing together industry, utilities, health, agriculture and the environment is needed to promote innovative safe recycling and reuse of wastewater (WWAP, 2017).

Resilience financing needs must be incorporated in the project from the start of the design (Schellekens and Ballard, 2015). The difficult task will be to design a framework to correctly benchmark and establish the effectiveness of interventions. This will unravel new investment opportunities, whereas not understanding resilience will be the actual barrier to the investment. (Garcia, J, P, etal, 2017:13) . However, cost-effectiveness should not be measured in the short run because industries that release wastewater are here to stay and will definitely be relied upon for the entire development of the nation. However, as noted above wastewater management when effective can be a motivation for further investment as climate changes emanating from wastewater will be curbed. The different industries should have similar standard operating procedures and similar criteria of environmental impact assessment and evaluation that shall be monitored routinely to ensure compliance to the basic guidelines given to each and every industry that release wastewater during production.

2.8. Theoretical framework for wastewater management

Solid waste varies in generation rates and compositions between localities due to socio-economic and climate season. This variability makes solid waste data more difficult to achieve, but also most essential for designing effective waste management. According to Ngoc and Schnitzer it is fundamental in waste management to know the pattern of waste generation and their factors. Similarly, Beigl, Sandra & Stefan opined that solid wastes data is relevant in estimating material recovery, human resource and equipment, physical, chemical and thermal properties as potentials for policy decisions. (Harir, A.I. 2015:3). In the study area chosen, many industries are coming up as a government policy which gazetted the place for industries, and since they manufacture different things, it is important to know the level of release of wastewater from these industries and measures undertaken to ensure they don't cause environmental security problems.

2.8.1. Resilience theory

The concept of resilience is one theory which is has been used in wastewater management project, as every system needs to become resilient to overcome future uncertainty. (Moddemeyer, 2015). The in urban water management is becoming more The concept of resilience in urbanwater management is gaining momentum in both academia and industry, drawing attention from international conferences and top level organisations (e.g. Amsterdam International Water Week (AIWW) 2015, Water Environment Federation Technical Exhibition and Conference (WEFTEC) 2015, Water Environment Research Foundation (WERF) (Gay and Sinha, 2013), and the International Water Association (IWA) waterwise cities initiative). Other initiatives include the "100 resilient cities". The main reason for employing resilience theory is the fact that wastewater infrastructures are usually designed to provide collection and treatment services, supporting human health and environmental protection. Now, planning has to account for the extremes of climate change which impacts on the flow to treatment and the receiving water.

According to Butler et al. (2014), (2016) studies dealing with qualitative metrics. He proposed an assessment that is intended to be descriptive, by means of a study of the properties and performance of a resilient system. Four types of resilience analysis are considered: Top-down, Middle based, Bottom-up and Circular. These approaches are classified and recommended based upon the following elements: emerging threats, intervening water system, system performance, and social, economic, and environmental consequences. The qualitative part of the study is carried out by

evaluating the critical functions of the system for the following properties: robustness, adaptive capacity/, rapidity, and resourcefulness, against the following short-term events: (1) extreme weather condition; (2) storm event; (3) power shortage; (4) drought; and long term (climate change); (6) temperature increases; (7) changes in precipitation pattern .

The degree of suitable resilience in the system is measured not only by he needs identified in a Resilience assessment, but also by the cost-assessment of the interventions. Investment in wastewater infrastructure is one of the biggest challenges for the water sector. Therefore, the uncertainty on the cost-assessment will be decisive in the decision making, and potentially the main barrier to resilience implementation. Consequently, water industries are wrong to consider investing in resilience in additional costs, rather as a vehicle to motivate investment by other stakeholders. Through evaluation of resilience of the plan, we conclude on the risk profiles, which definitely encourage new investment opportunities.

The current literature review considers stressors in areas such as: natural risk, mechanical failures, and planning. However, this is still a small subset of the whole range of stressors the wastewater sector will be facing in the future. Climate change is likely to affect wastewater treatment in several ways and the underlying climate variability is anticipated to increase (Milly et al., 2008). Flooding is also expected to increase in future (Campos and Darch, 2015a), prolonged periods of dry weather will lead to sedimentation in sewerage systems, followed by increased ‘first flush’ pollutant loads (Campos and Darch, 2015b). More treatment may be required if consents are tightened to reflect changes in environmental flows. Mechanical failures and preventive planning are rarely considered in water management, and neither are trends within the systems such as wearing or reduced efficiency. The challenge is to develop a comprehensive study of stressors affecting wastewater treatment, to understand all the potential vulnerabilities. (Garcia, J, P, etal, 2017:11).

Resilience theory advocates for fixing all disturbances caused by wastewater but at the same time going forward with the improvement of wastewater management for infrastructure improvement in urban areas. And since industrialization and urbanization in Rwanda is an ongoing process, then incorporation of resilience theory is appropriate as industries and government authorities can work in their means to bring about meaningful change and opportunities for further investment in almost all sectors and on top of that resilience theory is seen as a cross-cutting theory that will automatically impact on other sectors for the country’s development.

2.9. Conclusion of chapter two

In conclusion the literature review concerning wastewater management and its resultant impact on environment seems rich. However, wastewater management has been seen to be different in each country and it is not a recent phenomenon but there is some laxity in some cases where cities or governments take few steps if any to manage wastewater and its associated dangers. It has further been discovered that water is continuously becoming scarce and hence, wastewater is still useful and need to be treated for reuse and hence avoid some of the dangers that wastewater can cause if not properly managed. The treated or well managed wastewater has associated benefits especially in the conservation of our environment that is steadily getting degradation. The reviewed literature also shows some of the benefits of decentralized wastewater management if implemented in any country can be immense. And in case of policy interventions on wastewater, for especially planning urban infrastructure and igniting new innovations and investments, effectiveness in wastewater should be looked at as a trickledown on further investment and reuse of treated wastewater will improve diversification of water sources and cut down on water scarcity problems.

CHAPTER THREE: RESEARCH METHODOLOGY

3.0. Introduction

This chapter brings out the approaches, techniques and methods that was used in data collection and processing. It points out sources of data, nature and size of the population under study, the sample size and sampling techniques, methods of data collection, analysis of data that collected for proper research study. During this research study, this chapter deals with the methods used to come up with the research design, sampling and population size as well as data collection. However, data collection methods were focused on to ensure the quality of data for this study.

3.1. Study area

The study focuses on analysis of the effectiveness of wastewater management and environmental security by examining the effectiveness of wastewater management practices in City of Kigali more especially the case of Kigali Special Economic Zone where the study was conducted.
The researcher is a resident of Ndera in Gasabo district and a water engineer. Therefore, a lot of observations have been made about the study area by the researcher and in capacity as a resident, the researcher had few options to contribute to environmental protection of the area through wastewater management. Therefore, this how the study area was selected to ensure that the researcher contributes to the area of residence positively.

This study area was chosen because first of all Kigali Special Economic Zone and the other neighboring sectors in the are deemed to face the problems of environmental degradation as a result of industrialization which are growing steadily all the time with the government support and are associated with wastewater which have severe impact on environment if not managed well by City of Kigali can negatively impact on the environmental security.

3.2. Research Design

The design of this study is a qualitative research design which is expected to help in describing situations using small number of subjects that are very knowledgeable about issues under investigation. According to (Kothari, 2004:44) he asserts that “It is defined as the organization of circumstances for collection and analysis of data in a way that makes research follow logical sequence in accordance to the purpose of the research and procedures that must be considered.”

Therefore, it is a concrete layout that demonstrates how research was undertaken. It further gives skills and arrangement patterns for measuring, collection and analysis of raw data. It also, aims at understanding deeply the quality of ideas generated about issues under investigation. The respondents were drawn from the stakeholders for the growing industries in the Kigali Special Economic Zones who are familiar with the activities in the area and this was to ensure that empirical evidence is given through their responses. Therefore, since I gathered opinions and perceptions, I found qualitative design as the best for gathering perspectives about the project under study from the implementing partners and the beneficiaries.

3.2. 1. Population

This have included individuals and items with features of interest to the researcher. A population is the sum of all items with distinct characteristics that motivate the researcher to study them. This particular study according to the researcher considered community leaders, safety and environmental officers, civil engineers and environmental technology staffs, industrial staffs, school teachers, security officers, local government authorities among others that where be pointed out to be included in the population. According to (Kothari, C, R, 2004:69), it is indicated that population size must be given due consideration in cases of larger variance, selection of a reasonable sample was chosen. The population size determines the size of the sample to be considered for the study.

For this study on how I zeroed on the population I visited the district of Gasabo Headquarters and I talked to the director in charge of environment who helped me to come up with the list of respondents that can be in the population. Hence from the district, I got the officer responsible for environment, the environment Ministry Staff, REMA Staff, Managers and other senior workers of selected various industries in the Kigali Special economic Zone. Safety and environment officers, local leaders among others. A population of about 100 respondents were selected the as sample size. These proposed population consists of respondents whom the researcher feels have practical knowledge about the study being undertaken

The reason why this population was selected is that in the local government administrative structure, these are the most important and influential people in policy making and implementation and their information given during data collection can be based on as empirical die to hands-on experience in management of community affairs.

Table1: Population from which a sample size was drafted from

Type of respondents	Number of respondents	Number of expected respondents
REMA Staff	2	5
MINIRENA staff	2	5
Industrial managers	5	12
Safety and environmental officers	4	12
Industrial staff	12	25
Sector environmental officers	2	5
Citizen dwelling in the proximity of Kigali Special Economic Zone	20	20
NGOs staff dealing in environment	2	3
Security officers	3	5
Local governance officials	3	8
Grand total	55	100

Source: Sample size proposed by the researcher, December 2019

3.2.2. Sample size

According to (Kothari C, R, 2004:69), this means the selected items from the universe and that comprise the sample. A sample size should be designed in a moderate nature to get desired data and hence shouldn't be extremely wide and not so narrow so that it may not miss valuable information for the study. However, a sample should ensure efficiency, representativeness, reliability and flexibility so that the objectives of the study are well embedded in it.

