Pan African University
Institute of Water
and Energy Sciences

PAN-AFRICAN UNIVERSITY
INSTITUTE FOR WATER AND ENERGY SCIENCES
(including CLIMATE CHANGE)

Master Dissertation

Submitted in partial fulfillment of the requirements for the Master degree in

Water Policy

Presented by

Abdulrahman Mohamud DIRIE

Implications of Water Policy on Coastal Pollution:
A Case Study of Mogadishu Coast

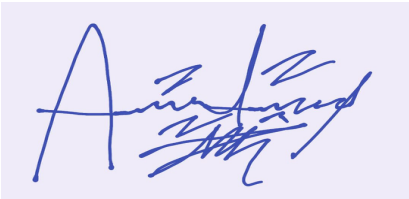
Defended on 19/09/2020 Before the Following Committee:

Chair	Mustapha Kamel Mihoubi	Prof	MRE
Supervisor	NADIA Badr El-Sayed	Prof	University of Alexandia
External Examiner	Ahmed Mohamed Badr	Prof	ElDin
Internal Examiner	Douaoui Abdelkader	Prof	University of Tipasa

ACADEMIC YEAR: 2019-2020

DECLARATION

I, **Abdulrahman Mohamud Dirie** hereby declare that this thesis represents my personal work, realized to the best of my knowledge. I also declare that all information, material and results from other works presented here, have been fully cited and referenced in accordance with the academic rules and ethics.

Signed  **Date: 24/07/2020**

CERTIFICATION

This thesis has been submitted with my approval as the supervisor.

Signed  Date: 28/07/2020

Prof. Dr. NADIA Badr El-Sayed

Head of Environmental Sciences Department – Faculty of Sciences –
University of Alexandria – Egypt.

ACKNOWLEDGEMENTS

Thanks to Allah, the Almighty this work has been realized. This research has been a success due to the cooperative effort from many people and organizations. I would like to express my deepest gratitude to:

My supervisor Prof. NADIA BADR for her availability, advices and supports throughout the completion of this work;

The African Union Commission (AUC) which offered me this valuable scholarship and supported me implementing this research and their initiative to create Pan University;

The Pan African University Institute of Water and Energy Sciences Including Climate Change (PAUWES), the Director and the water coordinator, their team and the guest lecturers;

I also wish to express special thanks to the Algerians people, hosting me in their favorable country;

The Somali Marine Resource Research Center (SMRRC) for the internship opportunity;

The Environmental Sciences Department of the Faculty of Sciences at the University of Alexandria, Egypt; and

Finally, I extend my special thanks to my friends, classmates of 5th cohort for their deepest friendship and support during our studies in Algeria. You have all been so kind to me.

May God Bless You All.

DEDICATION

I dedicate this work to All Fellow Africans. My Father and Mother (Mohamud Dirie HASSAN and Zahra Ali MOHAMED), my Wife Naima Mohamed Yusuf and my Twins Ayman Abdulrahman Mohamud and Iman Abdulrahman Mohamud. Their guidance, encouragement, affections, sacrifices, and prayers gave me the strength to achieve this success and honor.

My Brother Abdulkadir Mohamud DIRIE & his Family and my little brother Abdulfatah Mohamud DIRIE for their supports.

My family and friends for their support and kindness.

My colleagues and friends as well as all those who have not been mentioned.

TABLE OF CONTENTS

LIST OF ABBREVIATIONS AND ACRONYMS

SMRRC : Somali Marine Resource research Center

MoFMR : Ministry of Fishery and Marine Resources

SL : Somaliland

PL : Puntland

PENAF : First Ports Environmental Network-Africa

NEP : National Environmental Policy

AU : African Union

PAU : Pan African University

PAUWES : Pan African University Instituite of Water and Climate Change (Inc. Climate Change)

SDG : Sustainable Development Goals

WHO : World Health Organization

EPA : Environmental Protection Agency of USA

NTU : Nephelometric Turbidity Units

BOD : Biological Oxygen Diamond

COD : Chemical Oxygen Diamond

UNCLOS: UNITED NATIONS CONVENTION ON THE LAW OF THE SEA

(DoECC) : Directorate of Environment and Climate Change,

OPM : Office of the Prime Minister of Somalia

MoEWR : Ministry of Energy and Water Resources

SWALIM : Somali Water and Land Information Management under FAO

FAO : Food and Agriculture under UN

UN : United Nations

NDP : National Development Plan

NEP : National Environmental Policy

UNEP : United Nations Environmental Program

OSPAR : The Convention for the Protection of the Marine Environment of the North-East Atlantic

OG : Oil and Greases

TSS : Total Suspended Solids

DO : Dissolved Oxygen

FGS : Federal Government of Somali

EEZ : Exclusive Economic Zone

SML : Somali Maritime Law

MARPOL : Maritime Pollution

FCs : Fisheries Cooperatives

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

In Somalia, fishery is the back bone of the country economy. In line with African Union Agenda 2063, SDGs and NDP program, MoFMR and SMRRC initiated different programs to develop different marine environments in Somali territorial water. Hence, those initiatives were supported by formulation new water resources policy and national environmental policy. Therefore, the general purpose of this study; is to assess and identify how the water policy, environmental policy and maritime code/law deal with coastal pollution and the effect of that pollution on Somali coast particularly Mogadishu coast to investigate the main cause of pollution. The study focused on evaluation of all pollutants which are existing in front of Somali coastal, assessment of the effect of pollution on Somali marine environments and investigate Policy implementation on coastal pollution for area under the investigation. Hence, three different locations were selected from different districts of the capital city of Mogadishu, namely Eastern slaughterhouse location of Kaaraan district; Liido beach location of Abdul-aziz district and Buurfuule location of Hamar wayne district. A total sample of 191 different stakeholders of marine environment were selected randomly and responded to the questionnaires. In addition, marine water was collected and analyzed in the period of 2019. This study was used mixed methods. The collected data were analyzed using SPSS software, version 21, to test the significance of the result. In addition, physico-chemical and biological apparatus were used for experimental analysis. Therefore, based on the result, the major source of the pollution was foreign ships (65%) which is external pollution, the foreign ships dump hazardous and nuclear wastes to Somali territorial water. Meantime, local and internal pollutants (26%) which is caused by coastal residents and Somali boats are part of the pollution causes. The most parameters who caused the pollution in the selected locations were chemical parameters (44%) including turbidity, TSS, BOD and COD. As well as biological parameters (42%) which includes total plate count and total coliform count. While the physical parameters in the normal level only 14%. The participation of the different stakeholders is not involved in the policy formulation and strategy plan which is related to marine issues. This study concluded most of the selected locations (L1&L3) exceeded the acceptable and recommended standards or levels of WHO and EPA, this is harm for the human health which may cause waterborne disease for the human as well as its effects on the marine organisms in those locations. As well as the policies related to marine issues are not updated and correspond the other policies in the region and even in the globe. Therefore, this study recommends to make and formulate an appropriate, strong and updated policy which can correspond with the other policies in the globe in order to prevent the local and foreign pollution to the Somali territorial water, to establish strong centers who can monitor and do an accountability what the foreign ships do in the Somali territorial water, to allow participation of the different stakeholders in the different processes of marine policy making in order to consider the policy their inputs, ideas and concerns and finally, to conduct a further study to examine the feasibility of coastal pollution situation in the selected locations, as well as the other locations around the capital city.

Key words: Coastal Pollution, Internal pollution, External Pollution, Indian Ocean, Mogadishu.

1 INTRODUCTION

1.1 Background

1.1.1. General problem of Pollution in Africa

Although marine pollution has a long history, significant international laws to counter it were not enacted until the twentieth century (Murphy, 2006). Marine pollution was a concern during several United Nations Conventions on the Law of the Sea beginning in the 1950s. It made further international headlines after the 1967 crash of the oil tanker Torrey Canyon, and after the 1969 Santa Barbara oil spill off the coast of California.

Marine pollution was a major area of discussion during the 1972 United Nations Conference on the Human Environment, held in Stockholm. That year also saw the signing of the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, sometimes called the London Convention. The London Convention did not ban marine pollution, but it established black and gray lists for substances to be banned (black) or regulated by national authorities (gray). Cyanide and high-level radioactive waste, for example, were put on the black list. The London Convention applied only to waste dumped from ships, and thus did nothing to regulate waste discharged as liquids from pipelines (Hamblin & Jacob, 2008).

Africa currently has the fastest growing population in the world, projected to more than double between 2010 and 2050, and surpassing two billion (Cooper, James, Lombardi, Boardman, & Carliell-Marquet, 2011). By 2050, nearly 60 % of the population of Africa is predicted to be living in cities, compared to less than 40 % in 2011 (Petkova., Elisaveta, Jack, Nicole, & Kinney, 2013). Urbanization, coupled with increased industrialization, growing ownership of motor vehicles, and continued use of biomass as domestic energy source, may lead to substantial worsening of air quality across the continent. Urbanization is also a powerful driver of the global demographic and epidemiologic transition, characterized by declining birth rates, increasing life expectancy, and a shift from traditional threats such as infectious diseases and malnutrition to chronic, non-communicable diseases like heart disease and diabetes (Defo, 2014).

Developing countries are increasingly experiencing a double burden of infectious and chronic diseases (Boutayeb, 2010). This burden stems in part from living conditions in urban slums, with their poor environmental conditions and infrastructure as well as lack of access to health services. The West African coastline is home to major industries, mining activities, peri-urban and agro-industry, and tourism, as well as urban and seaside residences, all of which generate waste and cause pollution. Many areas along the coast also lack adequate wastewater and solid waste management systems. As a result, large volumes of untreated wastewater and solid waste are dumped into the open, polluting the land and water. Ports are crucial to the region's economy, but they have serious negative impacts on the environment. The first Ports Environmental Network-Africa (PENAf) workshop for West and Central Africa, held in Ghana in 2010, identified the key environmental issues as waste from shipping operations, oil spills, inadequate ballast water management, dredging, effluent, water quality, noise, dust, air pollution, and habitat degradation (Barnes-Dabban, Harry, Koppen, & Tatenhove, 2018)

1.1.2. Pollution on Coastal line in front of Somalia

1.1.2.1. Before 1991

(Carbone & Accordi, 2000) stated that Somalia has the longest national coastline (3025 km) in Africa. They also indicated that pollution of the marine environment is limited and does not currently pose a serious threat to the economy of Somalia. DE ballasting and tank cleaning operations by tankers represent the only significant forms of oil pollution. The location of major tanker routes well offshore results in oil residues found in inshore areas being highly weathered. Due to seasonal variations in ocean currents, it is most likely that the concentration of oil residues along the coast will be highest during the northeast monsoon season. A survey of the southern coast conducted during the mission indicated that oil residues in the form of tar balls compare favorably with other areas within the region (Messrs, Fowler, & Hamza, 1987).

This form of oil pollution represents an international problem whose solution lies in the enforcement of international regulations relating to the prevention of the pollution by ships in particular tanker DE ballasting and cleaning operations. The ratification and implementation of the MARPOL Convention by Somalia and neighboring countries and concerted regional action would be of direct assistance in reducing oil related marine pollution. Moreover, there were

different sources of pollution arisen from agricultural, industrial and municipal at that time (Messrs, Fowler, & Hamza, 1987).

