**The impact of grey Water management on wastewater management in Somali cities; case study of Burao**

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# DECLARATION (A)

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# DECLARATION (B) -Declaration of the Supervisor/Moderator

This research paper has been submitted for defense with my approval as Strategia Netherlands WASH Course Diploma Supervisor

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date\_\_\_\_\_\_\_\_\_\_\_\_

# DEDICATION

I sincerely dedicate all my efforts to whom I worship, for my merciful Allah and the guider of my life as well as to my entire family for their support and their patience with my engagement of this work.

# ACKONWLEDGMENT

Alhamdulillah, all thanks belongs to my Allah, the Almighty, Most Merciful and Most

Compassionate, whose countless blessings have made me who I am and brought me where

Currently I am. All praises to Allah for the strengths and His blessing in completing this Course and paper preparation.

I have warm gratitude for my all lecturers, moderators and coordinators, both Online Resources Center and Strategia Netherlands team. I thank you for the all the Knowledge, skills, and abilities you gave me.

Secondly, let me thank to my family-my wife my children for their support and patience with my work engagement

Finally, I have special thanks for my supervisor; Professor Fredrick Rotemo, for his guidance and support led me to prepare this paper.

# 

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# ABSTRACT

# The majority of population growth in developing countries will occur in main cities where there is a limited access to clean water and sanitation. Wastewater management priorities in these cities is different from those in larger cities and developed countries. For this reason, it is important to assess wastewater management in these cities of sub-Saharan Africa. This is because, this study assessed the impact of grey Water management on wastewater management in Somali cities; case study of Burao. Since, Burao residents discharge their grey water directly to the streets and contribute the storm water pools in front of the households. This case study especially emphasized on Burao Grey Water Disposal behavior change. The specific objectives of the study were:1) To Investigate the Health impact of Burao Grey Water disposal behavior and frequent diseases experiencing by Burao neighborhoods; 2) To assess the best suited Grey water disposal system which currently can be adopted in terms of cost prior to a comprehensive Waste water Management System and Grey water reuse with treatment plant; 3) To prevent eutrophication of Ground Water and contamination of drinking water in the distribution pipes; and 4)To avoid the creation of bad odors , stagnant water, pedestrian obstacles, and vector

# breading sites; like Mosquitoes.

# The research was performed in January 2019 in six neighborhoods of Burao; namely: Sheick Bashir, Farah Omar, Lihle, Mohammed Ali, Adan Soleiman and Sayid Mohammed with a total of 30 household-respondents. In these neighborhoods, the questions were addressed and discussed with household head. The study uncovered that the most inhabitants were not satisfied with this current behavior and they would like to shift by planning a new Grey water disposal method. In addition, the study explores that the most frequent disease that Burao inhabitants experienced is vector-caused disease; especially Malaria. Of the city. In the light of this study, the municipal authorities of Burao should provide the city with wastewater systems that drain to a central outlet system where the waste-water can be easily treated before final disposal for reuse in agriculture or any other ensured purposes.

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**List of Acronyms/abbreviations:**

TS: Terra Solidari 14

UN: United Nations 13

UNICEF: United Nations Children's Fund………………………………………………………………………………………………….2

Wold Health Organization 6, 10

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# 1. CHAPTER ONE: Introduction

## 1 0 Overview

This chapter presents the background of the study, statement of the problem, research questions, research objectives, research hypotheses and justification of this study.

## Background information:

Waste water generally is made of black water and grey water. Grey water also known as sullage, is non-industrial waste water generated from domestic processes such as washing dishes, laundry and bathing. Grey water comprises 50-80% of residential waste water. Grey water is distinct from black water in the amount and composition of its chemical and biological contaminants (from faces or toxic chemicals). Grey water gets its name from its cloudy appearance and from its status as being neither fresh nor heavily polluted. Essentially, any water, other than toilet wastes, draining from a household is grey water. Although this used water may contain grease, food particles, hair and any number of other impurities, it may still be suitable for reuse. Reusing grey water serves two purposes: it reduces the amount of fresh water needed to supply a household, and reduces the amount of waste water entering sewer or septic systems. Grey water is domestic waste water that is collected from dwelling units, commercial building and institutions of the community. It may include process waste water of industry (food, laundries etc.) as well as ground infiltration and miscellaneous waste liquids.