The researcher expected that Purposive Sampling (Non-Probability) conforms to high degree of accuracy desired for any particular study. Respondents were identified according to the uniqueness and their special knowledge about the study, their desire and availability to take a part in the exercise of the study where all people are considered as sample.

3.3. Methods for data collection and procedures

In this study the researcher collected data from both primary and secondary sources of data using different methods.

3.3.1. Primary data

This is defined as the information obtained from the field and included in the sample as fresh and in it is original in nature. In this research, data collection will be collected using questionnaire which will be addressed to respondents. Interview were also used with some managers considered to have important and special information related to the topic. Also focus group discussion was employed in primary data collection. This will help the researcher to eliminate the subjective biases by the respondents.

3.3.2. Observation

According to (Kothari, R, 2004:109), it is referred to a tool of scientific research employed by researchers to collect data. It is determined by the researcher to enable the achievement of the purpose and must be planned in a logical way to ensure reliability and variability while recording the data being collected. It was selected because the area of the study needed the researcher to have a clear view since it is accessible and later verify and compare some data given by the respondents. For proper management, there is need for the researcher to recommend policy interventions and this observation will helpful to ensure that empirical data is observed and analyzed. The researcher will not visit all sampled respondents or households but observation even at several industries will give a picture of environmental security issues paused by the wastewater management.

3.3.3. Focus group

According to (Nyumba, T, et al. 2018:10) it is observed that qualitative research method is more suitable for this tool of collecting information and it is economical as many respondents targeted are interviewed at the same time and in the same vicinity. The timeline allocated for this study is short and hence, this method is expected to be convenient. The researcher conducted two focus group discussions comprising 12 respondents each for the selected workers from different industries in the case study. It is selected since some respondents have a tendency of not being

available and can't answer the questionnaires. It will help the research to collect data in a short time and can verify easily those who are demonstrating the truth as some members in a group are expected to correct some respondents if the information given is not true.

3.3.4 Secondary data

This information from library research through retrieving the internet, records of institutions, journals and other data from archives. It is necessary to undertake research using it to enable comparison of statistics from different years and performance of some sectors within an institution or government entity and it gives basis for measuring the level of change on the subject being researched about after reviewing what previous researchers have written about or published concerning the study being undertaken and the researcher must give preference to various sources to ensure credibility (Kothari, R, 2004:124). This data will help the researcher to remain in the theme of the study by visiting the library, textbooks and internet source articles and journals to widen and deepen the understanding of the researcher of the research topic from the reputable scholars.

3.4. Data Analysis

This phase of research entail scrutiny and processing of collected data to ensure conformity to the laid-out research plan as set at the commencement of the study. It is crucial in scientific study to facilitate comparison of all available data as relevant to the study after making desired analysis and comparing of all collected data. It is an umbrella term to ensure that data is edited, coded, classified and tabulated where necessary and hence subjected to thorough analysis (Kothari, C, R, 2004:135).

Responses obtained from the field were analyzed and grouped according to the responses from the respondents in relation to the set objectives through a thematic approach. Collected data were analysed using qualitative techniques forming some themes namely thematic analysis. This thematic analysis is seen as the best for the research to come up with a good research study as the researcher will be much interested in the perspectives therefore, they must be arranged in particular themes to have a logical sequence.

3.4.1. Editing

This is identification of errors and omissions from the collected raw data and involves careful subjection of raw data to scrutiny in all necessary areas to ensure data collected is empirical and reliable. The process involves scrutiny of the returned and filled questionnaires to achieve the purpose of research study and determine accurateness and how data conforms to foundations of consistency (Kothari, C.R, 2004:135). Since the researcher will use questionnaires and when they are filled, some respondents may not have sufficient time so editing will be necessary during the conduct of this study. Editing will also try to ensure that the research is credible for the readers and cases of similarities are avoided.

3.4.2. Classification

This is the process of reducing data into homogeneous groups from varieties of collected data purposely for identification of various related meanings. Hence it is arrangement of collected data in several classes basing on common features (Kothari, C,R, 2004:136). Because Purposive Sampling will be used to select respondents with special knowledge about the subject, the researcher will have to classify data during analysis to ensure that groups are set in thematic approach which is defined " as a method for detecting, investigating, and recording patterns within data" (Braun and Clarke, 2006:79). This classification procedure is widely used in analysis of data in qualitative research. This classification will be derived majorly from the interview guide and focus group discussion questions.

3.4.3. Data quality control

Validity and reliability of the research instrument was ensured as follows;

According to (Roberta H., and Alison T, 2015),Validity is the extent to which a concept is accurately measured in a quantitative study while the reliability measured in qualitative study is the extent to which a research instrument consistently has the same results if it is used in the same situation on repeated occasions. In this study the interview guides a pre-tested through a pilot study before actual data collection is started was conducted. It was done in the Kigali special economic zone and on the selected individuals. However, although validity matters for this study, the researcher is interested in undertaking the research using only qualitative research design.

The interview guide that will serve the same purpose for focus groups will administered to selected Managers and senior workers especially those in charge of water and sanitation hygiene leave alone safety and security officers for the different industries. In order to ensure validity, the researcher constructed instruments/ interview basing on rules for constructing them, ensure that question or items inside conform to logical flow of the study and they were given to the supervisor for necessary validation. In this study, to ensure reliability of instruments, the researcher compared the findings from the pre-test and retest. The findings were highly co-related; hence the instrument was reliable or consistent.

3.5. Research Ethics

Before conducting the study, the permission was given by the University of Rwanda through the RDFCSC introducing the researcher and the purpose of data collection. In order to get consistent information to the study, the researcher wrote a letter to the respondents requesting to them to answer questions through a questionnaire addressed to them. The research conducted an interview and Focus group with some selected people considered to have more and additional information regarding the study. The answering of the questions was not by force and the importance of the study was clearly explained to the respondents. Before the study, the researcher contacted the local authorities and the security agencies to ensure that accessibility to the respondents is granted instead of taking advantage of respondents.The researcher affirmed to respondents concerned that the information given will be kept with confidentiality and used for academic purpose only. To ensure the confidentiality, the names of participants were not written on the questionnaire; and the names of people who accepted an interview with the researcher were not indicated in the study.

3.6. Chapter three conclusion

This chapter defined the methodology that was used for this research. In this chapter the main purpose was to choose the respondents and what instruments to be used in data collection. Primary data were gathered from participants by answering interviews and conducting group discussion especially on the selected respondents by the researcher as explained in the sampled population. Each selected group was divided into sub-groups to minimize similar responses and biases and also to ensure that the responses given in their answering questionnaires and the interview have a systematic order. Secondary data was collected from various textbooks, articles and websites online. The tools selected on the criteria of suitability to the study being undertaken by the

researcher. The chapter outlined how the data was analyzed through the qualitative approaches to accommodate different responses and perspectives that gave the researcher an opportunity to understand the research problem being investigated in this study.

3.7. Research limitation

At the beginning of the research number of respondents to be used were 100 people. But due to the lockdown period due to COVID -19 pandemic the researcher conducted interviews with only those that were accessible. The study to be successful I used 55 respondents that were reached through purposive sampling. I eliminated many respondents who were selected through the population and settle down to those who showed knowledge on the research study on wastewater management. The researcher was intending to access Rwanda Development Board and have interview with their staffs on the effectiveness of wastewater management in Special Economic Zone where industries were established and they are increasing day by day. The time limitation also hindered my research to have more views various field related to wastewater management and how is related to environmental security and in the study area. Out of 100 respondents, interacted with 55 who contributed to the research interviews.

CHAPTER FOUR: DATA PRESENTATION AND INTERPRETATION OF FINDINGS

4.0 Introduction

This chapter constitutes primary data collected from field research area. It is a presentation of data which are discussed and an interpretation of findings is made according to the theories related to the topic, research questions that were set in the previous chapters concerning assessing the effectiveness of wastewater management on the environmental security: a case study of Kigali Special Economic Zone.

As one of the research questions, the researcher wanted to determine from the respondents, the relationship of wastewater management and the environment security. Additionally, the researcher wanted to find out how unsuccessful wastewater management affects the environment thereby pausing many risks that continuously worsen the situation.

The presentation, analysis and interpretation of data will take a thematic approach in line with qualitative analysis so that observations gathered from the field is brought out with logical flow to enable the researcher put into perspective. In that regards the topic under study and subsequent themes were well-thought-out:

4.1. Respondents views on the understanding on wastewater

During the research process, the researcher was interested in investigation whether the targeted respondents can understand the concept of wastewater and eventually amplifies their thought by giving examples of wastewater types to show clear understanding. Most of those interviewed and those in the group focus discussion indicated understanding. Indeed, one of the respondents; during interview remarked that…

> *It is the water that is dirty after being used for different purposes either in the homes or industries and which is released after being deemed useless by the people that used it…(interview1 with IS00, SEC00 and IM00)*

This implies that as the greatest number of respondents could mention some of these elements within this definition and hence have a general knowledge about wastewater. In regard to types of wastewater, some respondent could not distinguish them well from the above definition and they indicated that

Wastewater is that from home laundry, dish washing, factories, and schools, hospitals as discharged water that was formerly used and not fit for human consumption…. (interview2 with NGO00 and KSCZ00)

These views demonstrate that the surveyed respondents have a clue on wastewater and where it is generated from. Therefore, the study about wastewater is stuck in the minds of people basing on how they were responding and they seem to have information about its dangers as they could easily mention the sources of wastewater and hence any study about it can bring vital recommendations on how they can surely benefit.

4.2. Views on wastewater characteristics and its status

The researcher went ahead to establish the relationship between wastewater and environment and hence ensure that respondents can recognize wastewater characteristics and how they feel wastewater influences on the environment. Many respondents showed knowledge on how wastewater is hazardous to the environment particularly wastewater from industries that are growing steadily. The respondents had this to say that …

Most of times the wastewater released from the Kigali special economic zones where industries have been established has a stinking odor that hit the noses of people who passes around and it shows that it can be harmful to both people and the environment interview 3 with KSEZ00

Figure 1: Stagnant wastewater in the drainage channel in KSEZ

Source: Photo taken by researcher, February 2020

This is implicative of the fact that wastewater is feared by the population as they expect undesirable and harmful consequences in their surroundings.