1.1.2.2. After 1991

Marine pollution has led to the lack of safe marine production, poor hygiene, and a lack of sanitation making it an enormous contribution to disease rates. Many practices have led to marine pollution including the disposal of sewage waste, waste water which refers to the chemicals that have been washed down drains from factories, and etc. (Islam & Tanaka, 2004). One of the main contributions to marine pollution in Somalia is Illegal Hazardous Waste Dumping. Many of the world's chemical industries and nuclear energy plants have produced tons of hazardous wastes. The fact that many developed countries have started creating so many industries has managed to lead to the high production of toxic hazardous wastes. Due to political instability, these countries have now used many African nations, including Somalia, as a location to dump their hazardous waste which is of course, illegal. Such impacts of that dumbing like Death of aquatic animals; the chemicals in the water could be consumed by the water life, which is harmful to them and can lead to death (Amina, 2018). Disruption of food chains; the effects of many forms of water pollution can be on marine environment or cause diseases. It is obvious that human eat fish and if we do consume the fish or animals that have been poisoned, it is possible that we can obtain diseases. There can also be an outbreak of cholera from drinking contaminated water. Water pollution can cause diseases/illnesses, death of marine life, lack of hygiene and lots more complications to the country (Amina, 2018). Sudan, Mauritania, and Somalia are some countries in Africa that are in an extreme risk from water pollution. The other problems which occur in Somali coastal are destruction of the coastal areas for building proposes which can cause coastal erosion.

Marine/Coastal Pollution (UN definition) – "The introduction by man, directly, or indirectly, of substances or energy to the marine environment resulting in deleterious effects such as; hazards to human health; hindrance of marine activities; impairment of the quality for the use of seawater; and reduction of amenities". Policy is a set of steps that rationalizes the course of actions by a government while water policy encompasses the policy-making processes that affect the collection, preparation, use and disposal of water to support human uses and protect

environmental quality. Water policy addresses provision, use, disposal and sustainability decisions. Environmental policy is the commitment of an organization or government to the laws, regulations, and other policy mechanisms concerning environmental issues.

1.2. Problem statement of the study

Somalia has coastal pollution problem in its urban and rural areas but the scale of the problem is not easily quantifiable because of the absence of water quality monitoring systems such as on the ground of many countries in Africa. In industrialized countries, factories, cars and power stations are usually blamed for polluting the air. Coastal pollution injures and kills marine life, interferes with navigation safety, and poses a threat to human health. In addition to that it kills fish, birds, marine mammals and sea turtles, destroys habitats and even affects animals' mating rituals, which can have devastating consequences and can wipe out entire species.

Mogadishu coastal pollution and its impacts have resulted in a number of environmental issues including the enrichment of enclosed waters with organic matter, pollution by chemicals such as oil, hazardous wastes and sedimentation due to land-based activities. This has been increased due to lack of strong government and policy in Somalia which can protect its territorial water. In addition to there is no study or research related to existing pollutants in Somali coastal as well as its effects on marine environments and the human health. Therefore; this study is a unique and the first study of its kind as the previous studies didn’t mention more about Somali coastal pollution and maritime policy and law.

1.3. Justification

In line with AU Agenda 2063, Aspiration 1, goal 9, 10, 15 and SDGs Goal 2, 14, this research is very important for the decision makers and private institutions because it will equip them with evidence based on the impact of water resources policy on coastal pollution. Hence, this will help us to achieve modern and productive seas through coastal protection, hence Somalia, and Africa in general ensure food security and effective marine product exploitation.

1.4. Scope of the Study

This study was carried out in Mogadishu coast of Somalia, within the selected districts of Kaaraan, Abdul-Aziz and Hamar wayne, operating in the respective coastal sites: Eastern slaughter site of Kaaraan district, Liido beach of Abdul-aziz district and Buurfuule of Hamar-wayne district. In addition, interviews and filling questioners done with some coastal residents and fishery cooperatives on how the pollution affect their health and productivity.

1.2. Aim of the work/Research objectives

1.2.2. General Objective

- To assess and identify how the water policy, environmental policy and maritime code/law deal with coastal pollution and the effect of that pollution on Somali coastal particularly Mogadishu coastal to investigate the main cause of pollution.

1.2.3. Specific Objectives

- Evaluation of all pollutants in front of Somali coastal.
- Assessment of the effect of pollution on marine environments.
- Statistical treatment of data for water quality (determining physical, chemical and biological parameters of the marine water).
- Survey and questionnaire with stakeholders (fishermen, local population, etc.) and policy makers (ministry of fisheries and marine resources, SMRRC, etc.).
- Investigate Policy implementation on coastal pollution for area under the investigation.

1.3. Research Questions

- How the general pollution affects the Somali maritime territory or environment?
- Did they implement the water, Environmental policy or maritime code/law of the country, if no why?

2 LITERATURE REVIEW

This chapter describes the literatures related to this specific objective of this work. The literatures were retrieved from the books, officials report and scientific papers published in highly reviewed journals and they are references according to the academic rules and regulations.

2.1. Various Causes and types of Ocean Pollution

As general, the three main sources of marine pollution are; effluents and solid wastes from land or human activities (e.g., shipping), runoff mainly via rivers, as well as atmospheric fallout. The relative contribution of each of these pathways to marine pollution varies greatly with substance and situation (Melidis & Sylaios, 2017).

2.1.1. Sewage

Pollution can enter the ocean directly through sewage or polluting substances flow through drainages. This is often how minerals and substances from mining camps find their way into the ocean (Vikas & Dwarakish, 2015).

2.1.2. Toxic Chemicals from Industries and Agricultural activities

Industrial and agricultural wastes are the most common form of wastes that are directly discharged into the oceans. The dumping of toxic liquids in the ocean directly affects the marine life as they are considered hazardous. In some cases, they raise the temperature of the ocean, known as thermal pollution. Animals and plants that cannot survive at higher temperatures eventually perish (Rangabhashiyam, Anu, & Selvaraju, 2013).

2.1.3. Land Runoff

According to (Brodie, et al., 2012) Land runoff is another source of pollution in the ocean. This occurs when water infiltrates the soil to its maximum extent and the excess water from rain, flooding or melting flows over the land and into the ocean. Often, this water picks up man-made, harmful contaminants that pollute the ocean, including fertilizers, petroleum, pesticides and other forms of soil contaminants. Fertilizers and waste from land animals and humans can be a huge detriment to the ocean by creating dead zones.

2.1.4. Large Scale Oil Spills also known as Oil pollution

Ship pollution is a huge source of ocean pollution, the most devastating effect of which is oil spills. Crude oil lasts for years in the sea and is extremely toxic to marine life, often suffocating marine animals to death once it entraps them. Crude oil is also extremely difficult to

clean up, unfortunately meaning that when it is split; it is usually there to stay. In addition, many ships lose thousands of crates each year due to storms, emergencies, and accidents. This causes noise pollution (excessive, unexpected noise that interrupts the balance of life, most often caused by modes of transportation), excessive algae, and ballast water. Often times, other species can also invade an ecosystem and do harm to it by interrupting the life cycles of other organisms, causing a clash of nature that has already been damaged by the overflow of pollution (Farrington, 2013).

2.1.5. Ocean Mining

(Tornero & Hanke, 2016) Showed that ocean mining in the deep sea is yet another source of ocean pollution. Ocean mining sites drilling for silver, gold, copper, cobalt, and zinc create sulfide deposits up to three and a half thousand meters down into the ocean. While we have yet the gathering of scientific evidence to fully explain the harsh environmental impacts of deep-sea mining, we do have a general idea that deep sea mining causes damage to the lowest levels of the ocean and increase the toxicity of the region. This permanent damage dealt also causes leaking, corrosion and oil spills that only drastically further hinder the ecosystem of the region.

2.1.6. Littering

Pollution from the atmosphere is, believe it or not, a huge source of ocean pollution. This occurs when objects that are far inland are blown by the wind over long distances and end up in the ocean. These objects can be anything from natural things like dust and sand to man-made objects such as debris and trash. Most debris, especially plastic debris, cannot decompose and remains suspended in the ocean's current for years (Naselli-Flores & Padisák, 2016).

2.2. Devastating Effects of Ocean Pollution

2.2.1. Effect of Toxic Wastes on Marine Animals

According to (Fingas, 2012) Mentioned The oil spill is dangerous to marine life in several ways. The oil spill in the ocean could get on to the gills and feathers of marine animals, which makes it difficult for them to move or fly properly or feed their children. The long term effect on marine life can include cancer, failure in the reproductive system, behavioral changes, and even death.

2.2.2. Disruption to the Cycle of Marine Life

Oil spill floats on the surface of the water and prevents sunlight from reaching to marine plants and affects the process of photosynthesis. Skin irritation, eye irritation, lung and liver problems can impact marine life over a long period of time (Overton, Wade, Radović, Meyer, Miles, & Larter, 2016).

2.2.3. Depletion of Oxygen Content in Water

According to (Gewert, Plassmann, & MacLeod, 2015) argued Most of the debris in the ocean does not decompose and remain in the ocean for years. It uses oxygen as it degrades. As a result of this, oxygen levels go down that in turn will affect the survival of marine animals like whales, turtles, sharks, dolphins, penguins for a long time.

2.2.4. Failure in the Reproductive system of sea animals

Industrial and agricultural wastes include various poisonous chemicals that are considered hazardous for marine life. Chemicals from pesticides can accumulate in the fatty tissue of animals, leading to failure in their reproductive system (Alina, Azrina, Mohd Yunus, Mohd Zakiuddin, Mohd Izuan Effendi, & Muhammad Rizal, 2012).

2.2.5. Effect on Food Chain

Chemicals used in industries and agriculture get washed into the rivers and from there are carried into the oceans. These chemicals do not get dissolved and sink at the bottom of the ocean. Small animals ingest these chemicals and are later eaten by large animals, which then affects the whole food chain (Owa, 2014).

2.2.6. Effect on Human Health

According to (Abdel-Shafy & Mansour, 2016), mentioned animals from impacted food chain are then eaten by humans which affects their health as toxins from these contaminated animals that in turn will deposite in the tissues of people and lead to cancer. (Melidis & Sylaios, 2017) Argued that the pollution in marine coastal areas is considered from point and non-point land-based sources, such as rivers, drainage ditches, submarine outfalls and coastal cities. Various uncertainties in physical, hydrodynamic, chemical and biological characteristics of the marine environment influence the health of marine environments and organisms.

2.3. Effect on marine environments

According to (Goudie & Viles, 2013) oceans are the largest water bodies on the planet Earth. Over the last few decades, surplus human activities have severely affected marine life on the Earth's oceans. Ocean pollution, also known as marine pollution, is the spreading of harmful substances such as oil, plastic, industrial and agricultural waste and chemical particles into the ocean. Since oceans provide the home to wide variety of marine animals and plants, it is the responsibility of every citizen to play his or her part in making these oceans clean so that marine species can thrive for a long period of time. According to (Kumar & Häder, 2012) argued "Many ocean pollutants are released into the environment far upstream from coastlines. Nitrogen-rich fertilizers applied by farmers inland, for example, end up in local streams, rivers, and groundwater and are eventually deposited in estuaries, bays, and deltas. These excess nutrients can spawn massive blooms of algae that rob the water of oxygen, leaving areas where little or no marine life can exist."