Most diseases in developing countries are caused by lack of clean water and sanitation. In 35 developing countries worldwide, 26 of which are in sub-Saharan Africa, and coverage of improved drinking water supply is between 50% and 75% (WHO and UNICEF, 2006). Even if several significant efforts in terms of access to drinking water are noticed, the issue of sanitation remains a major challenge in developing countries. Poor wastewater management coupled with a lack of sanitation facilities has aggravated the sanitation challenges in cities of developing countries. Most of the population in these cities does not have access to improved sanitation facilities. In most major cities, if wastewater is not collected by individual systems, it is discharged without treatment into the street or into public storm water drains, causing contamination of water bodies and health risks. Poor sanitation is one of the most important contributors to morbidity and mortality in the world. In fact, ill- health associated with inadequate sanitation facilities is one of the most significant concerns in many developing countries. Moreover, the lack of appropriate sanitation is both a cause and effect of the vicious poverty cycle in which millions of people are trapped. The sanitation problem is more accentuated in secondary cities, because governments prioritize major cities, which are often also the seat of government. Secondary cities have not attracted as much economic activity, nor have they exhibited much internal dynamism in terms of management. There is a clear disparity between the public services received by the towns or cities, depending on their economic strata. The majority of African secondary cities and sometimes the primary cities have no sewage treatment services. Management of wastewater is worse within secondary cities and wastewater is often directly dumped into rivers, lakes or via open fields. Wastewater management priorities in these cities will be different from those in larger cities and developed countries. For instance, the sewerage coverage in Kampala city is relatively low, at less than 10%. On-site sanitation coverage is 90%.On-site sanitation options include: Mostly pit latrines and septic tanks, but also buckets and Polythyne bags ("Flying toilets") which are common in informal settlements (UN-HABITAT, HARGEISA OFFICE, 2015).

No studies have been conducted on Burao wastewater management, especially Grey Water. This was because, the study assesseed Grey water management and associated health and physical risks within the second capital of Somaliland; Burao.

## 1.2. Problem Statement:

Drainage and Waste water management is poor in nearly all towns in Somaliland. Limited existing systems are mainly blocked by solid waste. Urban construction has disturbed the natural drainage systems and cause accumulation of water in ponds (leading to spread of diseases) and frequent flooding, similarly centralized sewage system does not exist in all Somaliland Cities. The situation with regard to waste Water management in Burao as not been studied to the same extent as that of Somaliland major towns, but it is clear that many problems and issues are common between the regions. Burao (Togdheer Region) is one of the lowest types of sanitation facilities in Somaliland (Somaliland Ministery of Planning, 2011) . Only a fraction of the very limited pre-war sewage system in Hargeisa; the Somaliland Capital is still functioning. This implies that a more cost effective waste Water disposal system must be developed for Somaliland. Burao has its own Grey Water discharge behavior problem, where households discharge their Grey water directly to the roads which can cause both health and physical risks, because of absence of drainage, sewage system or any other functioning Grey water management system. Due to that, this study addressed the lack of Waste Water Management system and especially Burao improper Grey Water disposal behavior.

## 1.3. Research Objective:

1.3.1. Main Objective: The purpose of the study is to change the current disposal behavior of Waste water Management in Somaliland cities with special emphasis on Burao Grey Water Management Case study.

### 1.3.2. Specific Objectives:

1. To Investigate the Health impact of Burao Grey Water disposal behavior and frequent diseases experienced by Burao neighborhoods.
2. To assess the best suited Grey water disposal system which currently can be adopted in terms of cost prior to a comprehensive Waste water Management System and Grey water reuse with treatment plant.
3. To prevent eutrophication of Ground Water and contamination of drinking water in the distribution pipes.
4. To recommend ways of avoiding the creation of bad odors, stagnant water, pedestrian obstacles, and vector breading sites; like Mosquitoes.

## 1.4. Research Questions:

This study will answer questions to know the impacts and most appropriate approach that Burao neighborhoods can change their current Grey water disposal method. Hence, the relevant questions are:

1. As a household head, how is your level of satisfaction with the current Grey Water disposal behavior?
2. What are the most frequent diseases that you are experiencing in your neighborhood?
3. What is the most suitable sanitary structure or system that you are suggesting to adopt for Burao Grey water discharge?

## 1.5. Research hypotheses:

For the researcher experience, Hypothesis Commonly used in quantitative research but instead:

"There is no significant correlation between the current grey water disposal behavior of Burao and the frequent diseases that they are experiencing".

## **1.6. Justification of the study**:

This study searched solutions for the improper disposal of Burao Grey Water, analyzed the health and the physical risks of their current discharge behavior. This study has its significance for: ***Burao municipality***: The Burao Municipal Authorities are likely to benefit from this study by getting a signal on the Burao Grey water discharge issue. **Researchers:** Those who will conduct like this research in the near future and they may use as Secondary data. ***NGOs and other organizations***: will benefit when they want to intervene such projects related to the Waste Water Management in general and Grey water in particular. ***Burao residents:*** will be the final beneficiary since they will change their improper Grey water disposal behaviour at the end and they would be the immediate looser if it was not conducted.