On the other hand, the respondents showed that due to the released wastewater that is not managed well the consequences have been devastating. One respondent remarked that " The wastewater from industries and in homes that flow towards the low elevated area, have not been managed well and are likely to affect the health aspect of human security of peoples with water borne diseases like cholera, diarrhea, typhoid, bilharzia and malaria as the germs that cause these diseases have got breeding areas in the wetland where the wastewater is released…..". This is a clear demonstration that released wastewater from both industries mixed with stormwater find itself in the low ground and cause problems by affecting the environment and make it unsuitable for human habitation due to these diseases that are likely to affect people. It should be noted that, wastewater has a destructive consequence when released untreated in the environment where people dwell and

as such management strategies should be increased to ensure that the environment remains safe for the current and future generation.

Furthermore, the wastewater was earmarked as one of the causes of landslides as Kigali City especially Gasabo is a hilly area with steep slope areas. Wastewater that have destroyed houses several times when released and make the safety of environment questionable. One of the respondents in the Focus Group Discussion indicated that

> *The water released from industries and storm water affect families who prefer residing on upper hills have been a disaster to the common man as it is released in abundance without thinking about its effects on water resources that people in proximity use… (interview 4with NGO00 and SEC00)*

This seems strange that the respondents indicate laxity on the side of the responsible authorities to come up with friendly strategies to combat these undesirable consequences that compromise water resources in areas where the wastewater is released.

On the other hand, some respondents demonstrated that released water has been a source of economic activities for them who have been in cities without jobs. During the interview with one of the local leaders he remarked that

> *some youth have found brick making business profitable for them in the slopes where water is released and pottery that surely fetch some incomes for them and they don't cause problems to the community basing on the fact that water scarcity during dry season in Kigali city is always worse and hence with this released water, people make use of it by practicing pottery and brick making business…(interview 5 with NGO00)*

This is looking at the positive influence of the released water which makes people get employed especially during dry season when water availability is a problem and it also means that this should just be streamlined to ensure that all wastewater that is to be treated before discharge as it present danger to the human being especially industrial wastewater that contain harmful chemical elements. Wastewater can be considered as of water source when treated well and discharged into the appropriate location. Hence, before any released wastewater should be tested in laboratory to meet the minimum standard to be certified by authorities and make sure that worst consequences of released wastewater are mitigated.

Moreover, through observation method, the researcher found respondents practicing nursery beds that lead to tree planting and floriculture in the down streams where the wastewater is released. They indicated that

> *The water released from special economic zone have tremendously changed their lives by supporting with sure source of water to practice urban farming and they end up growing flowers that are on demand especially those put in different verandas of homes and the soils where the released wastewater goes is fertile for nursery beds that have ready markets……(interview 6 with NGO00 and KSEZ00)*

This implies that the wastewater is not entirely a disaster to environment but an enabler to maintain the environment if users ensure that all wastewater is channeled to an appropriate destination. Again, it can be put to good use before it becomes a disaster to the communities. On the other hand, it is all about how the wastewater is managed because any water has become a scarce resource where any drop counts.

Therefore, it is important to note that wastewater management should map all stakeholders and include them in planning on how the wastewater can be released to mitigate negative consequences and to create desirable consequences for the communities around the Kigali Special economic zones where there are mushrooming industries. The authorities should ensure that they align wastewater policies in accordance with national laws and goals in order to decontaminate wastewater and generate more useful water to the users instead of wasting the water that is now taken as a scarce resource.

4.3. Respondents views on challenges of implementing wastewater management

In an endeavor by the researcher to ensure that views are generated on how wastewater management in the area is successful if not what might be challenges. Respondents were confident enough to state that the management of wastewater generated in Kigali Special Economic Zones and the surrounding areas is unsuccessful and has so far created undesirable outcome. The respondents some of whom in the FGD showed lack of information if some steps that have been in place to the effective wastewater management. Indeed, one respondent argued that

> *For us as the indigenous people we don't know how wastewater released from industries is supposed to be handled, since from ancient times wastewater as normal has been finding its way into wetlands……. (interview 7with KSEZ00)*

This statement points to a crucial factor while analyzing why wastewater management is not successful and that is failure to include all stakeholders in the planning process on how wastewater can be well handled. It is again important to raise awareness of citizen on what is to be done for wastewater prior to the release into the environment. It should be noted that all stakeholders who are affected by wastewater and those who release the wastewater must be put on board to ensure concerted efforts in ensuring that wastewater management is done in a holistic manner.

Furthermore, the respondents expressed dissatisfaction with the local authorities who don't prioritize wastewater management and even planning for it. They intimated to the researcher that

> *Some leaders only mention about wastewater in times of incidents that have taken lives or properties and during meetings they request the communities to support the industrialists in the best way possible so that development of the area can be realized…. (interview 8 with REM00,MIN00)*

Therefore, this points to an interesting phenomenon of priority in advancement of government and community development programs and also indicates that some local leaders don't make a cost-benefit analysis on issues concerning wastewater and industrialization. It should be noted that development and especially urbanization through industrialization has many costs associated with it that are detrimental to the environment and the people who inhabit. Therefore, effects on the environment must be mitigated through appropriate management of wastewater released from homes and industries before the cause disagreeable consequences for human survival.

Moreover, some respondents argued that steps for management of wastewater are in place but no regulation and standard available to monitor the implementation. Among the environmental safety and security officers interviewed they indicated that

> *the different industries have put in place officers responsible for environmental protection and there is environmental policy in place but it's a recent development as required by environmental authorities at the national level and hence monitoring how different institutions and individuals implement is not yet overdue…. (interview 9 with SE00)*

Therefore, this means that the industries established in the study area are fully aware of the negative consequences of wastewater and are implementing management policies although at a slow progress and which must be augmented to ensure quick and desirable results.

In addition to that one respondent in FGD argued that

> *The regulatory body namely the Rwanda Environmental Management Authority has been lenient to some places and industries within the study area in an endeavor not to slow development through bureaucratic demands as far as management of wastewater is concerned. (interview10 withSEC00)*

This statement points to the fact that a "carrot and stick" policy is employed by the environmental authorities and which if not checked well to ensure balance between benefits of development and its costs, it can cause more problems. Therefore, strictness in ensuring wastewater management and which combines all stakeholders and all those affected by wastewater must be put on board.

Furthermore, it was indicated by some respondents that wastewater management has not been given the same priority like solid waste management and there is lack of a central wastewater management and treatment plant or authority in place. The respondent during interview indicated that

> *The government was in process of establishing the waste management authority that will deal with all waste without turning to the environmental authority that has caused conflict of roles and once in place management of wastewater shall be successful…. (interview 11 with MIN00)*

This therefore implies that wastewater management is facing a lot of management mechanisms that can only be streamlined by a waste management body whose role is day today running of affairs of the wastewater and other waste products. Therefore, this is seen as ineffectiveness in management of wastewater and a danger to the environmental security.

More still, on failure of implementation of wastewater management has been absence of regular environmental impact assessment (EPA) by all those concerned to ensure that there is no degradation of environment and the security of environment is guaranteed. It was argued in an interview that

> *All districts have environmental officers and all industries in the study area have environmental safety officers but they rarely come on the field to evaluate if really wastewater released is up to the standard to be discharged in environment. Again, they are not known by the communities at the lowest level but are known by those intending to construct houses…(interview12 with SEC00)*

This shows that there is less coordination as regards environmental impact assessment is concerned and hence negative effects of wastewater are not given the priority it deserves. Therefore, there is need to sensitize the people on who does what in environment sector such that in case of the desire for help from these officials, the community can run easily to them and hence negative consequences of wastewater on environmental security are mitigated before the alarming situation. It was also seen from the perspective of lack of funds and the right people to do the job of wastewater management. They remarked during the FGD that "some people have been employed with no technical skills on how wastewater management is done and when some go for training they cannot reciprocate the knowledge because the funds to handle the process of wastewater management is done are not sufficient and those who have gone for study tours have not prioritized wastewater management as important since it hasn't caused visible incidents among the communities…". This implies that the leaders are trained to respond to incidents or disasters instead of a proactive approach that is cost friendly and with less pressure. They wait for incidents and consider these issues not very important because wastewater hasn't resulted into serious incidents that claims people's lives and properties and also because the very leaders who should implement management of wastewater are also at fault because they stay in such communities. Therefore, it is against this background that wastewater management has been difficult to implement in the areas under study.

There is also a problem of the areas surveyed during the research as one respondent through interview observed that

> *part of the area under study is semi-urban and depending on the activities undertaken around Kigali special economic zone and although strategies of wastewater management are implemented but different approach are used in managing*

wastewater and hence it is difficult to implement differently and at the end expect different results…(interview 13 with SA00)

This was an interesting interview that gives the snapshot of the study area as that one that is not completely urban industrial center. This is where the skills and knowledge on treatment and discharge of wastewater is expected to be uniform and generating similar results that aim at protecting the community in the study area. Hence, unless the areas around the industrial zone are classified and sanctioned by the authorities. Hence their activities designated to justify the implementation of wastewater management. The rest shall remain difficult to achieve. Thus, some efforts should be earmarked for this where monitoring of transformation of living standards of citizen living in the proximity of urban industrial areas is achieved instead of focusing on small part of the area. Wastewater management can't be achieved holistically without changing the affected areas and the affected communities.

4.4. Views on benefit of wastewater management policy to the community

The researcher while trying to understand more about the question of strategies that can be environmentally friendly to the communities concerning wastewater management conducted a focus group discussion involving different respondents with different knowledge on wastewater and they indicated that wastewater management to be effective many stakeholders can be brought on board and sensitized on the way forward for effective wastewater management to be achieved. They argued in FGD that

there must be intensive awareness on how wastewater management is done by all those concerned instead of waiting for the government yet they also constitute the government and must have tangible contribution to wastewater management since its negative consequences affect human security in one way or another. (interview 14 with LOC00)

Hence engaging the citizen on how wastewater can be managed well and considering their concern on existing wastewater systems can contribute to the improvement towards the effective wastewater management in the area. This indicates that there is less synergy mobilized by leaders by all stakeholders to undertake wastewater management and if it is done well the communities will participate in wastewater management and remarkable results shall be realized.