The 1982 United Nations Convention on the Law of the Sea defined marine pollution as "the introduction by man, directly or indirectly, of substances or energy into the marine environment … which results or is likely to result in such deleterious effects as harm to living resources and marine life" (article 1.1.4). The definition has subsequently been included in, for example, the OSPAR and Helsinki Conventions and the UNEP Regional Seas Program. It is worth noting that, in addition to the influx of different kinds of substances into the oceans, the definition of marine pollution includes the input of energy, which here refers to thermal (e.g., discharge of cooling water from nuclear plants) and acoustic (or noise) pollution (Wilhelmsson, Thompson, Holmström, Lindén, & Eriksson-Hägg, 2013).

2.4. Pollution in front of Somali Coastal

According to (Grünewald, 2012) Marine pollution has constantly been noticed in Mogadishu coast and the entire country's coastline at large. Reliable sources to mention but not limited to the local population of the coastal area have incessantly shared some videos, pictures and other related evidences that show clear pollution in the country coast where substantial flocks of oil and closed tanks (may be it contains nuclear materials and toxic) are found at onshore (Bassey, 2012). This oil and closed tanks were unleashed out by certain foreign ships, and the oil has resulted into physical and chemical changes of the seawater which in turn cause

harmful effects to human and perhaps may cause skin diseases (Hawken, Lovins, & Lovins, 2013).

The country is divided into three major zones: South and central (including Mogadishu), Somaliland (northern parts of the country) and Puntland.

2.4.1. South and Central Coastal Pollution

According to (Beri, 2011) Somalia is a country which is located in horn of Africa (East Africa). It has boarder with red sea and Gulf of Aden, a continental boarder with Kenya, Djabouti and Ethiopia, with the longest coastline in Africa. This country witnessed civil war (1991 to 2007), which caused to collapse the central government of the country as well as the development of the country including health, education and whole infrastructure. The absence of the government encouraged the foreign ships to dump and bury their waste in the Somali coasts. Mogadishu is capital city of the country which hosted the most population of the country and the most effected city by the civil war. The coast of this city is one of the places who affected by the civil war whether destruction of the beaches, dumping the wastes by the local people and the foreign ships (Daniels, 2012).

After the civil war, the government of Somalia re-established the different institutions that collapsed to recover the life of the people and perform every institute their duty. Somali Marine Resources Research Center (SMRRC) is one of the institutions which established for protecting and reporting the marine issues. This center established in 2013 to identify the level of destruction which occurred on the beaches more than 25 years, amount of biotic and abiotic marine resources in the country and how the government can advantage those resources. Finally, the SMRRC did a research on the situation of the Somali coastal to investigate and identify all above problems.

2.4.2. Somaliland (SL) Coastal Pollution

(Daniels, 2012) Identified that this region of Somaliland is located in the northern part of the country. There is a huge coastal pollution in this area while the public institutions are weak and cannot control this issue. The most pollution occur in this region is oil pollution and unknown dumbing wastes in tanks (probably are radioactive and nuclear wastes). Oil spillage into sea is not the only pollution catastrophe we encounter but also to mention hazardous wastes

namely radioactive wastes that are normally dumped into Somaliland marine ecosystems by reckless foreign ships (Dent, 2013). This in turn detrimentally affects the health of the people and impedes the marine biodiversity. Notably seafood, which can be considered a potential food reserve for future generations, is being jeopardized by such growing marine pollution incidents.

(Yousef, 2019) Argues that terrestrial environment resources in Somaliland have been suffering from cyclic droughts, climate change and growing concern of carrying capacity of land resources. These factors have put at risk future food security in our country, but the untapped marine resources (seafood) that is considered potential food reserves for future generations are now endangered by these growing marine pollutions.

2.4.3. Puntland (PL) Coastal Pollution

(Höhne, 2015) Shows that Puntland Established in 1998 in the north-eastern part of Somalia. It is self-governing State with a coastline of approximately 1400 km in length that abuts the Gulf of Aden in the north and the Indian Ocean in the east. With the upwelling system occurring off its Indian Ocean coastline and having near pristine coral reefs in the Gulf of Aden, Puntland has abundant and varied fisheries resources compared to the other regions of Somalia. However, like the rest of the Somali people, the local people of Puntland do not have a long fishing tradition save for small coastal communities who have been engaged in fishing since time immemorial for their mere subsistence and for occasional exchange of dry-salted product for imported commodities from the Arabian Peninsula.

Puntland is a member of federal states of Somalia, they faced the same problems those the other parts of the country faced. Although they established their own government administration by the end of 20th century, the system was weak and could not protect their coastal areas from the external and international ships to pollute their oceans and environment (Marchal, 2013). The local people dumbed their wastes to the sea without processing as well as the foreign and international ships dumped and buried their wastes including radioactive wastes in the sea. The effect of those wastes is clear today while some genetic mutation appeared in the country and noticed some closed tanks with unknown what is inside those tanks.

2.5. Policy implementation on coastal pollution for area under the investigation

2.5.1. National Environment Policy

According to (NEP, 2019) The National Environment Policy is intended to be a guide to several actions: 1. Regulatory development, 2. Programs and projects for environmental conservation; and 3. Review and enactment of legislations by agencies at Federal and State levels. The policy also seeks to stimulate partnerships of different stakeholders, i.e. public agencies, local communities, academic and scientific institutions, private sector investment, and international development partners, in harnessing their respective resources and strengths for environmental management. This is particularly crucial since it is recognized that maintaining a healthy environment is not the state's responsibility alone, but also that of every citizen. A spirit of partnership should thus be realized throughout the spectrum of environmental management in the country. While the state must galvanize its efforts, there should also be recognition by each individual - natural or institutional, of its responsibility towards maintaining and enhancing the quality of the environment.

According to National Environmental policy (NEP, 2019) “Land degradation (Soil Erosion, Deforestation, overgrazing etc.), natural resource depletion, water scarcity, climate change (Natural disasters: drought, flooding), absence of waste management system, hazardous waste (Illegal dumping), lack of marine and coastal management, invasive species (plants), absence of environmental regulatory framework and lack of environmental awareness are the key environmental challenges in Somalia".

In Somalia, Policy and legislation with respect to the environment is weak and outdated. Pre-1991 environmental laws date back to the 1960s, 70s &80s. Since the collapse of the state, no laws were passed, at least in the last three decades. Furthermore, until the establishment of the Ministry of Environment and Disaster Management in 2005, Somalia lacked any central body responsible for environmental matters (NEP, 2019).

Currently, there are a number of institutions both at the Federal and state levels that would play key roles in the management of the environment. However, the existing legislative framework is at the state level, namely, Somaliland and Puntland. The said two states are the only ones in Somalia who have enacted legislations related to the environment. Nevertheless,

enforcement remains weak. Therefore, adopting a national environmental policy and enacting up-to-date legislations are badly needed in order to address the environmental challenges stated earlier.

In the marine sector of this policy, the Somali maritime zone is one of the largest in the western Indian Ocean and has one of the most important large marine ecosystems as the country has the longest coastline (3025 km) in Africa. To conserve and sustainably utilize the marine resources of the country, the policy mentioned some steps such as creation Somali Maritime Administration/Authority in compliance with the constitution; and establishment marine protected areas ((NEP, 2019).

2.5.2. Somali Maritime Law – Law No. 5 of 26 January 1989

This law derived from Somali maritime law of LAW NO. 37 OF 10 SEPTEMBER 1972, but this one of 1989 more updated and classified than the one in 1972. Book VI which is also the last book of this law deals with prevention of sea pollution by the vessels. This book gave all the authority, program and regulations to the minister of fisheries and marine transport, while the minister sets up, rules and implement the law of prevention of sea pollution by the vessels (SML, 1989).

(SML, 1989) mentioned that the program includes the authorities of Democratic republic of Somalia to control their territorial water zones such as coastal areas, inland water, continental shelf, exclusive economic zone (EEZ) and demersal (below water). Moreover, this law can be implemented in open ocean of Somalia if the vessels and operation ongoing can harm or cause a risk of pollution to the Somali territorial water zones. In order to establish a program of prevention marine pollution by the vessels, the minister of fisheries and marine transport will review and make decision through MAARPOL Protocol which also known as “Protocol of 1978” which indicates the International Convention for the Prevention of Pollution from Ships (MARPOL). The MARPOL Convention was adopted on 2 November 1973 at IMO. After enforcement of this program anyone who violates will be punished to pay a penalty not exceeds Shs.So. 1.000.000 or jail not exceeds 5 years or both. The above penalties will be applied equally the Somali vessels and foreign vessels.

The ministry of Energy and Water Resources (MoEWR) preparing currently the national water policy of the country but it did not mention any policy related to coastal pollution, as well as MoEWR prepared the national water law and approved by the two houses (Parliaments and senates), this law mentioned only the responsibility of the minister, deputy minister and the structure of national water agency.

This study is a unique and the first study of its kind as the previous studies didn't mention more about Somali coastal pollution. Moreover, this research will carry out to fulfill the gab of that missing policy that could help in policy makers in improving the current policy specially the policy of MoEWR in order to add the marine policy to their work, as well as the policy of MoFMR which is related to marine issues and also this study will carry out to fulfill the gab of missing policy and planning from NEP and NDP.

3 MATERIALS AND METHODS

3.1. Study Area (Mogadishu City)

3.1.1. Location

Somalia is one of the East African countries with an area of 637,657 km^2 (246,201 mi^2). It is located in the Horn of Africa, bordered by Ethiopia to the west, the Gulf of Aden to the north, the Guardafui Channel, Somali Sea to the east, and Kenya to the southwest. The country claims a border with Djibouti through northwest. Somalia has the longest coastline on Africa's mainland, and its terrain consists mainly of plateaus, plains, and highlands. Climatically, it characterized by hot conditions prevail year-round, with periodic monsoon winds and irregular rainfall. From political point of view, this country is federal system and has six federal state members (FSM) named Somaliland (self-declared independent), Puntland, Galmudug, Jubbaland, Southwest state, Hirshabelle and Benadir region (where the capital of Mogadishu exiting in). This study was conducted in Mogadishu, composed by four sites in four different districts, such as Eastern slaughterhouse in Karan, Liido beach in Abdulaziz district and Buur-

Fuule in Hamar-wayne.

3.1.1.1. First site: Eastern slaughterhouse of Mogadishu

This site is located in Kaaraan district with Longitude of 45°22'26.83"E and latitude of 2° 2'51.10"N (Source: Google Earth). It is located at the northeast of the capital. It is a place that causes an environmental problem to the sea; because the blood which comes from the slaughterhouse goes to the sea directly without treatment. The average temperature of Eastern slaughterhouse of Mogadishu ranges between 25^0C to 30^0C.

3.1.1.2 Second site: Liido beach

This is located in Abdulaziz district, in the eastern parts of the city. It is the main beach of the city which many people visit in every weekend with more than 10 hotels and restaurants located in the area with high discharges of sewage with different kind of pollutants (Fig 1). Average temperature of Liido beach ranges between 25^0C to 30^0C.