## 1.7. Rationale:

Grey water generally has lower concentrations of pathogens in it than other wastewater; like black water, but it may still contain some pathogens, which are introduced into the grey water from washing babies’ diapers, laundry, personal hygiene or other sources (WHO, 2006) *WHO Guidelines for the Safe Use of Wastewater, excreta and grey water. World Health Organization, Geneva*.

According to the reports: 25% of World's Population and 60% population in developing countries lack basic house sanitation. 40% of urban and 84% of rural population in the 3rd World lack basic sanitation ( (WHO, 1990). 80% of health problems in developing countries is due to lack of safe water and basic sanitation. About 45% of all deaths in under- Fives is due to diarrhea (WHO, 1998).

The chemical components of grey water such as Nitrogen and Phosphorus are beneficial to plants, but become pollutants when they are directly released to soil, rivers and other water sources in the cities. Similarly, discharging grey water to the streets and in front of dwellers can cause health consequences in several routes.

For the above reasons, there is a suspicion and Burao inhabitants believe that there was a link between the Burao Cholera break-out in 2017 (WHO and Somaliland Ministery of Health, 2017) which claimed nearly seventy people in and around Burao and its improper Grey Water disposal behavior. This study will be a unique and the first study which is conducted on Burao Grey Waste Water disposal.

## 1.8. Scope and Limitation

Despite the huge Research topic: "*The impact of Grey Water management on wastewater management in Somali cities; Case study of Burao".* The study specifically addressed andfocused on the issue of Burao Improper Grey water Disposal issue excluding Grey water reuse and it’s Treatment which becomes a very small portion among the Waste Water Management. This study was conducted within a period of one month.

The limitations of this study were include: that the researcher reviewed and analyzed various sources that was researched and published for different aims and problems that could not match to this study purpose clearly. Secondly, the researcher encountered a problem to meet and interview with many important Household heads since they were female and became ashamed through interview privately. Time availability for many expected key interviewee remained a constraint. Thirdly, the time and deadline stress was among the limitations.

# **2.0. CHAPTER TWO: LITERATURE REVIEW**

In reviewing literature, this study explored and reviewed previous books and publications on Waste water Management in general and Grey water in particular though in this grey water issue researches and books were very limited. There were few publications and reports specifically related to this study. Variety documents were reviewed including limited research reports, professional papers, project documents, project and annual reports, those reflecting information about the Waste Water Management and Grey water issue. The review literature were among websites, policies, guidelines, and academic texts. This review's purpose was at identifying the research gaps to the existing literature and emphasizing on the need to conduct this case study which was concerned with Grey Water management-Burao case study. Respectively they were:

**WASH Minimum standards:**

***Minimum Standard 6: Drainage***

Surface water in or near emergency settlements may come from household and water point wastewater, leaking toilets and sewers, rainwater or rising flood water. The main health risks associated with surface water are contamination of water supplies and the living environment, damage to toilets and dwellings, vector breeding and drowning. Rainwater and rising floodwaters can worsen the drainage situation in a settlement and further increase the risk of contamination. A proper drainage plan, addressing storm water drainage through site planning and wastewater disposal using small-scale, on-site drainage, should be implemented to reduce potential health risks to the population. This section addresses small-scale drainage problems and activities. Large-scale drainage is generally determined by site selection and development.

*Drainage standard 1*: drainage works People have an environment in which the health and other risks posed by water erosion and standing water, including storm water, floodwater, domestic wastewater and wastewater from medical facilities, are minimized. Key indicators (to be read in conjunction with the guidance notes) Areas around dwellings and water points are kept free of standing wastewater, and storm water drains are kept clear. Shelters, paths and water and sanitation facilities are not flooded or eroded by water.

2. *Wastewater*: Sullage or domestic wastewater is classified as sewage when mixed with human excreta. Unless the settlement is sited where there is an existing sewerage system, domestic wastewater should not be allowed to mix with human waste. Sewage is difficult and more expensive to treat than domestic wastewater. At water points and washing and bathing areas, the creation of small gardens to utilize wastewater should be encouraged. Special attention needs to be paid to prevent wastewater from washing and bathing areas contaminating water sources.

3*. Drainage and excreta disposal*: special care is needed to protect toilets and sewers from flooding in order to avoid structural damage and leakage ( (Engineering in Emergencies, 2013).

## 2.1. Sanitation and behavioral change

The most important aspects of safe Sanitation is that it is achieved only through Behavior Change. Let us first understand two important terms i.e., Sanitation and Behavioral change. The word sanitation means “the hygienic means of promoting health through prevention of human contact with the hazards of wastes as well as the treatment and proper disposal of sewage or wastewater”. And the word „Behavioral change‟ means “it can refer to any transformation or modification of human behavior. It may also refer to: behavior change (public health), a broad range of activities and approaches which focus on the individual, community and environmental influences on behavior (SWachh Bharat Mission).