On the other hand, wastewater management can be beneficial in the sense that not much discharged water will be wasted but will be reused. They argued in the different interviews that

There is need for water especially in dry spells to support economic activities like construction works as a number of new buildings are under construction Special Economic Zone. Additionally, irrigation in the urban farming especially in horticulture and floriculture and also in pottery and tree planting and hence wastewater should be directed well in places where these activities that generate income for the community undertaking those jobs… (interview 14 with SA00)

It should be noted that wastewater is normally directed in wetlands and swamps where these activities that can conserve the environment from different insecurities are conducted and hence it is a question of how and when management of wastewater will be done and not why because the advantages were illustrated by the different respondents that were contacted in the data collection process. The mentioned activities contribute to the decrease of unemployment rate where many rural urban migrant laborers have come anticipating jobs to survive. And again, if wastewater management is done well, WASAC water that is used in construction and irrigation can allocated in other areas such as hospital and schools. The respondents further indicated in FGD that

Different industries should establish wastewater treatment plants that can decontaminate the wastewater and it becomes suitable for irrigation and other activities such as constructions works etc. And in the process the plants will provide employment to some community members…. (interview 15 with SA00)

It should be noted that, the area has not been proactive in establishing wastewater treatment plants. Furthermore, the respondents indicated that problems of climate change need concerted efforts by all stakeholders since precipitation is mostly taking place in wetlands and swamps where the wastewater is directed then there is need for extra prudence that can lead to appropriate wastewater management. They argued that

There have been different campaigns to protect environment and wetlands especially in their original forms but external factors like wastewater have not been assessed well and their negative influence on wetlands that protect and conserve the environment. …. (interview with IM00 and 16LOC00)

This implies that conservation of environment has not been very effective and not holistic manner to mitigate the anticipated negative consequences of wastewater on environmental security. Therefore, those who have not been involved in the whole management process are likely to develop the "I don't care attitude" that is devastating while implementing a crucial policy like this that concerns the management of wastewater. Wastewater management should be taken at the

forefront while executing the environmental impact assessment by all those concerned with conservation and promotion of environmental protection and if there is knowledge and skills gaps by those responsible then suitable training should be conducted in an endeavor to ensure that environmental officials are able to conduct environmental impact assessment while including the management of wastewater.

Respondents through interview further mentioned that

> *with the coming of green houses and irrigation as a policy, then wastewater if managed well can be used for those purposes and profitably they gain from the incomes earned from those activities……. (interview 17 with SA00)*

Therefore, this means that wastewater management should be spearheaded well and it supports such activities. The green houses can use wastewater if treated or not discharged with a lot of contaminants and it benefits those participating in such activities. Those who have started practicing piggery can also use it and after treating it such farming will progress well and irrigation of kitchen gardens that produce vegetables for sale or use domestically which can solve some of the problems for those who are vulnerable and need vegetables to support their lives and those not vulnerable but needing balanced diet to keep healthy. The above activities can be done if wastewater is managed centrally and in an organized manner.

Having stated that, a well and appropriate wastewater management is seen as a solution to conservation of environment and hence making it attractive for different institutions to open their business. On top of that social amenities are also attracted to tap the demand of the increasing population in the urban industrial area such as the Kigali Special Economic zone. A respondent interviewed had this to say

> *wastewater management if implemented well will automatically make environment safe for the inhabitants around the industrial area and the staff of industries plying their business in the area so that they can accommodate the growing demand for services such as banking institutions, hospitals, markets, supermarkets and malls, schools have started opening their doors in the area……. (interview 18 with SE00)*

This implies a positive development when the services are brought nearer to the end users to shorten the time, they have been spending looking for these services in faraway places. Therefore, wastewater management if effectively implemented can be a catalyst for other institutions for people since the environment is deemed friendly for the communities around the place where effective wastewater management plants are established.

In addition to that, respondents indicated that wastewater from industries and homes can be more useful as a source of energy if managed well and can make simple lighting to the communities around and hence a substitute to thermal and hydro power. The respondents through the FGD observed that

> *there is nothing wrong for the authorities to diversify the sources of power like making biogas from wastewater and directing the discharged water into a treatment plant that can organize it into energy and by this there shall be cutting on the costs of electricity by the locals of the area….(interview 19 with MIN00)*

This seems to be an interesting benefit from the interviews as how the effective wastewater management can be modernized into something beneficial to the communities to the extent that their living standards are simplified through the generated energy. Since the area as already been gazette for industries and surely many of them are coming up at a progressive trend, there is need for a central treatment plant to add value to this wastewater discharged form industries. Therefore with the institution of the waste body in Rwanda that will have an oversight and implementation role on handling wastewater and solid water throughout the country then, this will be realistic and achievable smart goal of having energy produced after all energy supposed to be consumed by all the communities around is not in surplus.

4.5. Views on measures to minimize wastewater release

The researcher went ahead to find out what environmentally friendly policies or strategies that the community can adopt to minimize discharge of untreated water in the environment. On top of that, the respondents had to share their perspectives on how the government can contribute to this and the respondents generated several opinions towards this through both interview and focus groups. One respondent during interview argued that

> *the government must expropriate some locals whose houses are within the radius of the discharged water and relocate them to other areas because some places are highly risky for human habitation due to this discharge of wastewater… (interview 20 with NGO00)*

This implied that some areas although water is to be treated, still some effects can be felt by the people who are nearby the industries and hilly homes that discharge untreated water and hence the environment becomes untenable for the people who reside within the parameters of the sources of discharged wastewater and hence will definitely cause unbearable problems to the community.

Therefore, in places that have been gazette as industrial areas and prime residences, some people must be expropriated to other areas to reduce risks to human beings.

Furthermore, the respondents remarked that for the upcoming industries, environmental impact assessment that will determine the impacts of those industries depending on what they produce be thoroughly done and all stakeholders put on board to avoid unexpected gaps in the implementation of environmental impact assessment. During the FGD, one respondent asserted that "the criteria of environmental impact assessment should be shared among the stakeholders especially the community who are well versed with the areas where the industries are to be established…

> *It is evident that environment impact assessment has been excluding some of the vital partners who would ensure that the participate well and the criteria is not shared but imposed on people which brings up a problem of low support and good will during implementation by all partners. … (interview 21 with* IM00*)*

Therefore, the issue of inclusiveness must be given due attention, where all stakeholders in places that face wastewater discharge are put on board, for environmental conservation to be attained. Again, regular environmental assessment should be the order of the day.

More still, the respondents asserted that all industries should nationally centralized treatment plants where wastewater can be decontaminated before being released and this will be important in the sense that, all waters shall be utilized well and the contaminants of environment shall be regulated. They had this to say during FGD

> *Without industries having a central treatment plant to decontaminate water, then the future of environment is in jeopardy as environmental degradation is ever worsening and reversal of the trend is more than impossible…… (interview 22 with IM00)*

Therefore, for industries if they continue handling issues of wastewater independently and yet the discharge of wastewater varies from industry to industry, then the costs of production for each industry product will be unfair and increasing. But it shall be incumbent upon the central regulatory body to harmonize this. Therefore, there are many chances that gaps in handling issues of wastewater management will be realized and at the end it's the community where the wastewater is discharged that will be affected. This implies that a strict regulation should be in place to ensure that industries implements wastewater management collectively.

Furthermore, the respondents found many local leaders at fault for not enforcing some of the regulations concerning wastewater management and in some cases segregate in handling wastewater management to all people and homes across all social classes. They claimed that "it is common that well to do homes don't participate in implementing of many government programs including this management of wastewater from their homes and the local leaders always keep a deaf ear and a blind eye for that matter…". Therefore without inclusive implementation of wastewater management right from homes, its success will remain a dream and people should be sensitized on this because the negative effects of careless discharge of wastewater in the environment don't segregate among classes of people and they spill over to other areas hence the need for concerted efforts if meaningful results can be realized.

Respondents also indicated to the researcher that the movement of water from homes is not well directed such that it may not cause problems. One local leader during interview remarked that " the terracing of the areas from the Kimironko area and Ndera areas is not up to the standard and water is just discharged from homes and the industries sometimes have nothing to do in safeguarding the environment when the surrounding people destroy and hamper their efforts and this should be exclusively handled by national authorities with logistics and sufficient funding to streamline all the roads..". This assertion by one of the local leader points to the issue of water harvesting which hasn't been implemented by all stakeholders, a lot of water including wastewater is released from different homes and surrounding industries but tapping it for future use is not done. Therefore, water harvesting is not embraced and if it is embraced by all the stakeholders then, chances are high that the problem of water scarcity that is needed for all the activities either in the rainy season or dry season can be solved with water harvesting.

Some respondents believe that some human activities that destroy some areas and give chance to those who release wastewater should be handled with the strictness it deserves. During the data collection through observation method, the researcher noted a lot of soil mining is done on the side of Ndera that is used roads rehabilitation, brick laying and improper farming leave alone small livestock being reared in some areas. These have given a leeway to those who discharge wastewater to those areas where those human activities are done and hence reduction or suspension of these disastrous human activities should be managed well in order to have better results of environmental conservation free from insecurities through inclusive wastewater management.

More still, the people among the communities who are supposed to implement wastewater management are not really qualified to that and also face the problem of unfriendly Kigali altitude that requires much funds to level the ground and facilitate wastewater movement. Therefore, according to them through the FGD they observed that

> *mass sensitization is important for all the communities and the stakeholders to ensure knowledge about wastewater management is acquired and through this the communities shall be able to demand accountability from their leaders as regards their contribution on wastewater management is concerned…(interview 23 with SA00)*

This implies that few people surely are participating in wastewater management due to skills gap and priority issues and hence there is need for great efforts in mobilization of all those concerned to ensure that wastewater management becomes part and parcel of everyone residing or working in the areas under study.