3.1.1.3 Third site: Buur-fuule (Hamar-wayne Slaughterhouse)

This is another slaughterhouse but it is for fish slaughterhouse that is located in Hamar-wayne district (one of the old Mogadishu places). Average temperature of Liido beach ranges between 25^0C to 30^0C. This area of the capital affected by several types of pollutants. In this location of Buur-Fuule, there are many sewages which is directly discharged to the sea without any treatment that causes high turbidity, total plate count and total coliform count in the area. This may result in waterborne diseases and skin diseases when the people swim and fish in that location. On the other hand, the first location (Eastern slaughterhouse) is the second most populated location after Buur-Fuule, while the Eastern slaughterhouse of Mogadishu discharge their blood directly to the sea which may cause high COD and BOD in the area (Figure 2).

Figure 1: Somali Administrative Map (Source: SWALIM)

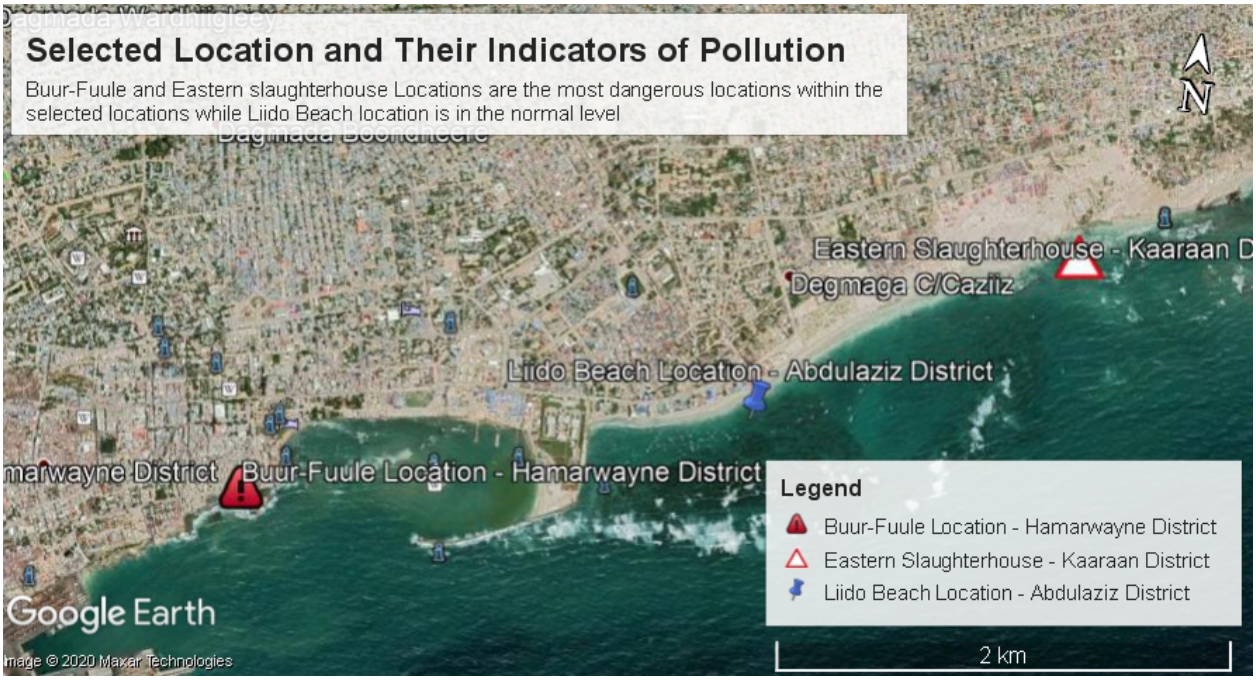


Figure 2: Locations of the three sites and their level of pollution (Source: Google Earth)

3.2. Sampling

For sea water quality assessment, water samples were collected from 3 locations adjacent to the capital city of Mogadishu (Figure 2). Water samples were collected during two seasons, the winter season (January 2019) and the summer season (July 2019) to monitor the temporal changes in the water quality. Surface samples were collected from 500 m out of the coastal area and from 1m below the surface water using a Silicon/Teflon water pump.

3.3. Analytical Techniques

The physico-chemical parameters that are analyzed to determine water quality are: Temperature, pH, Dissolved oxygen, Oil and Grease, Total Suspended Solids (TSS), Chemical oxygen demand (COD), Biological Oxygen Demand (BOD), Turbidity (NTU) as well as Microbiological Parameters Analyzes.

3.3.1. Field measurements

Temperature, Oxygen and pH of surface seawater were measured immediately after collection using HQ 40D portable multi-parameter meters (Hach Company, USA).

3.3.2. Laboratory measurements

3.3.2.1. Total Suspended Solids (TSS)

Total suspended solids are composed of organic and mineral fine particles, insoluble and are the source of the turbidity of water. The materials and experimental procedure used to determine the total suspended matters in the laboratory are explained below:

3.3.2.1.1. Materials and Reagents

- ✓ Vacuum pumps
- ✓ Filtration unit
- ✓ Micro fiberglass filters
- ✓ Stove
- ✓ Desiccator
- ✓ Analytical balance
- ✓ Pliers

3.3.2.1.2. Experimental Procedure

- ✓ The filter is washed in the vacuum filtration unit by passing distilled water, then placed in the stove at a temperature of 103 to 105°C, during 2 hours. It will then be kept in a desiccator and weighed.
- ✓ After that, the filter is placed in the funnel of the filtration device, and connected to a vacuum suction device.
- ✓ A sample volume of the treated wastewater is filtered in a few seconds.
- ✓ We carefully remove the filter from the funnel using flat-ended pliers. It is then weighed using the analytical balance.
- ✓ Then the filter is dried at about 105°C, cooled, and finally weighed to get the suspended matter results.

The following formula is used to obtain the results:

$$\textbf{TSS (mg/l) = (M2-M1)*1000/V}$$

Where:

TSM: Total suspended matters (mg/l)

M2: Mass of the filter after drying (mg)

M1: Mass of the empty filter, before filtration (mg)

V: Volume of the water sample filtered (ml)

Figure 3: Total Suspended solids measurement

3.3.2.2. Chemical Oxygen Demand (COD)

Chemical oxygen demand represents the quantity of oxygen required to chemically stabilize the carbonaceous organic matter using strong oxidizing agents under acidic conditions. The test consists of a chemical oxidation of the organic matter by a strong oxidant (acid) at high temperature and by the potassium dichromate ($K_2Cr_2O_7$). Oxidizable substances react with a sulfuric acid (H_2SO_4) solution and potassium dichromats in the presence of silver sulphates (Ag_2SO_4) as a catalyst. The presence of chloride is masked with mercury sulfate ($HgSO_4$). We measure the decrease of the yellow coloring of Cr^{6+}. The result is expressed in mg O_2 /l

Materials and Reagents

The following materials are used:

- ✓ COD measurement kits (Example: LCK 314 15-150 ppm / LCK 114 150-1000 ppm)
- ✓ Distilled water (dissolution cleaning).

- ✓ DRB-200 Digester
- ✓ Spectrophotometer DR 5000
- ✓ Gradette support
- ✓ Graduated pipette 2 ml
- ✓ Pipette aspirator 2 ml

3.3.2.2.1. Experimental Procedure

A. We select the COD program: this program heats the vat for 2 hours at 150 °C During the cooling phase; four sound signals indicate that the vats have been cooled to a temperature of 120°C.
B. The vats are prepared by mixing the kit contents to have a homogeneous solution and 2 ml of water sample are pipetted carefully.
C. The thermostat heats up to the set temperature. Two sound signals indicate that the required temperature has been reached.
D. Then the vats are placed in a heating block DRB -200, while closing the protective cover. We put the vats in the conventional COD digester during two hours at 150°C.
E. We remove the hot vat and invert carefully twice.
F. The vat is cooled at room temperature in the vat support.
G. Finally, we clean the outside part of the vat and measure it with a HACH brand spectrophotometer.

Figure 4: Chemical oxygen demand measurement

3.3.2.3. Biological Oxygen Demand (BOD)

The concentration of organic matter in wastewater is measured by the biological oxygen demand (BOD) value. In the laboratory, the amount of oxygen is expressed under the conditions of the test (incubation for 5 days at 20 °C in the darkness).

3.3.2.3.1. Materials and Reagents

For the BOD system, we have:

- ✓ Measuring heads (BOD sensors)
- ✓ Measuring bulbs brown
- ✓ Magnetic stirrers
- ✓ Pliers
- ✓ Rubber carcass for the necks of the bulbs
- ✓ Sodium hydroxide (NaOH) lenses
- ✓ Thermostatic incubator with constant temperature at 20 degree Celsius
- ✓ Inhibitor of nitrification.
- ✓ Containers and pipettes of several sizes
- ✓ Distilled water
- ✓ Calibration tablet for system controls OXITOP: D (+) glucose $C_6H_{12}O_6$ and L-glutamic acid $C_5H_9NO_4$.

3.3.2.3.2. Experimental Procedure

A. A sample volume corresponding to the desired BOD to be obtained is selected.
B. We clean the bulbs with distilled water to lighten them, then with the sample of the treated water.
C. Add a quantity of the homogenized sample.
D. Agitate each bulb with a magnetic stirrer.
E. Put on the neck of the bulb a rubber carcass. Inside, add with the pliers the lenses of NaOH. Then fill with the treated water up to the limit without exceeding.
F. The bulbs are placed in an incubator for the measurement of BOD_5.The incubator is set to zero value and starts working for five days at 20°C. The result of the value will be displayed directly on the device.

Figure 5: Biological oxygen demand measurement

3.3.2.4. Turbidity (NTU)

The unit used for measurement is Nephelometric Turbidity unit (NTU). The measurement of turbidity is a key test of water quality.

3.3.2.4.1. Experimental Procedure

- ✓ Prepare standard solutions of formazine and follow the process of calibrating the apparatus with an emphasis on being free Distilled water from turbid and follow operator instructions.
- ✓ Prepare at least one standard solution in each user range.
- ✓ Mix the sample well “and wait a little” until the air bubbles come out, then pour them into the special package and place them in the designated place and record the reading.

Figure 6: Nephelometer

3.3.2.5. Oil and Grease Test

It is a mixture of types of organic compounds that are graded in partial weights and include carbohydrates, fatty acids, oils and lipids, which can be extracted with an organic solvent (soluble in it).

3.3.2.5.1. Experimental Procedure

A. A liter of the sample is placed in a separatory funnel, and 5 mL of hydrochloric acid is added to it (1: 1).
B. A round bottom flask is weighed, oven-dried, and cooled to room temperature (mg, W1).
C. 30 ml of n-hexane is added to the sample and shaken well for two minutes, then placed on the stand until the aqueous and organic layers are isolated.
D. The top layer is taken and passed on Sodium sulfate (placed in a filter paper) before being collected in round bottom flask.
E. Repeat steps 3 and 4 times.
F. The filter paper was washed with 10 ml of solvent.
G. The distillation flask is heated using a water bath at 80 ° C until dry.
H. Distillation jar is weighed after being dried and cooled (mg, W2).