In general Behavioral change process involves the following:

1. Awareness;
2. Desire;
3. Knowledge and skill ;
4. Trying out;
5. Repeating & maintaining ;and
6. Sustaining

## 2.2. Link between stagnant Grey Waste water and Vector breeding; Mosquito in particular:

A major concern with using grey water is the potential health risks associated with ponding of grey water from unsatisfactory disposal practices and inadequately maintained grey water facilities. Surface ponds of grey water and poorly maintained grey water treatment plants provide ideal breeding habitat for mosquitoes. Some mosquito species are capable to breed in temporary and semi-permanent ponds that develop through poor wastewater disposal practices. Mosquitoes will also breed in any treatment plant, holding tank or receptacle where water is allowed to stagnate for a few days (SANDEC & ETH DUWIS, 2005).

## 2.3. Management of non-sewered sanitation:

Municipal Government generally has very limited capacity and resources to deal with on-plot or non-sewered sanitation. A complex range of stakeholders have emerged to provide individual or shared sanitation services in urban areas including: Municipal/Central government, private developers, informal private sector, water utilities, civil society (NGOs and CBOs) and individual households.

The public role in non-sewered sanitation may appear to be less significant than for sewered systems, but there are many sanitation related public activities that need to be carried out to ensure that contamination of the local environment and health risks are minimized. The arrangement of non-sewered sanitation services is often considered a series of services-often termed the “Sanitation Service chain”.

Where there are no sewers transporting sewage from a household to a treatment facility in a continues system, the chain consists of a series of separate activities-or services-that rely on the next step to “transport” sewage away from the latrine or septic tank. The chain of services starts with the service needs of a household latrine or public sanitation facility, where excreta and waste water are generated. The chain then supports the services needed in the environment around the latrine facility, then in the local neighborhood and out to the wide urban area (such as a locality or ward, or the whole town or city). It continues until the service chain ideally reaches a point where the waste can be safely treated, reused, or disposed of (Sansom K. , 2013).

## 2.4. Methods of Sanitation:

Although the idealized image of an urban sanitation service is separate sewers with waste water treatment, this is far from the reality for most of the world’s urban residents. In reality deliberate and accidental misconnections will mean that storm sewers contain faeces and foul sewage flows will vary considerably according to the amount of rainfall. Even where the storm water and foul wastewater are kept separate, urban runoff is not clean and can cause pollution. This will include faecal material from open defecation, poorly constructed and maintained shared or individual latrines, flying toilets (excrement in plastic bags thrown away as solid waste), septic tank overflows, and flooded sewers.

Coverage of sewers is low in many developing countries; where there are sewers, treatment facilities may not exist or not be working correctly, leading to pollution downstream. Maintenance and repair of infrastructure have a low priority and can be expensive. Water borne sewage requires vast quantities of water, a cost that the poor and the environment may not be able to bear (Sansom K. , 2013).

The range of Methods for disposing of excreta is wide, including:

1. Flush toilets, leading to:
2. Sewers with or without treatment;
3. Small-bore and simplified sewerage system;
4. Septic tanks; and
5. Cesspits and tankers (with or without treatment)
6. Pit latrines, including:
7. Simple pits;
8. Ventilated pits;
9. Composting vaults; and
10. Buckets and vaults
11. Other routes (Mainly unacceptable), including:
12. Open defecation; and
13. Plastic bags (Flying toilets)

(Emmerson, 1998), suggested alternative source of water is grey water. Grey water is the water that goes down domestic bathroom and laundry drains. If this water is diverted for relatively safe applications such as garden irrigation, then a family can reduce their water usage by around 30-50 percent saving. Grey water reuse also offers environmental benefit but a caution should be exercised to avoid public health and the environment risk.

(Abdillahi, 2015), investigated the effect of urban sewage on water pollution in Hargeisa, Somaliland. The researcher focuses on the drainage and pollution aspect of water and those factors which are contributing the storm water; like types of construction, economic and the like, but the study does not concentrate on the waste water and its collection.

## 2.4. Research gap/Conclusion:

Mainly, all the above literature concentrate on the general aspect of Grey water; like Source separation, sewers, transporting, treatment, recycling and reuse; on the contrary this study investigated and engaged with only Burao current Grey water discharge behavior and its change plan since there was no one single study has been previously conducted.

## 2.5. Theoretical Framework

This study will be guided by The Transtheoretical Model (also called the Stages of Change Model), developed by Prochaska and DiClemente in the late 1970s. The Transtheoretical Model provides suggested strategies for public health interventions to address people at various stages of the decision-making process. This can result in interventions that are tailored (i.e., a message or program component has been specifically created for a target population's level of knowledge and motivation) and effective. The TTM encourages an assessment of an individual's current stage of change and accounts for relapse in people's decision-making process.