4.6 views wastewater managing in the localities

In an endeavor by the researcher to find out how the people in the study area have been managing wastewater, the researcher had to visit the study area and pose some questions through interviews and focus groups. One respondent who was interviewed observed that

> *they have been digging holes at homes where they pour water after washing clothes and dishes but don't put any treatment in this water since they don't need it anymore and it just dries up…(interview 24 with SE00)*

From this assertion some respondents are not doing enough to manage wastewater and some of these holes have become breeding grounds for mosquitoes that cause malaria and other diseases that disturb the people in the areas under study.

And from observation also some industries do the same but are not certain that the water after being discharged in those pits remain there or go ahead and cause problems like contamination of the area and slow destruction of foundations of houses and during rainfall some of the houses have been collapsing and the blame is shifted on rain yet the process of collapse of houses had started before due to poor management of wastewater. Therefore, it is evident from the above that, severity in enforcement of wastewater management practices are not uniformly implemented and accordingly, wastewater is surely devastating the climate and environment of the area but it looks

as if people are not conversant of the consequences of wastewater in the coming years and hence there is need to take it as a priority.

Interestingly some respondents demonstrated less knowledge on management of wastewater and those especially not in the vicinity of the blossoming industries. One respondent during interview asserted that

Most times water is scarce and those with tap water are still few while others fetch from the borehole and hence, they don't have any wastewater because they cannot accumulate it yet the little water they have is always for domestic use and its used and finished….(interview 25 with KSEZ00)

This implies that although they may understand wastewater, but they don't know well its impact on environmental security as they think they have used all the water and what they pour after use is not taken as dangerous or supposed to be treated for further use. Therefore, it is imperative to note that to some respondents, its wastewater from industries that is posing a problem and not from their homes because what they generate as wastewater is marginal to them and cannot be a source of any problem.

Furthermore, management of wastewater hasn't been prioritized and others do it by default as one respondent argued during FGD that

> *locally people pour all used wastewater in the nearest drainage commonly known as "Ruhurura" among the locals and it finds its way in the wetlands or swamps and these drainage sometimes are overwhelmed by not only wastewater but also solid waste which hampers its movement to the final destination……(interview 26 with SEC00)*

This implies that each home locally discharges wastewater and one way of managing it is sending it to others and there is no verification whether it is devastating or it reached the intended destination. The local leaders and other authorities are part of these communities and hence cannot enforce laws against it as they are also partnering in crime. Therefore, a central body which is independent of all this mess is overdue to ensure that wastewater management takes precedent and the negative consequences brought by wastewater are combated.

4.7. Views on safeguarding environmental security

The researcher while trying to handle the study from all angles of the variables namely wastewater management and environmental security desired to know the role of security personnel if any while implementing effective wastewater management. The respondents gave varied opinions to illustrate expected role of security officers if the policy is to be achieved. The respondents through FGD indicated that

> *most of the people who release wastewater without due regard to where it is heading and that it can cause devastating effects to the inhabitants breaks the environmental law and hence must be brought to account for their actions…(interview 27 with LOC00).*

This implies that some people are aware of the existing laws on environment and break them knowing the consequences of violation of laws but since the law enforcers are keeping a blind eye on them then their illegal practices continue persistent. It also implies that these laws are not very specific on wastewater management and no serious penalties and the ones in existence are no scaring for those intending to break the law and those of recidivism. Therefore, legislators can enact stringent laws which the law enforcers will depend on while apprehending those people who are jeopardizing the security of environment.

Security organs in Rwanda have been seen in campaigns of human security where they contribute to the human security of community through different activities ranging from health, food, environmental protection among others. One responded from the interview conducted observed that

> *the army and police and their sister security organs can give lessons and examples through physical participation like how they do in army and police week even in monthly community work that involves general cleaning and show the community how in the simplest way wastewater management can be done…(interview 28 with NGO00)*

This implies that security officials are always looked upon if policies of government are expected to move in green light and hence have the trust of the people on policies and are well supported to take a lead in identification of lead community trainers who will scale up the wastewater management practices taught to a multitude of the population. Therefore the role can be to participate and show the community that effective wastewater management is for their own benefit and it has health advantages where people avoid being contaminated by untreated water and also

training the community on the simplest way to manage wastewater and in the process save government funds that would be used to ensure a holistic implementation of wastewater management in all communities within the study area .

Another issue that was brought to the researcher's attention was the issue of security officers establishing or strengthening their environmental and waste management departments. Through the interview a respond remarked that

> *For the police we always see traffic police not environmental police and for army we always see those patrolling and those boarding aircrafts going for peacekeeping missions but their environment departments are not visible and we wonder if they have them…(interview 29 with IS00)*

Figure 2:Discharge of wastewater in drainage channel

Source: Photo taken by researcher, February 2020

This implies that wastewater management has not taken ground in all institutions of the government including the security personnel to the extent that the community and the industrialists are challenged not to remain behind in this government program of fighting the negative effects of wastewater through it effective management. In point of fact, some wondered, how these security institutions have managed wastewater since they have large infrastructures that surely discharge

wastewater. Therefore, security officers have a big role to play in scaling up activities of wastewater management in the communities through strengthening their departments concerned with this activity so that they can be visible in the communities. One security officer among the respondents through interview indicated that

> *as the security officers they are ever prepared for any call to help the community in whatever way provided it is sanctioned by the commander in chief and will allocate substantial resources from themselves just to make the work good and produce best results that are visible to the community and with wastewater management, it is a question of when not how because it lies within the parameters of human security which is the contemporary focus of security forces…(interview 30 with SEC00).*

This implies that different institutions and security ones in particular have not been vigilant on issues of wastewater management and scaling up to the different communities.

Therefore, it is a wakeup call that can be given by the recommendations of this study that they will participate fully because their disaster management institutions have been in place and they have contributed to ending certain disaster and relocating people from high risky zones in different places of the country and instead of reacting to incidents of wastewater which are definitely overdue or not yet analyzed well despite them being present but can help in ensuring effectiveness of wastewater management is done in an endeavor to promote environmental security. This is actually one of the best objectives of the security forces with the change in security dynamics that physical security provisions are never successful without ensuring human security.

Respondents further mentioned that Rwanda is having many retired personnel from service both the military where they have a department and substantial budget that is seen from the many developmental activities they have done. The police also should be having this department of retired and demobilized police officers and instead of remaining redundant they can be made active and the credit will be taken by the security forces in combating environmental insecurities. Through interview a respondent observed that

> *the reserve force of the army has been planting trees, building schools, hospitals and other infrastructures in record time and they have used insufficient financial resources and hence if they put their attention on these policies of wastewater management then it will also be successful depending on the record the ex-servicemen have……(interview 31 with SEC00)*

This shows that environmental security can be best implemented by the security forces due to their courage and resilience while using meager resources which has been a problem to many civilian institutions that are riddled with bureaucracy, delaying tactics and respect of all procedures that in the end increase costs of ensuring that something is done well in a short time. Therefore, the respondents still believe the security officers have a big role to play in quick response ensuring environmental security through wastewater management.

4.8. Views on security related problems to wastewater management

The researcher went ahead to investigate the problems that are security related that can result from wastewater if managed ineffectively or inappropriately and gathered views through interviews, observation and focus group discussion. They argued that wastewater management if ineffective is a way for investment insecurities whereby the investors pull out of developing the country through industrialization and other business ventures simply due to increased costs of production, low supply of raw materials and speculations in the market. A respondent interviewed remarked that

> *In the case where the country doesn't have a central body to enforce sewerage and wastewater management through appropriate laws and policies, the contaminants affect the environmental security and investment by becomes unpredictable….(interview 32 with IM00)*

Figure 3: Wastewater released in the wetland in KSEZ

Source: Photo taken by researcher, February 2020

It should be noted that unpredictability in investment returns makes investment unsustainable and those who have participated in investment faces insecurity in capital markets and increased prices of their product. Therefore, such situation in investment security causes low innovations and hence sustainability of investment advancement is affected.

More still, it was observed that ineffective wastewater management is a major cause to many diseases like cholera, non-communicable diseases, malaria among others which are entirely life threatening to the communities and sometimes can result into health disasters. A respondent went ahead and asserted that

> *the security forces have resorted to human security that involves health security and it is in conformity with contemporary security challenges and dynamics that dictate that for physical security to succeed forces all over should first maintain human security where the issue of health security of the whole population is predominant…(interview 33 with SEC00)*

It should be noted that without a healthy population, security remains in tatters and therefore if wastewater is one of causes of destabilization of health security then much efforts should be directed towards its effectively. Therefore, health security is a concern of all governments in an endeavor to maintain health standards as high for its population since unhealthy population cannot work and it is costly during treatment. This if maintained will make a backbone for entire security achievable and sustainable.

Respondents further indicated that water itself has become a security concern in many areas where due to struggles to get water for domestic human consumption and animal consumption, a lot of problems related to security can emerge. This is due to the struggle for the fittest or ensuring that each community member has enough water for the several uses and some of the dry season have been prolonged leading to water insecurity. A respondent interviewed observed that

> *a lot of water is discharged from homes and industries that are prevalent in this study area instead of being treated and stored for future use and yet it will be needed in the future when all available produced water in the dry spells in not sufficient for the water demands of the communities in the study area….therefore policies on rainwater harvesting and wastewater management and treatment should take a center stage to avoid insecurity associated with water scarcity….(interview 34 with IS00)*

Figure 4:Drainage channel conveying wastewater in the wetland

Source: Photo taken by researcher, February 2020

It should be noted that water scarcity and insecurity for that matter falls in the domain of human security which is a great concern for security personnel and hence response should be rapid and consistent to ensure that such water insecurity is avoided before it causes problems. It is worth noting that although water insecurity has not been a big and pronounced problem but it shouldn't be underestimated before it multiplies to the communities in the study area as it has been a problem in many areas where water scarcity has made people resort to full scale war.