Calculation:

$$\text{Oil \& grease (mg/L)} = \frac{(W2-W1) \times 1000}{\text{Ml of sample}}$$

Figure 7: Fats, Oil and Grease (FOG) in water and wastewater sampler and test

3.3.2.6. Total Plate Count

The plate count method relies on bacteria growing a colony on a nutrient medium so that the colony becomes visible to the naked eye and the number of colonies on a plate can be counted.

3.3.2.6.1. Method of Total Plate Count

To be effective, the dilution of the original sample must be arranged so that on average between 30 and 300 colonies of the target bacterium are grown. Fewer than 30 colonies make the interpretation statistically unsound whilst greater than 300 colonies often result in overlapping colonies and imprecision in the count. To ensure that an appropriate number of colonies will be generated several dilutions are normally cultured. This approach is widely utilized for the evaluation of the effectiveness of water treatment by the inactivation of representative microbial contaminants such as E. coli following ASTM D5465.

The laboratory procedure involves making serial dilutions of the sample (1:10, 1:100, 1:1000, etc.) in sterile water and cultivating these on nutrient agar in a dish that is sealed and incubated. Typical media include plate count agar for a general count or MacConkey agar to count Gram-negative bacteria such as E. coli. Typically, one set of plates is incubated at 22 °C and for 24 hours and a second set at 37 °C for 24 hours. The composition of the nutrient usually includes reagents that resist the growth of non-target organisms and make the target organism easily identified, often by a color change in the medium. Some recent methods include a fluorescent agent so that counting of the colonies can be automated. At the end of the incubation

period the colonies are counted by eye, a procedure that takes a few moments and does not require a microscope as the colonies are typically a few millimeters across.

3.3.2.7. Total Coliforms Count

The presence of bacteria is detected in this way by the method of cultivating a specific concentration of the sample in the test tubes on the broth (Lauryl Tryptose), which is a food medium containing lactose and colon bacteria can grow on this food medium at a temperature of 35-37 ° C and do by lactose fermentation and gas production within 24 - 48 hours.

The resulting gas is collected in Durham tubes, and then the tubes in which the gas is taken are used to count them and find out the number of colonies in 100 milliliters of the sample using the prepared schedule.

3.3.2.7.1. Method of Total Coliform Test

This method depends on three stages:

- ✓ Presumptive Test
- ✓ Confirmed Test
- ✓ Completed Test

Figure 8: Bacteriological count by using Agar plates and Oven

3.4. Statistical Analysis

Statistical treatment of data of water test (determining physical, chemical and biological parameters) has been done by statistical program SPSS, Version, 21.

3.5. Questionnaires

3.5.2. Research Design

This study is aimed to assess the effect of water resources policy on the coastal pollution prevention in Mogadishu city of Somalia. It focused on: 1) Identification of the effect of pollution on Somali coastal particularly Mogadishu coast to investigate how the water policy, environmental policy and maritime code/law dealing with that pollution. 2) Evaluation of dominant pollutants in front of Somali coastal. 3) Assessment of the effect of pollution on marine environments. 4) Survey and questionnaire with stakeholders (fishermen, local population, etc.) and policy makers (ministry of fisheries and marine resources, SMRRC, etc.). 5) Investigation of Policy implementation on coastal pollution for area under the investigation.

This study involved primary and secondary data. The primary data collected using questionnaires administrated to the different sampled fishermen and fisheries cooperatives who use and deal with the marine resources and fishing in Mogadishu; interviews and direct observation in selected coastal sites. While the secondary data were collected using desk reviews of different reports, programs and policy related to water resources management; environmental policy and management and maritime law and code.

Mogadishu coastal was selected for this research due to the extended illegal, over fishing and pollution, experience there. Hence, much protected areas have been developed to enhance the food production and coastal development. Questionnaires addressed to the fishermen who do fishing and the coastal residents (local population) who reside in the different sites and areas of Mogadishu, namely Eastern slaughterhouse of the city site in Kaaraan district; Liido Beach site in Abdulaziz district; and Buur-fuule or Hamar-wayne slaughterhouse site in Hamar-wayne district. In addition, fisheries cooperatives' leaders responded to the different questions related to the role of fisheries cooperatives in coastal protection, fishing development in general. Furthermore, also an interview was conducted to the local leaders of those districts and of the Mogadishu municipality and officers from the ministry of fishery and marine resources and other governmental officials such as officials from office of prime minister of the environment who are in charge of this matter. They were qualitative and quantitative data were gotten using simple randomized probability sampling technics.

The fishermen responded to the different questions, which helped us to get the primary data. The questions were related to the source of pollution, the types of pollution, the availability of fishes, the reasons for decreasing fish quantity. In addition, the people enumerated the major challenges and proposed the information for enhancing the coastal pollution prevention in their respective ocean. Besides of that, the stakeholder's involvement in coastal pollution prevention; collaboration with the private sector.

3.5.3. Target population

According to (Robinson, 2014) target population refers to total group of persons or elements that the researcher chooses to his/her study. The target population of this study constituted of 40 members of marine scientists, 113 coastal residents and 20 from three fishery cooperatives and fishermen, 25 from ministry of fishery and marine resources (MoFMR), and 25 from civil society organizations. Therefore, 223 individuals will form the target population of this study.

3.5.4. Sample Size and Sampling Procedure

Sample size refers to smaller group from the study population selected by using probability or non-probability methods to participate in the study (Uprichard, 2013). Meanwhile, sampling is a process of choosing a representative or sample segment from the target population of the study (LeWinn, Sheridan, Keyes, Hamilton, & McLaughlin, 2017). The researcher will select the respondents for the study by using both probability and non-probability sampling methods. Stratification of the groups ensures the different groups that fall within various sub-categories of the population will get chance to participate the study (LeWinn et al., 2017). Simple random sampling confirms that each member of the population will have an equal chance of being involved in the sample. Purposive sampling is used when there are limited numbers of respondents that have enough information in the area being studied on (Sekaran & Bougie, 2016).

Therefore, a sample size of respondents was determined using Slovin's formula and the total numbers of 191 of fisheries related people and different stakeholders who use the fishing, fishery research, and policy making in the respective coastal sites were selected to respond to the questionnaires. Therefore, a formula (1), was used to determine the sample:

$$n=N/ (1+Ne^2) \quad (1)$$

Where: **n:** Sample size

N: Population size

e: margin on error

Therefore, a sample size of respondents in the respective coastal sites, are summarized into a table 3.2.

Table 1: Target population and sample frame

Category	**Population**	**Sample size**	**Percentage**
Marine scientists	40	36	18%
Coastal residents	113	88	51%
Fishermen and Cooperatives	20	19	9%
Ministry of fishery	25	24	11%
Civil society organizations	25	24	11%
Total	**223**	**191**	**100%**

As the above table marine scientists, coastal residents, members of fishery cooperatives, members from ministry of fishery, and members from civil society organizations samples were selected according to the institutions they were members of by using stratified random technique.

This gave each group a chance to provide representatives for the study. Then the study applied simple random sampling. A total number of 36 marine scientists were obtained from the target population that is 18% in order to participate in the proposed study. Similarly, the study got 88 coastal residents which 51% and 19 members from three fisheries cooperatives and fishermen whose target population apply 9% each group, and another 24 from ministry of fishery and civil society who constitute 22% totally. The study will apply purposive sampling technique to find representatives from policy stakeholders.

3.5.5. Data Collection of Questionnaires

3.5.5.1. Preliminary Data collection

A preliminary survey conducted, at the different coastal sites selected, to alert the fishermen and to examine a real ground area if my research questions will respond, to the current situation of marine resources use and the governmental efforts in marine pollution prevention. Later from May to June 2020, I collected the data from field using different methods described below.

3.5.5.2. Data collection methods

The different methods used to gather the data included, the questionnaires; a little direct interview; direct observation and literature of the different books, programs, policy and marine code related to coastal pollution in Somalia.

3.5.5.2.1. Questionnaires

A total number of 191 questionnaires were administrated to the marine scientists, coastal residents, members of fishery cooperatives, members from ministry of fishery, and members from civil society organizations selected randomly have responded our questions. Therefore, 36 questionnaires addressed to marine scientists in that area; 88 administrated to coastal residents of Mogadishu, 19 to the fishermen and fishery cooperatives, 24 to the ministry of fishery and marine resources and finally 24 questionnaires administrated to the Somali civil society organization.

3.5.5.2.2. Interview

A semi structured and unstructured interview were used to gather the data. This kind of data collection was selected to allow the interviewees to express their mind freely in their own words and thoughts on how the water policy enforcement may help the enhancement of coastal pollution prevention and performance. Also, four sector fishery experts drawn from each site, where a coastal site located was interviewed. In addition, four coastal residents' elders who are working in the development of the selected sites were interviewed also, more than three times depending on the different state and the situation of fishery harvestmen.

Sector fishermen's interview: Those interviews helped to collect the information related to:

- ✓ The circumstances in which there is a need for private sector involvement in fishery development.
- ✓ The role of Government in sustainability of public/ private partnership in fishery.
- ✓ How the people and Government in general, benefit from the private /sector investment in fishery.
- ✓ The strategies that the government plans to attract more investor in fishery development in Somalia.

3.5.6. Data analysis

The collected data were analyzed using SPSS, 21 Version. These data were interpreted and analysed, with references to the existing water policy and setting of coastal pollution prevention in Benadir Region Mogadishu city, then the conclusion and recommendation and policy brief were designed, for the sake of enhancing the sustainable marine resources use in fishery to meet the food demand while we are exploiting the marine resources sustainably.

4 RESULTS AND DISCUSSIONS

To evaluate the coastal pollution in Mogadishu city of Somalia, physico-chemical and microbiological analyzes were performed on the coastal areas of Mogadishu in order to assess and investigate its quality and level of response to the requirements and standards established for surface water. Also questionnaires were distributed to the local and coastal residents in order to get their responses and ideas about effect of coastal pollution. Results obtained from analyzes carried out are interpreted and compared to some existing recommendations and norms (WHO and EPA). The results include the following parameters usually measured in the field: Temperature, PH and Dissolved oxygen (DO) while other parameters were measured in the laboratory: Oil & Grease, Turbidity (NTU), Total dissolved salts (TDS), Total Suspended Solids (TSS), Biological oxygen demand (BOD_5), Chemical oxygen demand (COD). While Biological parameters were measured such as: total plate count at 37˚C; cfu/mL and at 37˚C; cfu/mL and Total Coliform count.