## 2.6. Conceptual frame work

This portion prospects a schematic interpretation of the researcher’s conceptual framework as shown in the figure below.

Figure 2. 1 Conceptual framework

**Independent variables Dependent Variables**

**Improper Grey Water discharge behavior realization**

+

**Acceptable (Suited Methods/ Grey Water discharge and proper Grey water Management System**

**The link between the current improper Grey water discharge and Health (Vector bread) risk-Knowledge**

**Source: The researcher**

# 3. CHAPTER 3: METHODOLOGY

The chapter presents description of the research methodology which was used to answer questions described in chapter one of this case study. The methodology was used in this case study includes research design, target population, sampling design and data collection and analysis procedures.

## 3.0. Philosophical paradigm:

Philosophical paradigm of this study is Constructivism since this philosophy accepts reality as a construct of human mind, therefore reality is perceived to be subjective.

## 3.1. Study Design:

In this study, the researcher adopted a descriptive design (Case study) according to Research Questions and Personal Experiences. Descriptive in that data collected was used to describe a phenomenon.

## 3.1.1. Study site:

Somaliland is situated in the Horn of Africa and is bordered by Djibouti to the West, Ethiopia to the South, and Puntland state of Somalia to the East. Somaliland has a land surface area of about 180,000 km2 (UN-HABITAT, HARGEISA OFFICE, 2015). It is regarded internationally as a self-declared autonomous region of Somalia, although the Government of Somaliland considers itself as an independent state. Somaliland has six main regions, in which there are six capitals namely: Hargeisa-the Capital, Burao; the Second capital, Borama, Erigavo, Berbera, Gebiley and Lasanod.

***Burao Profile:***

Burao is the second-largest city of the self-proclaimed "Republic of Somaliland"; it is situated in the central part of the Togdheer Region of Former Somalia, about 290 km East of the capital, Hargeisa and 136 km S E of the port of Berbera. The approximate coordinates are 9031'N, and 45035'E, while the altitude is 1040 m amsl.

The Town occupies a central position on the extensive Haud Plateau, a sparsely populated plain that serves mainly as a livestock grazing area (Marco, 2005). Due to the presence of the dried- River of Togdheer (the largest seasonal stream of the region), the availability of water is much better than elsewhere on the plateau. Since the construction of the paved road connecting the town with Mogadishu, Berbera and Hargeisa, transport facilities have greatly improved. Geographically, Burao is the center of Somaliland, has boarders with 4 Out of Six regions of Somaliland. Burao is the economic center of Somaliland, since it is the largest livestock center in the country and it is the Gateway to Somalia. These factors have led to a rapid growth in population: over a period of only 50 years, the population of Burao grew from a few thousand in 1960 to about 480,000 in 2019 (TS Organization, 2012) Burao currently hosts nearly half a million inhabitants.

### 3.1.2. Research Approach:

This study utilized a qualitative approach. According to Cress well (1994) a qualitative study is defined as an inquiry process of understanding a social or human problem, based on building a complex, holistic picture, formed with words, reporting detailed views of informants, and conducted in a natural setting. The researcher selects this approach due to:

1. The nature of the research questions. This case study, the research question often starts with a *how*or a *what*so that initial forays into the topic describe what is going on;
2. That the variables cannot be easily identified, theories are not available to explain behavior of participants or their population of study, and theories need to be developed;
3. The need to present a detailed view of the topic. The side angle lens of the distant panoramic shot will not suffice to present answers to the problem, or the close-up view does not exist;
4. Study individuals in their *natural setting.*This involves going out to the setting or field of study, gaining access, and gathering material. If participants are removed from their setting, it leads to contrived findings that are out of context; and
5. The most important one that; *audiences are receptive*to qualitative research.

### 3.1.3. Research Method:

The type of method which was used to conduct this study was Case study method. This method was selected by the researcher since this study focused one single case.

### 3.1.4. Data needs, types and sources:

In this study, Interview and secondary data (Document reviews) were used to collect the data. The interview probes were structured and detail-oriented in such a way that it collect in qualitative manner. Primary Data: interview probes were selected which directly asked to household heads to collect their responses so that it were tabulated and analyzed. The research was used structured probes. For Secondary Data: despite the gap of existing previous researches on this issue; the study reviewed some available data from relevant sectors; such as reports from health organizations, International agencies, reports and Government Institutions.

### 3.1.5. Population, Sampling procedure and Data collection:

In this study the target population was respondents coming from all six districts of Burao capital which were 60 households from all neighborhoods and a sample size of 30 household heads as respondents in order to collect accurate information about the variables.