It was further noted that the discharged wastewater has been a cause of erosion of fertile soils around the area and sometimes depending on degree of discharge from industries and homes has destroyed crops through soil movement and landslides. This has been a recipe for food scarcity as

food sources are tampered with this wastewater and hence causing food security issues. Through interview with one of the respondents, he had this to say

> *food insecurities have been affecting the surrounding areas and the horticulture farming being affected by the released wastewater that contaminates the land, erodes away fertile soils and destroys the crops and vegetable grown in the slopes of the hills around Kigali special economic zone…(interview 35 with KSEZ00)*

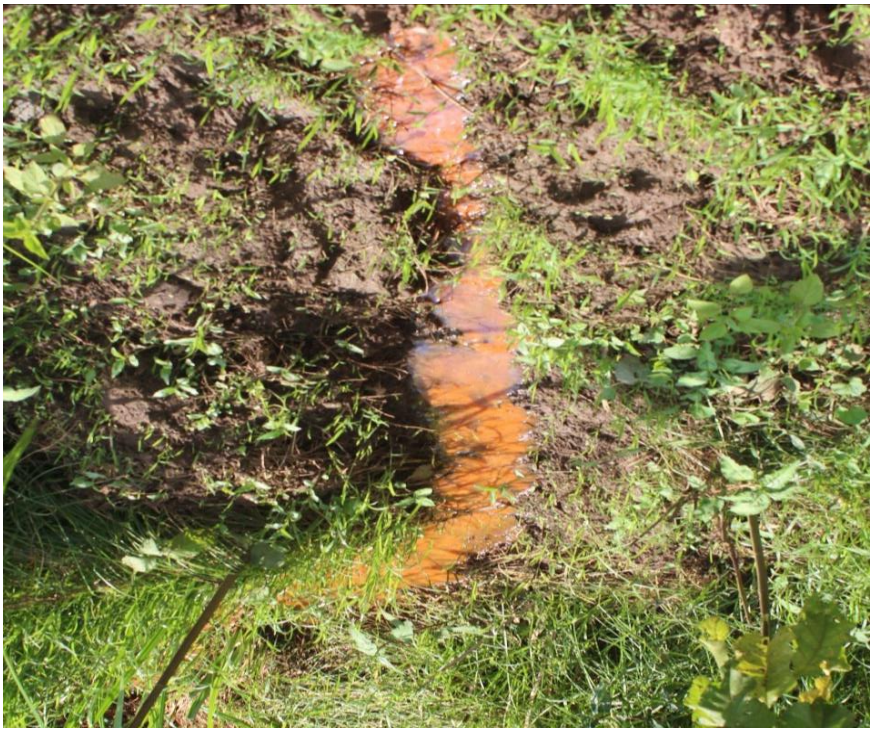

Figure 5:Drainage channel conveying wastewater in the wetland

Source: Photo taken by researcher, February 2020

This implies a security problem where a hungry nation is an angry person as the common saying goes. As earlier noted, that, food security falls in the category of human security issues that have of recent become part and parcel of all security personnel. In respect to responding to the contemporary challenges that are different from physical traditional security that must be guaranteed in tandem with human security. Therefore, the security personnel have to ensure food security and hence any issue that tampers with food security becomes a source of concern for the security personnel. It is against this background that wastewater management should be made effective to ensure that environmental security is safeguarded so that food security is guaranteed.

4.9. Findings on the theoretical framework on wastewater management

According to Ngoc and Schnitzer, it is fundamental in waste management to know the pattern of waste generation and their factors. (Harir, A.I. 2015:3). Waste Management Theory is based on the hypothesis that the way we describe a target prescribes action upon it, which implicates that sustainable waste management depends greatly upon how waste is defined. (Pongrácz, E, 2004:3). The researcher was interested in verification of the theories that entirely explains the wastewater management in the sense of effectiveness or ineffectiveness. From the available findings, the respondents had varied opinions on the two theories that were close to explaining the phenomena of wastewater and its management. During FGD the respondents observed that

> *it is a common thing in this area that the wastewater is from the industries and some are released when untreated and contaminates the environment, where wetlands and swamps are found thereby affecting the aquatic life in the area…(interview 36 with IS00)*

Therefore, if wastewater management depends on how waste is defined then this implies that industrial wastewater in the Kigali economic zone is common in the area and therefore management should be aimed at treating the wastewater from the industries and since it is dangerous compared to waster from homes then management should be prudent and the action upon this wastewater should be taken from strategic point of view by focusing on different consequences that emanate from industrials wastewater.

According to (Harir, A.I. 2015:3), it is fundamental that waste management to know the pattern of waste generation and their factors. According to respondents interviewed they observed that

> *it is true that wastewater generation is not seasonal as industries and homes don't stop operations of whatever they routinely do that produces the wastewater and discharge depends and pattern depends on few skills of the workers within the industries and homes whose knowledge on how harmful the wastewater is questionable…(interview 37 with MIN00)*

It can be argued that, pattern of waste generation depends on the size and type of industries that are predominant in the area. The level of production and size of the industries determines the wastewater discharged from the different industries. In the study area, some industries are on large

scale and other on small scale therefore the generation of wastewater entirely depends on the production process to determine the pattern of discharge of wastewater.

Furthermore, on how the theory denotes that how we describe the target determines the action upon it in terms of wastewater management. Respondents observed that

> *sometimes the wastewater is unpredictable in the area and in most cases multiplies in the rainy season or some homes and industries release it deep in the night where no action can be taken since it was not predicted and hence the action happens as crisis management instead of routine appropriate mechanisms of wastewater management…(interview 38 with SA00)*

This therefore shows that wastewater theories don't adequately explain how wastewater can be satisfactorily managed without any gaps but there is need for a regulatory body to handle it and fully supported such that industries are made serious in terms of wastewater management and they are held accountable to the regulatory body, therefore through the body wastewater management shall be planned well because the patterns and trends of wastewater release shall be easy to monitor and evaluate and gaps shall be minimized.

4.10. Chapter four conclusion

In conclusion, following the gathered findings from the field and in regard to the research questions that were set for this study a lot of the questions which the researcher had to answer the statement of the problem were exhaustively handled. Findings shows that the idea of wastewater is known by the respondents and they tried to now the different types of wastewater and how traditionally they have been managing wastewater despite the ineffectiveness that have been associated with them. Respondents further demonstrated understanding on how wastewater is harmful to the lives of people if discharged before decontamination especially the industrial water. They could mention the harmful effects of wastewater to the environment and the inhabitants.

Moreover, respondents indicated the challenges that are facing effective wastewater management such as failure to prioritize it since it hasn't caused many incidents and yet some of the leaders respond after incident have occurred, instead of being proactive. They also indicated that lack of skilled personnel to handle wastewater management is coupled with the absence of a waste management regulation to guide the management practices and as well conducting a monitoring

and evaluation for the different homes and industries that discharge wastewater. There is also another observation indicated that lack of a central treatment plant for the discharged wastewater that can decontaminate before it is discharged from the environment. Respondents also indicated that the environmental personnel are the very ones responsible for wastewater and much of their efforts is directed to environmental issues while disregarding wastewater and hence it would be independent so that monitoring issues become easier to produce required results.

Furthermore, on benefits of effective wastewater management, still respondents could mention that a central treatment plant for wastewater can provide employment to some unemployed personnel. They further indicated that decontamination of wastewater before it is discharged can safeguard environment from degradation. Decontaminated water can help to multiply the available water since it is a scarce resource and during the dry season probably the scarcity of water can be solved. The treated water according to the respondents also can help to support urban farming and rearing of small livestock where by floriculture and horticulture can be supported by the decontaminated discharged water from industries if it is directed towards the swamps and wetlands and when safe then this type of farming shall be sustainable and throughout all the seasons.

On how the security and environmental personnel and how they can contribute to wastewater management, the respondents indicated that they have to be vigilant and hold whoever discharges untreated wastewater carelessly to the environment accountable. Respondents further indicated that some personnel are not well trained to face the problem of wastewater management and hence explains their lukewarm response. The security officials need to participate like how they have been participating in other campaigns that are human security related and those of government where they have been taking a lead to show the community what is possible.

Lastly on how ineffective wastewater management is associated with security, respondents indicated that majorly environmental security when affected by contaminated water is a recipe for disasters that can spill over to other areas. Human security elements like food security, health security and investment can also be devastated by ineffective wastewater management and yet it is a focus of security officers to focus on the contemporary security challenges that are dangerous to humans than maintaining the traditional physical security. Foreign direct investment (FDI) is affected since foreigners cannot invest in a country where wastewater is threatening their lives and also handling it by themselves wholly can increase their cost of production which can increase the

price of finished goods and hence little incomes shall be realized due to the current low purchasing power of the communities surrounding the Kigali special industrial zone and other areas. Therefore, in general environmental protection to ensure its security should be the main aim of all policies and practices of wastewater management should be the cardinal aim because it is the mother of all security problems associated with ineffective wastewater management.

4.11. Discussion of chapter four

As the researcher, these findings portray that wastewater management is still ineffective as it is still mixed up with other sectors and whose personnel are less conversant with how to make wastewater management successful and avert the negative consequences of its ineffectiveness to the environmental security. The resources have largely been earmarked for solid waste management and environmental protection without minding the consequences independently brought about by wastewater if not managed properly.

The independent authority to manage wastewater and enforce standards of wastewater management wasn't operational during the data collection phase. This indicated gaps that can be phased out over a long time. The environment authority and environmental personnel were discovered not to carryout regular environmental impact assessment and when they do it, it is irregular that they monitor and evaluate the adherence to these standards by both the people in their homes and the industries. The personnel responsible for wastewater management are not qualified personnel since this sector remains a new phenomenon and hence security officers have been using their local knowledge to enforce the regulations regarding the wastewater without deeply understanding the real negative consequences of wastewater itself and they have been caring much on the environmental domain instead of focusing on the discharged water from homes and industries. The human activities on the shores of the study area where industries are blossoming go on unabated since those who could regulate them or harmonize them have insufficient knowledge about wastewater management. A lot is still needed to ensure that wastewater management is done well following acceptable standards that will definitely preserve environmental security. Wastewater management if done effective, there are a lot of associated benefits including economic activities that can uplift the standards of people near the wastewater treatment areas.