Table 2: Winter Data

TEST REPORT NO: 2019/SLAB/0008					
SAMPLE **DATE & PLACE SUBMITTED** **MARKS**	**Sea Water** **17th January at Mogadishu-Somalia** **2019/SLAB//0008/WINTER DATA** **3 Locations: Site 1: Easter slaughterhouse, Site 2: Liido Beach, Site 3: Buur-Fuule**				
Tests	**Methods**	**L 1**	**L 2**	**L 3**	**Standard Specifications**
pH	APHA METHOD 4500–H^+	8.20	8.19	8.16	7.6 – 8.4
Oil &grease; mg/l	APHA METHOD 2550 B	1.5	0.7	1.3	5 - 10
Dissolved Oxygen (DO) mg/l	APHA METHOD 4500	4.13	5.67	2.30	6 - 14
Turbidity (NTU)	APHA METHOD 2130 B	2.3	1.7	14.8	2
Total Suspended Solids (TSS) mg/l	APHA METHOD 2540 D	13.3	9.8	42.0	30
COD	AOAC Method 973.46	46.42	37.10	76.44	50
BOD	AOAC Method 973.46	62	34	98	50
Total Plate Count @ 37˚C; cfu/mL	ISO 6222	230	78	6400	25 - 250
Total Plate Count @ 22˚C; cfu/mL	ISO 6222	310	120	7100	25 - 250
Total Coliform count; cfu/mL	ISO 4832	30	3	245	NIL

Table 3: Summer Data

TEST REPORT NO: 2019/SLAB/0008					
SAMPLE **DATE & PLACE SUBMITTED** **MARKS**	**Sea Water** **17th January at Mogadishu-Somalia** **2019/SLAB//0008/WINTER DATA** **3 Locations: Site 1: Easter slaughterhouse, Site 2: Liido Beach, Site 3: Buur-Fuule**				
Tests	**Methods**	**L 1**	**L 2**	**L 3**	**Standard Specifications**
pH	APHA METHOD 4500–H^+	8.20	8.19	8.16	7.6 – 8.4
Oil &grease; mg/l	APHA METHOD 2550 B	6	4	12.43	5 - 10
Dissolved Oxygen (DO) mg/l	APHA METHOD 4500	4.16	6.87	1.29	6 - 14
Turbidity (NTU)	APHA METHOD 2130 B	2.3	1.7	22.5	2
Total Suspended Solids (TSS) mg/l	APHA METHOD 2540 D	28.58	6.43	60.6	30
COD	AOAC Method 973.46	51.13	27.10	89.44	50
BOD	AOAC Method 973.46	64.50	20.50	112.00	50
Total Plate Count @ 37˚C; cfu/mL	ISO 6222	6700	260	7700	25 - 250
Total Plate Count @ 22˚C; cfu/mL	ISO 6222	7500	350	8700	25 - 250
Total Coliform count; cfu/mL	ISO 4832	110	12	368	NIL

4.1. Physico-Chemical Parameters

In the studied locations, different temperatures in various sampling stations during summer season were ranged from 23.9^0 C to 29.9^0 C, while in winter season the values ranged from 25.1^0 C to 32.1^0 C (see figure 4.1). The higher temperature recorded in February (while March is the hottest month in southern Somalia) may be due to the effect the high atmospheric temperature and/or the decomposition of organic compounds that included in the water discharged from different small factories around the coastline area.

4.1.1. pH

4.1.1.1. Results

There were a slightly variation of pH values among various sampling locations (from 1 to 3) in both seasons, ranged from 6.13 to 6.16 in winter season which are below the limit range of

7.6–8.4 assigned by WHO and EPA guidelines for marine water and from 8.16 to 8.20 in summer season which are within the limit range.

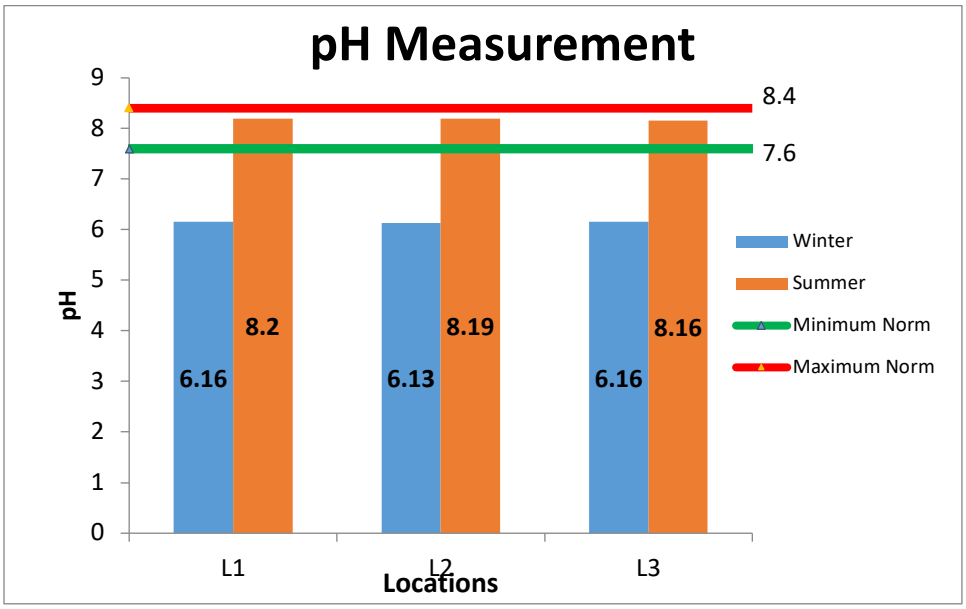


Figure 9: Seasonal and regional variations of pH values along Mogadishu coast

4.1.1.2. Discussion

As the pH values estimated in all water samples were in slightly acid in winter season and slightly alkaline in the summer season, it is implausible to result in health issues such as acidosis or similar complications (Asamoah & Amorin, 2011). Additionally, an overall excess of alkalinity in the body may cause gastrointestinal issues and skin irritations. Too much alkalinity may also agitate the body's normal pH, leading to metabolic alkalosis, a condition that may produce the following symptoms: nausea, vomiting, hand tremors, muscle twitching, tingling in the extremities or face and confusion.

4.1.2. Oil and Grease Measurement

4.1.2.1. Results

Oil and Grease concentrations for the studied locations, recorded high values at L 3 in both summer and winter with a value of 12.43 mg/l in the summer and 11 mg/l in the winter

(Figure 10) which are above the limit range of 5–10 mg/l assigned by WHO and EPA guidelines for sea water

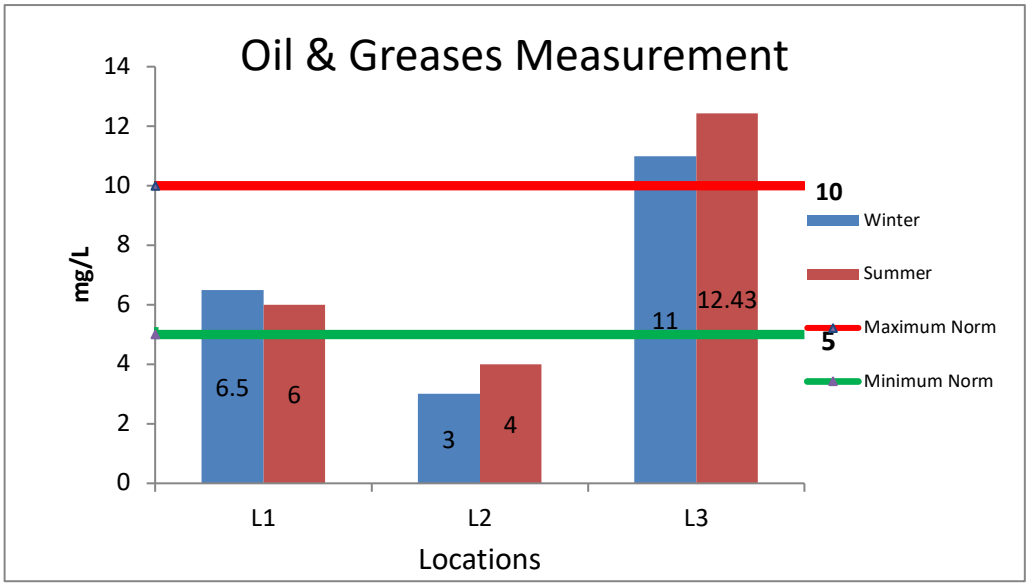


Figure 10. Seasonal and regional variation of Oil & Greases concentrations (mg/l) along Mogadishu coast

4.1.2.2. Discussion

The reason of getting high concentration of OG in that location is because of the many sewage that is directly discharged to that location without any treatment (Figure 12) as well as oil discharged from the ships in Mogadishu seaport (the Mogadishu seaport is located near this location). (Almeida, Silvério, Silva, Paulino, Nascimento, & Revez, 2013) Claimed the concentration of dispersed oil and grease (OG) is an important parameter for water quality and safety. OG in water can cause surface films and shoreline deposits leading to environmental degradation, and can induce human health risks like mutagenic and carcinogenic for human being when discharged in marine water, surface or ground waters. Moreover, they may interfere with aerobic and anaerobic biological processes and lead to decreased wastewater treatment efficiency. Regulatory bodies worldwide set limits in order to control the amount of OG entering natural bodies of water or seas through industrial discharges and sewage (as happened in Mogadishu), and also to limit the amount present in drinking and salt water (Pan & Wang, 2012). Organic toxic waste (oil and grease (O&G)) causes ecology damages for marine organisms, plant, and animal. They discharge from different sources to form a layer on water surface that decreases dissolved oxygen.

Figure 11: Effect of sewage pollution on L3 of Buur-Fuule

4.1.3. Dissolved Oxygen (DO)

4.1.3.1. Results

Dissolved Oxygen (DO) concentrations for the studied locations, recorded a minimum value at L 3 in both summer with a value of 1.29 mg/l and winter seasons with a value of 2.30 mg/l which is below the guidelines and standards assigned by WHO/EPA (6–14) which indicate the lower quality of water for aquatic life (Figure 12). A high concentration of DO was recorded at L 2 in summer season with a value of 6.87 mg/l and winter season with a value of 5.67 mg/l which is between the guidelines and standards assigned by WHO/EPA.

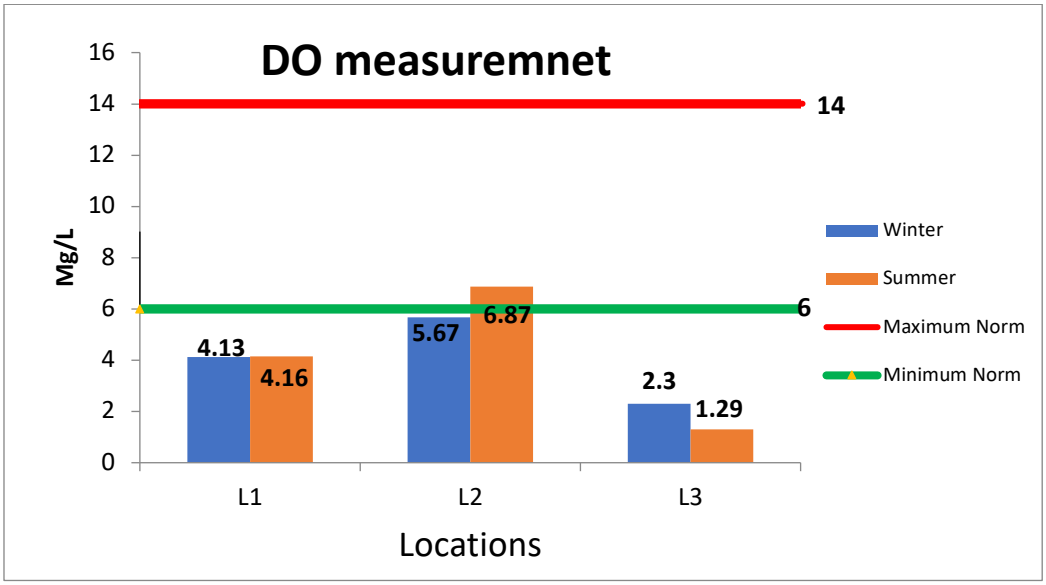


Figure 12: Seasonal and regional variation of DO concentrations (mg/l) along Mogadishu coast

4.1.3.2. Discussion

A higher temperature recorded in summer season that increases evaporation process associated with increasing sewage discharges contained more reducible material (mostly in the surface layer) and the location of the study area together with limited aeration, play an important role in dissolved oxygen depletion in this location. However, a high concentration of DO was recorded at location 2 in summer season with a value of 6.87 mg/l and winter season with a value of 5.67 mg/l which is between the guidelines and standards assigned by WHO/EPA.