Simple random sampling was used to collect this data or select the respondents since they lived different districts in the capital so that they would get equal opportunity to be reached.The data was collected by using Interview instrument. The Interview probes were contained ten (10) questions, relating to: socio-demographic, Grey water disposal behavior at household and city level, and associated health and physical risks.

Interview design: The detail-oriented interview probes were used to ascertain facts, opinions, beliefs, attitude and practice about the study area. An example of the interview sample used is at the appendix.

Table3. 1 Target Population

|  |  |  |
| --- | --- | --- |
| ***Category*** | ***Frequency*** | ***Percentage*** |
| Sheick Bashir | 10 | 17 |
| Farah omar | 10 | 17 |
| Lihle | 10 | 17 |
| Adan Soleiman | 10 | 17 |
| Mohammed Ali | 10 | 17 |
| Sayid Mohammed | 10 | 17 |
| **Total** | **60** | **100** |

**Sample Design**

A sample is a representative of population. The sampling technique adopted was stratified random sampling method. It was used since it is reviewed to be free from biasness of population; it considered all different neighborhoods. A sample size of 30 respondents was drawn representing 50% of the target population.

table3. 2 Sampling design

|  |  |  |  |
| --- | --- | --- | --- |
| ***Category*** | ***Frequency*** | ***Sample size (50%)*** | ***Percentage*** |
| Sheick Bashir | 10 | 5 | 17 |
| Farah omar | 10 | 5 | 17 |
| Lihle | 10 | 5 | 17 |
| Adan Soleiman | 10 | 5 | 17 |
| Mohammed Ali | 10 | 5 | 17 |
| Sayid Mohammed | 10 | 5 | 17 |
| **Total** | **60** | **30** | **100** |

### 3.1.6. Data Analysis:

Since the approach of the study is qualitative one and its audiences are receptive*.* Then the data obtained by interview probes was recorded andthe responses were standardized and registered in a file; whole percentages were used for data analysis. Then, detailed data were analyzed on the basis of the simple tabulation and the cross tabulation of a range of variable. Data analysis were carried out in Microsoft Excel tools. Moreover, the tables and figures were drawn with Excel software.

### 3.1.7. Data Presentation:

Data collected from field was presented to analyze and discuss in line with to research objectives and interview probes. Analysis presented by using frequency tables and percentages, presented in graphs, charts and to be interpreted then. The structured and detail-oriented interview probes were analyzed in qualitative nature.

## 4.0. Validity and Reliability/Credibility

Validity in qualitative research means “appropriateness” of the tools, processes, and data. Whether the research question or Interview probe is valid for the desired outcome, the choice of methodology is appropriate for answering the research question, the design is valid for the methodology, the sampling and data analysis is appropriate, and finally the results and conclusions are valid for the sample and context.

So, to enhance the credibility of this study and ensure the ‘trustworthiness’ of the findings during research design and implementation; these strategies were utilized:

* 1. Engaging with other researchers to reduce research bias;
  2. Demonstrating clarity in terms of thought processes during data analysis and subsequent interpretations;
  3. Respondent validation: includes inviting participants to comment on the interview transcript and whether the final themes and concepts created adequately reflect the phenomena being investigated; and
  4. Establishing a comparison case/seeking out similarities and differences across accounts to ensure different perspectives are represented.

# 

## 5.0. Ethics

This study followed the principles of voluntary participation. Interviewees were asked the information as informed by the researcher that research aims. All reviewed literature documents will be published for public uses and therefore there will be obligations to ask permissions to the authors. Referencing principles will be applied in this study. Interviewees were given the option to quit at any time. Reliability of reviewed documents was supported by life experiences of the researchers in Somaliland public institutions. This study considers thoughts and models of literature review.

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# **CHABTER 4: PRESENTATIONS OF FINDINGS, ANALYSIS AND INTERPRETATION**

## 4.1. Introduction

This chapter undertake to analyze and discuss the data collected from the respondents in relation to research objectives and Interview probes. Analysis were presented by using frequency tables and percentages, presented in graphs charts and interpreted thereafter. The structured questions of the interview were analyzed in qualitative nature.

## 4.2. Presentation of findings

### 4.2.1. Household Water source

Table4. 1 Water sources to assess their Grey water production

|  |  |  |
| --- | --- | --- |
| **Water Source** | **Frequency** | **Percentage** |
| Piped Water | 15 | 50 |
| Water Kiosk | 5 | 17 |
| Water tanker/vendor | 10 | 33 |
| **Total** | **30** | **100** |

Figure 4. 1 Household Water source

The above table 4.1 and figure 4.1. Shows the Household water source of respondents. From the analysis majority of the respondents at 50% stated that their water source is piped water, 33% of the respondents from Water tanker, while the rest of 17% collect water from public kiosks. Based on the study it can be concluded that majority of the respondents consume piped water. Based on that, their generation of Grey waste water will be more than any other water source consumers.