CHAPTER FIVE: SUMMARY , CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

The research study was undertaken in the Kigali Special Economic Zones and the surrounding areas to assess the effectiveness of wastewater management on environmental. This was to be achieved by looking at the research objectives and reviewed literature to be compared with the findings and thereafter suggest recommendations that can eliminate the identified research problem in the statement of the problem.

The study was anchored on three objectives namely, to determine the link between wastewater management and environmental security, to analyze the environmentally friendly strategies that can be used in industrial wastewater management and to investigate the security problems that can be caused by ineffective wastewater management. The objectives guided the study in conformity with the research questions that have been answered in the previous chapter. The following summary linked the ideas and arguments of the scholars and the objectives to come up with the summary.

5.1. Summary of findings on wastewater management concept

From the findings, the respondents complied with some of the definitions of wastewater that had earlier been reviewed in the literature. They observed that wastewater is also generated from homes after dishwashing, laundry, and using of the bathroom which is discharged through their local ways of pouring in the trenches. Respondents further indicated that the industries also release wastewater in the process of production of finished products that some of them use water as an ingredient and others washing down their machines after being used. This is quite relevant to (Cheremisinoff, N, P, 2001:2) who argued that wastewater is a consequence of several uses of water. They include domestic like showering, dishwashing, laundry and, of course, flushing the toilet. On top of that, companies apply water in many of their activities including processes, products, and cleaning or rinsing of parts. Following the usage of water, it transforms into wastewater stream, until it reaches wastewater treatment plant. The treatment of wastewater is to safeguard the environment eventually when the decontamination of wastewater is done it shall be released or treated for further uses that will go a long way in regulating the problem of water insecurities that are prevalent in the area.

5.2. Summary of findings on meaning wastewater management

The respondents during data collection believed that wastewater is harmful to their lives and the environment and hence there is need to handle it effectively in order to safeguard their lives and the environment security in which they dwell. Respondents indicated that management of wastewater should be done by central body which shall collect all the wastewater from the industries and homes and channel it to treatment plants. Following the treatment, the wastewater shall be decontaminated and can be domestically used again by the communities because water scarcity has been affecting them. Respondents also observed that wastewater is an environmental hazard which later can accelerate climatic changes in the area like leading to loss of rain and clean air if untreated water is released the precipitation is affected by the emissions form industries.

They also indicated that wastewater is a problem when it comes to soil destruction through erosion and hence management should be prioritized. This is quite similar (Singh, P, B, et al, 2015:22-23) who observed that wastewater management can be termed as handling or decontamination of waste water with a view to decreasing its contaminants in appropriate levels and to be safe for release to the environment. This has two forms namely the centralized and the decentralized whereby the former means large scale systems which collect wastewater from variety of users for decontamination in specified facilities and decentralized deals with wastewater from domestic users or small groups of people within the surroundings or a minor community level. From this background respondents demonstrated understanding of the meaning of wastewater management and its associated benefits if done effectively.

5.3. Summary of findings on dangers of wastewater

The researcher while summarizing on the dangers of wastewater discovered that wastewater is a problem although its incidents especially on health haven’t been summed up in general. Wastewater according to the respondents is a time bomb that needs careful and immediate policy interventions due to its associated health and other security related problems that are a danger to the community. Respondents further indicated that since wastewater treatment or decontamination is somehow a rare activity in the area, it means that the wastewater released by industries and homes is a danger because there is no central regulatory body to enforce wastewater treatment policies and hence it is a problem to the community around the study area. This data collected is

quite similar to the reviewed literature about the dangers of wastewater. According to (Bahri, A, 2012:21), it is asserted that microbial pollution, caused by exposure to animal wastes, inappropriate wastewater disposal and inadequate sanitation facilities, is the most important contaminant affecting human health. Indeed, achieving the sanitation target of the Millennium Development Goals is proving a greater challenge than expected and universal sewerage is thought to be an unattainable goal, even in the long term.

Therefore, since among the Sustainable Development goals, there is safe water and sanitation in general and wastewater in particular as goals to achieve then, it is timely that wastewater management is handled with the urgency it requires in an endeavor to achieve the goals associated with safe water achievement goals by United Nations and its member countries. Hence the reviewed literature portrays a danger in regard to wastewater management due to associated problems and the respondents didn't either too portray a rosy situation concerning how wastewater is managed and hence in summary a lot is needed to be done as far as wastewater management is concerned to curtail the dangers associated with wastewater.

5.4. Summary of findings on Challenges, opportunities and policy Implications

According to (UN REPORT, 2018:68) Managing wastewater by increasing wastewater collection and treatment (on site and off site) can support achievement of the 2030 Agenda. Wastewater should be seen as a sustainable source of water, energy, nutrients and other recoverable by-products, rather than as a burden. There researcher wanted to analyze the benefits, challenges and implications in terms of policy when there is either effective or ineffective wastewater management. Accordingly, the available data from respondents paint a grey picture as far as wastewater management is concerned. It is indicated as a non-prioritized sector whose would be professionals employed to give guidance and implementation have had a somehow blind eye towards wastewater management as most of them are more environmentalists than waste managers despite the thin line between both domains.

The findings indicate that the opportunities that are clearly laid down in the UN report 2018 have not been harnessed such as generating energy from wastewater, multiplication of water sources for the community and the industries as wastewater is decontaminated and treated for further use. Most of the wastewater goes to waste indeed and yet water is a scarce resource for the communities in the study area and beyond. It was observed that wastewater is released in drainage channels and

its destination is unknown to many members of the community as their interest is to get rid of the wastewater and nothing like knowing that its release to inappropriate ways is shooting themselves in the foot as the negative consequences return to haunt them later and affect a wide community yet such scenario would have been avoided.

The associated products of wastewater according to respondents have not been achieved too in addition to nutrients connected to treated wastewater. The wastewater through prudent management would be treated and released in swamps to support fish ponds or in general aquatic life but due to contaminated water even the not facilitated aquatic life is in danger of extinction. As noted from the respondents uses of wastewater that is treated before being released in the environment is an advantage for the safety of environments that can be a stepping stone to other activities that improve lives of people. The respondents noted that treated wastewater if released well and in time will increase efforts in floriculture and horticulture which can improve living standards through changing the nutrition and income standards. However, according to available data from respondents, they are still behind this UN REPORT program of making wastewater not a burden but as an opportunity. Therefore, on this reviewed literature and specifically on the aspirations of the UN REPORT a lot is needed to be done and prioritize wastewater management and do it with the intention to harness the advantages of wastewater management.

As far as policy implications is concerned, the respondents indicated absence of satisfactory central regulatory body and central treatment plant or a fully equipped plant that can streamline effective wastewater management. There is need according to respondents to encourage and support private individuals to ensure that concerted efforts and synergy in wastewater management is done well by all stakeholders since if private and public enterprises join hands would lead to successful wastewater management that would enable the community to harness advantages associated with effective wastewater management. However, some respondents among officials of the government, they argued that wastewater management authority is in offing and some steps have been taken to underline it's would be duties and responsibilities. On the other hand, personnel who have knowledge in wastewater be recruited to work in these positions to bring up a change in how effective wastewater management can be. It was observed that such responsibilities are still combined with those of environment that makes the situation cumbersome as environment is given more time and logistics compared to wastewater management or distribution by those

environmental authorities is skewed in favor of environmental conservation rather than all things that enable environmental protection and conservation successful.

Still on policy implementations, the respondents believe that environmental impact assessment and fulfillment of standards of environmental safety is transparently done. It is noted that some industries are established in areas where they should have not been established due to the threat of degradation of environment. This therefore means that the assessment wasn't done well or the periodic assessment is done badly not basing on the visible environmental hazards so far identified. It was also indicated that some of the safety standards are not yet implemented because some industries have not reached a breakeven point. Some industries don't have environmental and safety officers in place to streamline wastewater management and other environmental procedures, they don't train their staff on the subject of wastewater where they could underscore the advantages, challenges and strategies of wastewater management in an endeavor to get goodwill from all staff that the industry employs. This skills gap was identified as a policy challenge that much efforts should be directed upon and all the community members must be having the knowledge and skills including those in industries. Therefore, for effective results, all stakeholders must play their roles through guidance from higher authorities.

5.5. Discussion of findings in the context of the researcher

The researcher throughout the study discovered interesting things that have been achieved although not on a large scale and those that need attention after learning the recommendations of this study. It was discovered that the release of wastewater doesn't follow all the required standards and hence a recipe for security problems that might not be cost-effective to handle. This was observed among the respondents who argued that in their homes, they don't follow required procedures to release wastewater and although they would have wanted to reuse the wastewater after decontamination, it's not yet achievable due to lack of regulatory bodies to ensure that terms and conditions apply in disposal of wastewater. The communities are only interested in the results that have been underlined that if wastewater management turns out effective and hence their contribution as stakeholders will automatically be recognized.

Environmental impact assessment is done but not regularly and hence the standards that are set are not monitored and evaluated well to find out if they meet the expectations. In addition, the staff

who are left to implement them don't have sufficient skills and influence to make changes in wastewater disposal and management and at the end it is not given the priority it deserves. This capture the work done by the environmental authorities and all this can be history when waste management is separated from environmental protection because as population grows the demands of both becomes wide and demanding to the extent that efforts cannot be easily apportioned fairly.

More still, other challenges of released contaminated wastewater into swamps and wetlands through local drainage and trenches is an environmental problem that should attract attention of all responsible authorities. Environmental protection as a new domain must be given priority. The swamps act as precipitation centers and where climatic changes are regulated if handled well therefore, they should be safeguarded. Respondents believe that with decontaminated wastewater being disposed in the slopes of the industries in the study area, then beneficial uses of water shall be increased and water insecurities shall be regulated.

Wastewater management should be given priority through many strategies and encouraging many stakeholders including private investors to join the bandwagon of wastewater management due to its associated advantages and associated risks if not done effectively and it was discovered that all stakeholders are not on the same page and skills when it comes to wastewater management. Indeed, some didn't know their exact roles which brings in the idea of training and sensitization leave alone mobilization of stakeholders. Therefore, that is a gap that is identified and should be closed if effective wastewater management is to be achieved.