Marine water holds less oxygen than freshwater, so oceanic DO concentrations tend to be lower than those of freshwater. In the ocean, surface water mean annual DO concentrations range from 9 mg/L near the poles down to 4 mg/L near the equator with lower DO levels at further depths (Ezekwe & Edoghotu, 2015). If dissolved oxygen concentrations drop below a certain level, fish mortality rates will rise. In the ocean, coastal fish begin to avoid areas where DO is below 3.7 mg/L, with specific species abandoning an area completely when levels fall below 3.5 mg/L. Below 2.0 mg/L, invertebrates also leave and below 1 mg/L even benthic organisms show reduced growth and survival rates which may effect on food security and human health.

4.1.4. Turbidity (NTU)

4.1.4.1 Results

As (Figure 13) shown Turbidity In the studied area, recorded high concentration of 22.5 NTU at location 3 in the summer season and 14.8 NTU at location 3 in the winter season which are both above the limited guidelines and recommendations of WHO/EPA which is 2 NTU, while the concentrations of locations 1&2 are in the accepted levels of turbidity.

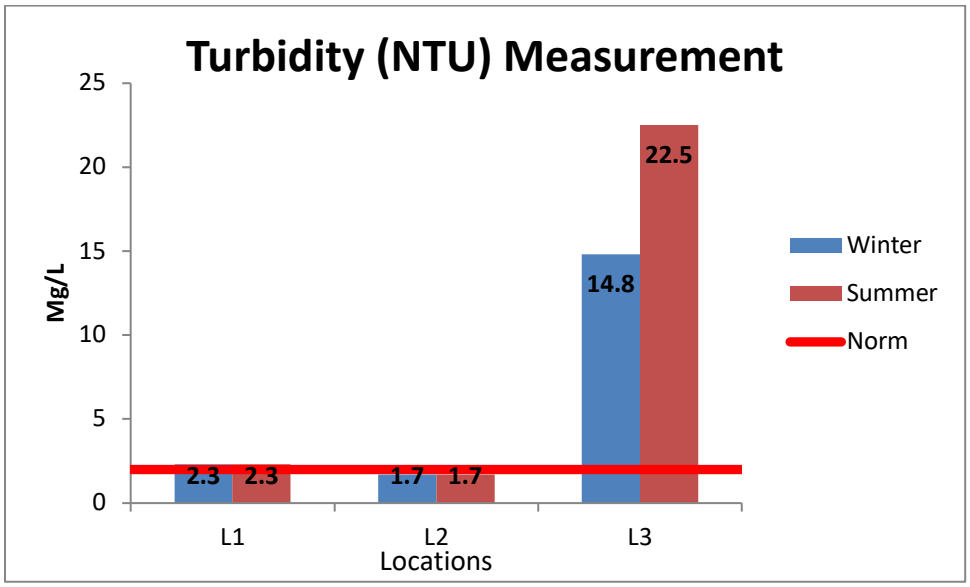


Figure 13: Seasonal and regional variations of turbidity values (NTU) along Mogadishu coast

4.1.4.2. Discussion

Turbidity (NTU) is a measure of water clarity. Turbidity describes the amount of light scattered or blocked by suspended particles in a water sample-particularly sediment. Clear water has low turbidity and cloudy or murky water has a higher turbidity level.

According to (Uejio, Yale, Malecki, Borchardt, Anderson, & Patz, 2014), turbidity has health effect on the human being as turbidity increases, the risk for gastrointestinal illness also increases—particularly for at-risk populations such as newborns, the elderly, and people with weakened immune systems (e.g. those with HIV/Aids and undergoing chemotherapy). Sources of turbidity can include hazardous organisms or pollutants associated with or attached to other particles. Some organisms found in water and people use that water or those organisms with high turbidity can cause symptoms such as nausea, cramps, and headaches. Besides affecting

water quality (fresh water), many common contaminants that increase turbidity can also change the odor of the marine water.

Figure 14: Effect of sewage on turbidity

4.1.5. Total Suspended Solids (TSS)

4.1.5.1. Results

The total suspended solid was found to be ranged from 9.8 to 42 mg/L as minimum and maximum records for winter season and 6.43 to 60.6 mg/L as minimum and maximum records for summer seasons respectively (Figure 15).

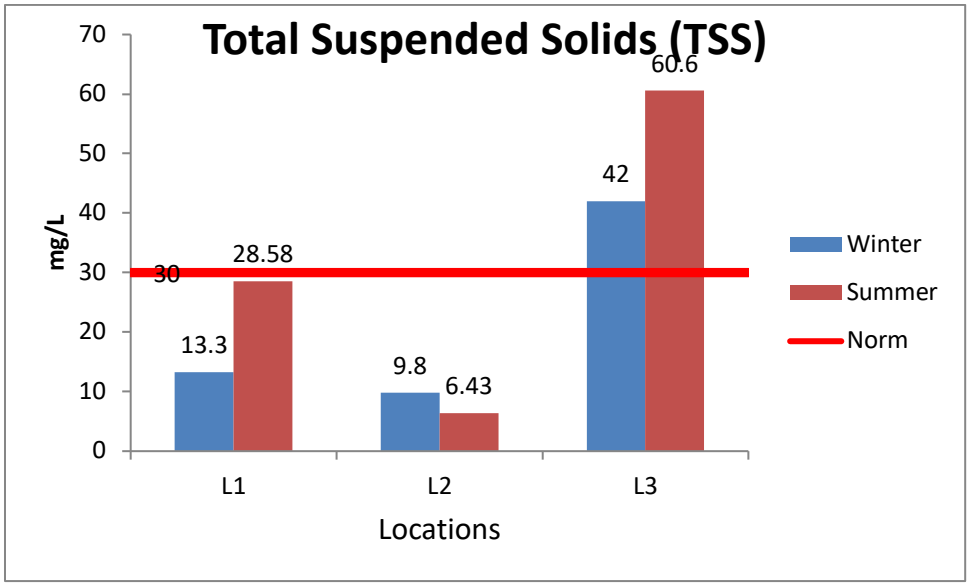


Figure 15: Seasonal and regional variation of TSS concentrations (mg/l) along Mogadishu coast

4.1.5.2. Discussion

The increased TSS values recorded in L1 & L2 (summer season) reflected the effect of small industrial effluents, coastal destruction by the local population for the purpose of building material and sewage discharge into the coastline in these locations.

(Badr, Al-Qahtani, Alflaij, Al-Qahtani, & Al-Saad, 2020) Mentioned that the total Suspended Solids (TSS) consists mainly of inorganic fraction (lithogenic clay, slit, sand and particles resulted from chemical processes) as well as degradable and non-degradable organic fractions. In this study, the irregularity for TSS values with different locations and seasons might be related to the quantity of wastewater and sewage discharged to the coastal area of Mogadishu.

In terms of health effect of TSS, high concentrations of suspended solids can cause many problems for stream health and aquatic life. High TSS in a surface water can often mean higher concentrations of bacteria, nutrients, pesticides, and metals in the water that can be harm to the human and marine organisms.

4.1.6. Chemical oxygen demand (COD)

4.1.6.1. Results

As shown from (Figure 16) the COD was recorded in the range of 27.1 to 89.44 mg/L for three locations. The highest COD was observed at Buur-fuule (L3) during summer season, and while the minimum value was recorded at Liido beach (L2) during summer season.

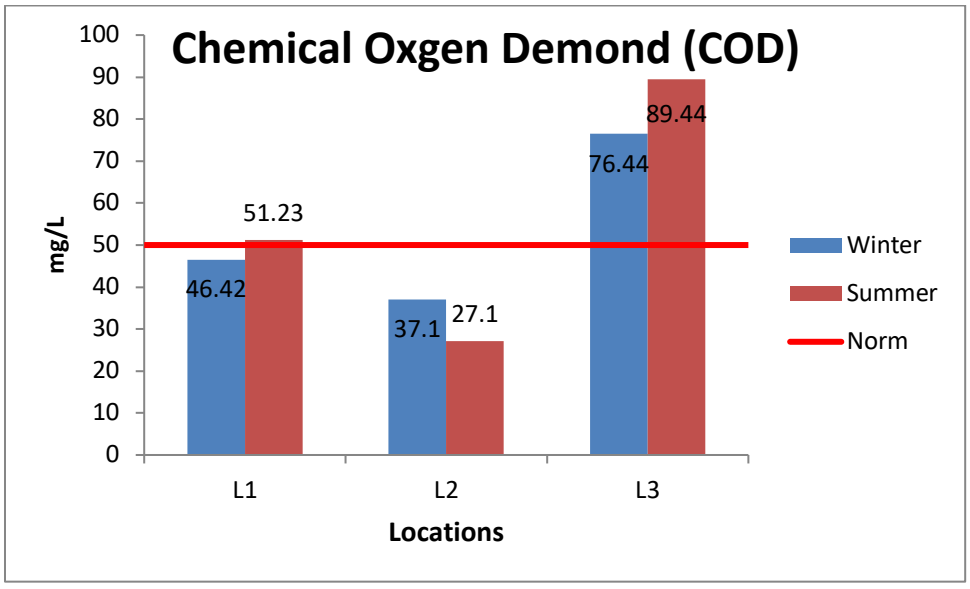


Figure 16: Seasonal and regional variations of COD values (mg/L) along Mogadishu coast

4.1.6.2. Discussion

Chemical oxygen demand (COD) is an indicative measure of the amount of oxygen that can be consumed by reactions in a measured solution. It is an important water quality parameter because, similar to BOD, it provides an index to assess the effect discharged wastewater on the receiving environment. Higher COD levels mean a greater amount of oxidizable organic material in the sample, that will reduce dissolved oxygen (DO) levels (Verma & Singh, 2013). A reduction in DO can lead to anaerobic conditions, which is deleterious to higher aquatic life forms. The COD test is often used as an alternate to BOD due to shorter length of testing time.

4.1.7. Biological oxygen demand (BOD)

4.1.7.1. Results

Figure 17 reveals that, the BOD at three sampling locations ranged from 20.5 to 112 mg/l. The highest BOD value was detected during the summer season at L3 (Buur-Fuule) which exceeded the permissible level of 50mg/l and minimum BOD value of 20.5 mg/l was recorded in summer season at Liido Beach.