### 4.2.2. The Household current Grey Water Disposal method

Table4. 2 Current Method

|  |  |  |
| --- | --- | --- |
| **Current Method** | **Frequency** | **Percentage** |
| Septic Tank | 3 | 10 |
| Toilet | 3 | 10 |
| Open-discharge/In front of the house | 24 | 80 |
| **Total** | **30** | **100** |

Figure 4. 2 Current Method and Grey Water disposal behavior

The above table 4.2 and figure 4.2. Shows the current Grey water disposal method of respondents. From the analysis majority of the respondents at 80% stated that their disposal method is open-discharge, 10% of the respondents use septic tank as a disposal method, while the rest of them which is 10% use their toilet as Grey water disposal method. Based on the study it can be concluded that majority of the respondents use open-discharge/in front of their dwellings to dispose of their Grey water.

### 4.2.3. The Health impact of Burao current Grey Water Discharge behavior

Table4. 3 Health impact

|  |  |  |
| --- | --- | --- |
| **Water Source** | **Frequency** | **Percentage** |
| Malaria | 15 | 50 |
| Cold/Flue | 10 | 33 |
| Typhoid | 5 | 17 |
| **Total** | **30** | **100** |

Figure 4. 3 Most frequent diseases

The above table 4.3 and figure 4.3 Shows the most frequent disease of respondents. From the analysis majority of the respondents at 50% stated that their most frequent disease is Malaria, 33% of the respondents fall cold or Flu, while the rest of them which is 17% frequently feel Typhoid. Based on the study it can be concluded that majority of the respondents frequently fall in Malaria caused by Mosquito breeding in the stagnant water, while others feel other diseases which indirectly coming from that poor sanitation behaviour.

4.2.4. How the household heads satisfied with current Grey water disposal behavior (as a **rank)**

Table4. 4 Level of satisfaction and willing to change

|  |  |  |
| --- | --- | --- |
| **Rank of Satisfaction** | **Frequency** | **Percentage** |
| Very satisfied | 0 | 0 |
| Satisfied | 0 | 0 |
| Ok | 5 | 17 |
| Dissatisfied | 10 | 33 |
| Very dissatisfied | 15 | 50 |
| **Total** | **30** | **100** |

Figure 4. 4 Level of their current Disposal behavior satisfaction

The above table 4.4 and figure 4.4. Shows the current Grey water disposal behaviour satisfaction of respondents. From the analysis majority of the respondents at 50% stated that they are very dissatisfied their current disposal method , 33% of the respondents are dissatisfied with this current disposal method, while the rest of them which is 17% are in OK level of current Grey water disposal method. Based on the study it can be concluded that majority of the respondents are very dissatisfied while others are dissatisfied with this current method of their Grey water disposal.

### 4.2.6. Most suited Method which the household head prefer to change this behavior)

Table4. 5 Suitable Method

|  |  |  |
| --- | --- | --- |
| **Sanitation Method** | **Frequency** | **Percentage** |
| Sewers and sewage system | 4 | 13 |
| Simplified Sewage system | 2 | 7 |
| Centralized Septic tank | 24 | 80 |
| **Total** | **30** | **100** |

Figure 4. 5 Suitable Methods

The above table 4.5 and figure 4.5. Shows the most preferable suitable method of respondents. From the analysis majority of the respondents at 80% stated that they would like is Centralized Septic tank, 13% of the respondents prefer Sewers and Sewage system method, while the rest of them which is 7% would like Simplified system method. Based on the study we pointed that majority of the household heads prefer and selected a centralized septic tank.

# CHABTER 5. DISCUSSIONS AND RESULTS

## 5.1. Water sources

According to data table 4.1. And figure 4.1. The study found that the majority (50%) of the household heads or the respondents use piped water, this sounds that their grey water generation will be more enough to dispose of.

## 5.2. The household respondent’s current Grey water disposal method:

Based on data table 4.2. And Figure 4.2. The study found 80% of the respondents representing 50% of Burao neighborhoods use Open-discharge or in front of their dwellers for Grey water disposal. This poor sanitation behavior needs to address and change.

## 5.3. Link between the Improper Grey Water Disposal and vector breading/ Health impact:

Based on the data table 4.3 and figure 4.3. Showed that 50% of the respondents stated that they frequent fell Malaria caused by Mosquito and the Mosquito breeding and multiplies in those Grey water stagnant water in front of their houses. So, there is a link between the Grey Water disposal behavior and the vector breading.

5.4. Level of their Grey Water Disposal behavior satisfaction (Sanitation behavior **Change):**

According to data table 4.4. And Figure 4.4. The study showed that 50% of the interviewees are very dissatisfied with their current grey water disposal for their own experienced reasons. This sends a message that the respondents are willing to change their poor grey Water disposal behavior.