It is evident from collected data that security personnel have a lot of roles to play in ensuring that wastewater management is made effective. Indeed, their role is seen during data collection as somehow neglected or not given the required efforts it deserves. This means that the security people have not done enough and its high time they did the needful and show the way to other stakeholders in wastewater management. Depending on the history of the country the security forces have been at the fore front of ensuring that rebuilding and building the nation is done the way their commander in chief envisages. They have been not only morale boosters in implementation of the programs but active actors and who should give equal efforts to all government programs including the effective wastewater management.

Due to inappropriate and ineffective wastewater management some environmental security problems are prevalent and some have been associated with the released wastewater. Human

security problems such as food scarcity, water scarcity, environmental degradation, disaster outbreak, health security. These security problems were discovered and although they are not so prevalent but their prevention can go a long way in solving the associated problems. Since the study had a variable on environmental security, it is vital to note that if these identified security problems are not averted then their consequences can be devastating when they commence resulting into incidents. On top of that the cost for managing incidents, disasters, hazards, epidemics among others is much higher than management of wastewater effectively as a prevention tool.

On theoretical explanation of wastewater alone when separated from all waste that includes solid waste is hard to come by which gives a thorough explanation. Wastewater management is relatively a new phenomenon in developing countries and the research undertaken is yet to be sufficient and hence the reviewed literature doesn't give much although some theories were analyzed. These theories if all waste is together, a tangible theoretical explanation is relatively available to give an explanation that is need. Indeed all the reviewed literature if compared with the data gathered from the field, there is a clear explanation that wastewater management has had insufficient research by scholars and those in power have not invested much in the research about wastewater rather all efforts have been earmarked for environmental protection that takes all logistics at the expense of wastewater management and its research. However, this doesn't insinuate that theoretical explanation is absent rather it means that a lot is still needed to add on the available literature.

5.6. General Conclusion

Conclusively, the study went well and the data tried to answer the research questions that were set at the beginning of the study. Despite the time constraints which was worsened by the period of confinement due to COVID-19, the study went well as respondents were committed to give their views when the researcher assured them of the confidentiality of the information they were to give. Effective wastewater management is yet to be achieved since the urban planning and construction trends leave alone the existence of high-risk zones that are still habitable by the people in proximity of the industries still has issues. These issues have contributed to challenges in the decontamination of wastewater and its reuse in the safest way and much is lost despite the continued problem of scarcity of water especially in the dry spells.

It is also evident that all stakeholders are not involved in ensuring wastewater management is made successful and this points to a situation that it is not given the priority it requires to be effective. Diseases are not averted and are expected to increase if there is a slow pace of implementation of all procedures of environmental protection an effective wastewater management. It is also visible that human security related problems are given a fertile ground to blossom if identified settlement problems are not solved to conform to settlement and construction procedures that are in addition to failure to implement the environmental impact assessment standards that are set but somehow not monitored and evaluated such that whoever contravenes them faces the long arm of the law.

5.7. Recommendations

Following the successful data collection of findings, their interpretation and analysis, the researcher found it reasonable to recommend the following:

- The government should put in place a central regulatory body and if the law determining its operations has been passed, then its operations should be fast tracked to help in minimizing the gaps that have been identified in the study like all stakeholders to follow the same procedures and guidelines while releasing wastewater. The body if put in place will increase its presence on the ground and shall have field staff who shall be responsible for ensuring that decontamination of wastewater is done effectively to ensure environmental security.

- The government should operationalize a centralized wastewater treatment plant. This plant shall mitigate the unemployment problem in the area where the study was carried out. Wastewater treatment should be independent in order to manage effectively.

- Environmental impact assessment of industries and habitation areas in the proximity, should be done regularly following a periodic calendar and abrupt inspection to minimize gaps in implementation of procedures and guidelines given during assessment in order to ensure compliances.

- The criteria for environmental impact assessment should include wastewater impact assessment and disseminated to all the communities around which shall be used as notes during sensitization of the local communities. It was discovered that people were

found ill-informed about wastewater management and some are not even able to recognize that how it is generated and that once generated is not decontaminated for further use. Therefore, the tools depended upon while assessing waste should be disseminated to all stakeholders to ensure effective wastewater management.

- The responsible authorities should recruit competent professionals who have primary training in wastewater disposal and decontamination. It was discovered that most personnel who are expected to manage wastewater are not well trained or were recruited without following the expected procedures and hence have not been giving priority to wastewater management which this study was carrying out.

- Diversification of water through wastewater management should be made a priority because wastewater is a sure source of energy that can solve the energy problems existing and the treated water can be utilized for different uses and also support some economic activities like floriculture and horticulture. The development of urban farming to tap the ready existing market and cheap transport costs has become trending with the coming up also of green houses and nursery beds also in town areas and this can be supported by irrigation. Therefore, this decontaminated wastewater can be a sure source of water to help in this development that can improve nutritional and income standards of the communities around the study area.

- The authorities should sensitize people on the local strategies that can help in decontamination of wastewater. Many people queried on the study intimated to the researcher that the level of wastewater generation is low in homes and hence its disposal after decontamination is not taken as a serious issue. Therefore, there must be standards on disposal of wastewater that must be enforced by the law enforcement personnel such that all stakeholders are held accountable in circumstances where compliance is questioned.

- The security organs should a lead in initiating some of their funds and logistics in engaging in effective management of wastewater because if a disaster associated with wastewater occurs then both personnel will be at the forefront of disaster management and its associated costs that are too much more especially if they were not budgeted.

- The government should ensure that all industries have Water, Sanitation and Hygiene officers who shall work in coordination with security, safety and environmental officers in all industries. These are qualified personnel to handle wastewater management effectively because they shall undergo careful vetting basing on the criteria set that is in conformity with the job specifications that fits environment and wastewater management and protection of the associated dangers. Some industries have not operationalized these two important departments and their roles are being performed by other personnel with inadequate skills to move the management of wastewater effectively. It should be noted that these personnel should also be at sector levels and district levels to ensure that no gaps exist in the whole process of wastewater management.

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APPENDICES

Appendix A: **INTERVIEW GUIDE/ FOCUS GROUP DISCUSSION QUESTIONS (IBIBAZO)**

1. In your own view, how do you understand wastewater?

(Wumva iki iyo bavuze amazi yanduye?)

……

……

2. What kinds of wastewater are common in your area?

(ni ubuhe bwoko bw'amazi yanduye akunze kuboneka muri aka gace?)

……

……

3. What are characteristics that help you to recognise that this is untreated wastewater?

(Ni ibiki biranga amazi yanduye atasukuwe?)

……

……

4. Does the wastewater generated from the special economic zone and the surrounding area well treated before discharge to downstream?

(Amazi yakoreshejwe mu cyanya cy'inganda i Masoro arasukurwa mbere y,uko arekurirwa?)

……

……

5. Have you observed any untreated wastewater discharged in the wetland or rivers?

(haba hari amazi yanduye atasukuwe yoherezwa mu bishanga cg mu migezi muri kano gace?)

……

……

6. What are consequences in case untreated water is released in down streams and wetland?

Ni izihe ngaruka ibibonamo iyo amazi yanduye yoherejwe mu bishanga cg mu migezi?)

……

……

7. Why is wastewater management policy difficult to implement in this area?

(Kuki gutunganya amazi mabi yakoreshejwe bikomeje kugira imbogamizi mugushyirwa mubikorwa muri aka gace?

……

……

8. Do we have regulations for effluent discharge into sensitive waters in Rwanda? Yes or no, if your response is yes, tell me about these regulations

(Mu Rwanda twaba dufite amabwiriza agenga uko amazi yakoreshejwe ayoborwa mu bishanga no mu migezi?)

……

……

9. How do u see the effectiveness of the wastewater management in Kigali Special Economic Zone for the environmental security?

(uburyo bikorwamo ubuna buhagije ngo burinde iyangizwa ry'ibidukikije nk'ahantu hari inganda?)

……

……

10. What can the Government of Rwanda do to minimize untreated wastewater discharge in the environment?

(Leta y'u Rwanda yabafasha ite kugirango bagabanye ingano y,amazi mabi yakoreshejwe kuyarekura adatunganijwe?)

……

……

11. How can the security agents help in the implementation of wastewater management measure?

(Inzego z'Umutekano zafasha iki abayobozi b'inzego z'ibanze kugira ngo bashyire mubikorwa ingamba zo gutunganya amazi yanduye babungabunga ibidukikije?)

……

……

12. How people in the proximity will be affected long run effect on existing water resource due to wastewater from industrial area?

(Abaturage baturiye ahagenewe inganda baba baratekerejweho uko amazi yo mu nganda mu gihe kirekire yakwangiza amasoko y'amazi basanzwe bakoresha?)

……
……

13. What are the security related problems that result from ineffective wastewater management? (Ni izihe ngaruka k'Umutekano zikomoka mukudatunganya neza amazi yanduye arekurwa munganda?)

……
……

14. Mention challenges that you think contribute the ineffectiveness of wastewater management (Ni izihe mbogamizi utekereza ko zituma itunganywa ry'amazi yanduye ritagerwaho)

……
……

15. what are do you think can be done achieve effective wastewater management to a level that wastewater reuse will be attained?
(Ubona hakorwa iki ngo amazi yanduye atunganywe abe yanakongera gukoreshwa?)

……
……

16. How do the officers in charge of environment can help in this area to control wastewater management practices in place?
(Abayobozi bashinzwe ibidukikije n'ubuhinzi babafasha iki guhangana biterwa n'amazi mabi arekurwa adatunganijwe?)

……
……

List of respondents and their codes

Category of respondent	**Code**
REMA Staff	REM00
MINIRENA staff	MIN00
Industrial managers	IM00
Safety and environmental officers	SA00
Industrial staff	IS00
Sector environmental officers	SE00
Citizen dwelling in the proximity of Kigali Special Economic Zone	KSEZ00
NGOs staff dealing in environment	NGO00
Security officers	SEC00
Local governance officials	LOC00