## 5.5. Suited Methods/ Grey Water Disposal methods preference:

Based on the data table 4.5 and figure 4.5. The study showed that the respondents prefer to use a centralized septic tank for their grey water disposal since the Municipal authority current cannot afford to implement sewers with sewage system.

## 5.1. Limitations of the study

. Limitations of this study were include:

1. The study concentrated on Burao Grey Water discharge/disposal behavior change approaches which mainly focuses to neighborhoods and household heads level.
2. The population of study was taken from the six Burao neighborhoods who have had experience in their Grey water disposal behavior issue and its impact.
3. The researcher encountered a problem to meet and interview with many important and issue- concerned household heads, though immediately were replaced, while time availability for many expected key informants remained a constraint; and
4. Absence of previously conducted researches on Somaliland Grey Water or Wastewater Management at large issue was the biggest challenge.

## 5.2. Conclusions

According to the findings and discussions above, this study explored that:

1. Burao Households produce more grey water since the majority of their water resource is piped Water system.
2. The study found that 80% of the respondents representing 50% of Burao neighborhoods use Open-discharge or in front of their dwellers for Grey water disposal. This poor sanitation behavior needs to address and change.
3. A 50% of the Interviewees stated that they frequent fell Malaria caused by Mosquito, while Mosquito bread and multiplies in those Grey water stagnant water in front of their houses. So, the result is that there is a link between the Grey Water disposal behavior and the vector breading.
4. This showed that majority of the respondents are very dissatisfied with their current Grey water discharge behavior. This means that they are ready for and willing to change their improper behavior.
5. A septic tank is the most suited Grey water disposal that they suggested.

## 5.3. Recommendations

The study recommends:

1. It would be significant for the Burao Local authority to increase levels of investment in Waste Water Management, especially Grey Water Disposal and other sanitation facilities, prior to complete waste water management they should encourage and take the lead construction of centralized septic tanks.
2. In addition, Burao Local Council must multiply the public awareness campaigns of the populations to hygiene and healthiness programs for improvements of the environmental health benefits and facilitate the construction of basic improved sanitation facilities; including sewage system and for the households based on joint efforts with the community.
3. According to the study findings the local authority should provide a vector control means campaign before switching this grey water disposal behavior to protect the mosquito breeding.
4. Central Government should provide drainages in both Primary cities and the secondary cities of Somaliland and effective and sustainable Grey wastewater management, treatment plant according to the population size.
5. According to the need; provision of more additional vacuum trucks is also advisable;
6. Finally, it is advisable to invest a comprehensive research on the issue of Somaliland Waste water management in general and Burao Grey Water Disposal in particular.

# 

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# APPENDICES

APPENDEX 1. 1: RESEARCH INTERVIEW

Questionnaire on "***The impact of grey Water management on wastewater management in Somali cities; case study of Burao***"

*Kindly answer the questions by putting a tick in the appropriate box or by writing in the space provided.*

**SECTION A: Demographic characteristics of Respondents (*GENERAL* INFORMATION)**

1. **Gender:**

Male { }

Female { }

1. **Age:**

Between 18-25 { }

Between 26-35 { }

Between 36-45 { }

Between 46-55 { }

Above 55 { }

1. **What is your household Water source/point:**

**………………………………………………………………………………………………………………………………………………………………………………………………………………**

1. **What is your current Grey Water Disposal Method?**

………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………

1. **Duration of residing in this neighborhood**

1 years and below { }

2-5 years { }

6-8 years { }

9-11 years { }

1. ears and above { }
2. **What is your house/Family responsibility?**

Father { }

Mother { }

Elder son { }

Elder daughter { }

Other { }

**SECTION B: Health impact or frequent diseases**

1. How often you and your family member feel sick frequently?

………………………………………………………………………………………………………………………………………………………………………………………………………………………………

8. What is the most frequent illness/disease you feel?

………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………................................................

**SECTION C: Most suited system of Grey water Management**

8. As a household head, how is your level of satisfaction with the current Grey water disposal behavior of Burao?

……………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………...................................................

9. What are the main challenges do you encounter (if) on this Burao Grey water discharge behavior?

………………………………………………………………………………………………………………………………………………………………………………................................

...................................................................................................................................................

10. Suggest the means (Methods) and systems in which Burao Grey water management can be improved?

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APPENDEX 1. 2 Somaliland Cities Map

##### Image result for somaliland map

Figure 1: Somaliland Cities Map

APPENDEX 1. 3TYPES OF WASTE WATER

APPENDEX 1. 4 GREY AND RUN OFF WATER STAGNANTS PHOTOS