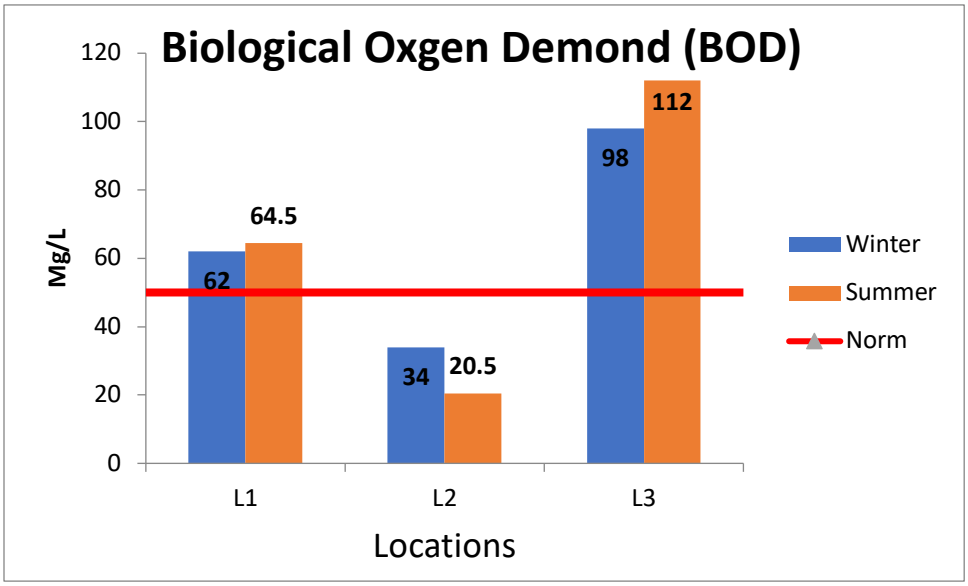


Figure 17: Seasonal and regional variations of BOD values (mg/L) along Mogadishu coast

4.1.7.2. Discussion

Biological oxygen demand (BOD), measures the amount of oxygen consumed by microorganisms in decomposing organic matter in stream water. BOD directly affects the

amount of dissolved oxygen in rivers, seas and streams. The greater the BOD, the more rapidly oxygen is depleted in the water. This means less oxygen is available to higher forms of aquatic organisms that become stressed, suffocate, and die. This in turn will effect on the food security and health of the human being (Bhateria & Jain, 2016).

4.2: Biological Parameters

4.2.1. Total Plate Count

4.2.1.1. Results

As shown in the Figures 18 and 19 the value of total plate count fluctuated from 78 to 8700 cfu/mL. The maximum value of total plate count was 8700 cfu/mL in summer season at 22^0 C in L3 (Buur-Fuule) and the minimum value recorded 78 cfu/mL in winter season at L2 (Liido Beach),

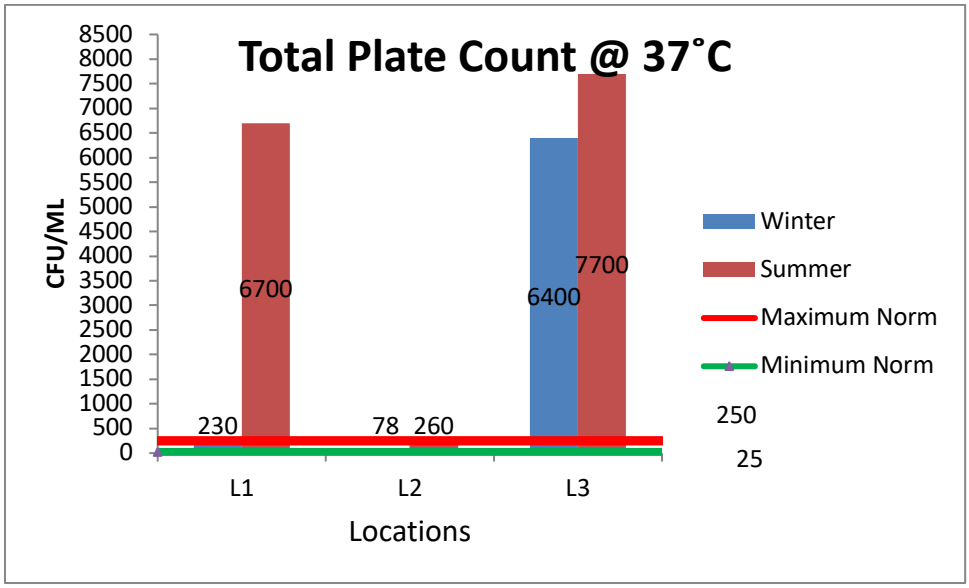


Figure 18: Seasonal and regional variations of Total Plate Count @ 37˚C; (cfu/mL) along Mogadishu coast

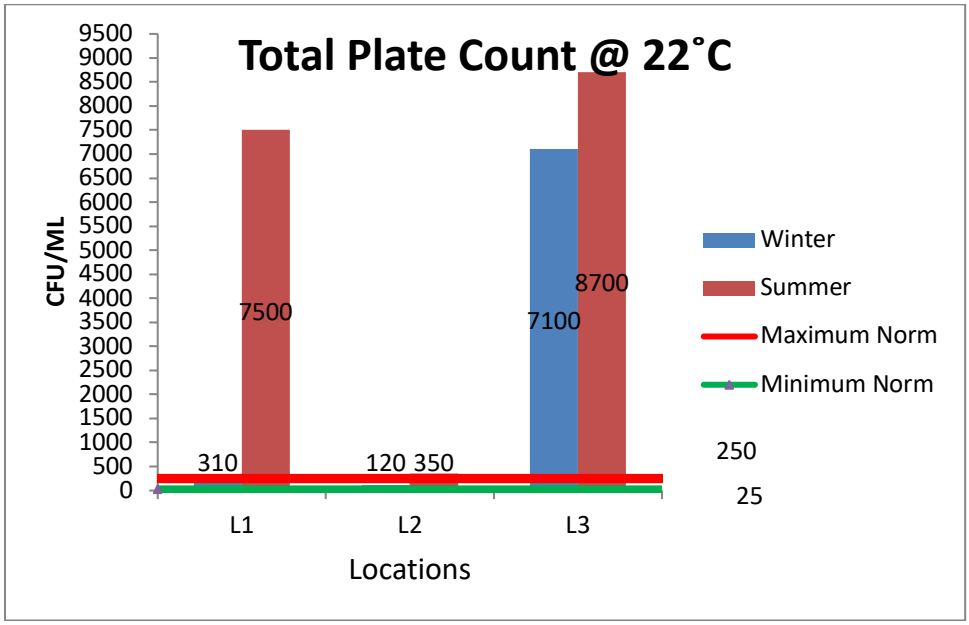


Figure 19: Seasonal and regional variations of Total Plate Count @ 22˚C; (cfu/mL) along Mogadishu coast

4.2.1.2. Discussion

During the study, the researcher noticed that L1 also was in risk and showed high concentrations of total plate count due to the direct discharged of blood from Eastern slaughterhouse of the city (L1) to the sea. Moreover, the untreated sewage which is discharged to the sea made high concentrations of Total Plate Count at L3.

4.2.2. Total Coliforms

4.2.2.1. Results

For area under investigation, the Total coliform count value ranged from 3 to 368 cfu/mL. As a minimum and maximum values, respectively (Figure 20)

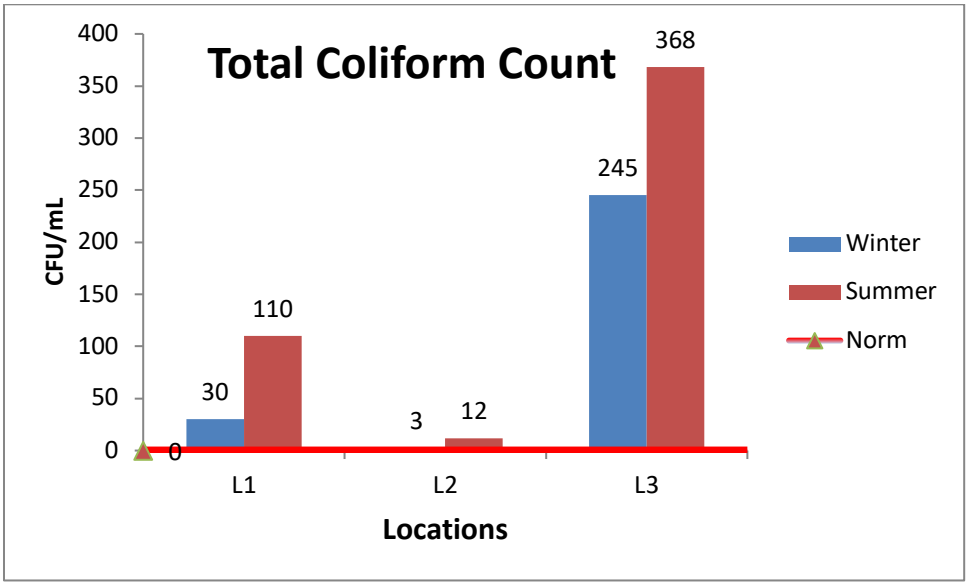


Figure 20: Seasonal and regional variations of Total Coliform count; (cfu/mL) along Mogadishu coast

4.2.2.2. Discussion

According to (Khatri & Tyagi, 2015), that total coliforms include bacteria that are found in the soil, in water and in human or animal waste. If coliform bacteria are present in sea water, the risk of contracting a water-borne illness is increased by transmitting to the marine organisms and then to the human or by swimming the local people in that area. Although total coliforms can come from sources other than fecal matter, a positive total coliform sample should be considered an indication of pollution in the marine environment. In this study, L3 (Buur-Fuule) is facing problem of fecal pollution, reached a number higher than all other locations (368 cfum/L), due to the huge sewage discharged to this area without any treatment.

4.3 Questionnaires

A survey research design was based on collection of data from coastal residents, Fishermen & fisheries cooperatives, marine scientists, governmental officials and civil society in Mogadishu especially in the studied areas (Eastern slaughterhouse, Liido beach and Buurfuule). The number of respondents were 191 persons, in the age range of 18 to >45 years old with working history from 1 to >9 years, affected by coastal pollution, solid & liquid wastes from the slaughterhouses and direct discharges of the sewage to the sea. A structured questionnaire covering three aspects was used in the collection of data from the respondents, the questionnaires were based on the research objectives. They were asked about their demographic data, pollution in S[illegible] on Co

Figure 21: Sewage discharges to the L3 of Buur-Fuule

Figure 22: Data Collection using Manual and ODK Collect (Online)

4.3.1 Demographic data

The characterization of demographic data of the respondents was based on the identification of their sex; level of education and description of their living district. Hence based on the results, a total number of 191 respondents participated in this research, 44.5% were in Lido beach site of Abdul-aziz district; while 35.6% were from the Buurfuule/Hamarwayne fish market site of Hamarwayne district and 19.9% of the respondents were the workers of Eastern slaughterhouse of the city site of Kaaraan district (Fig.23).

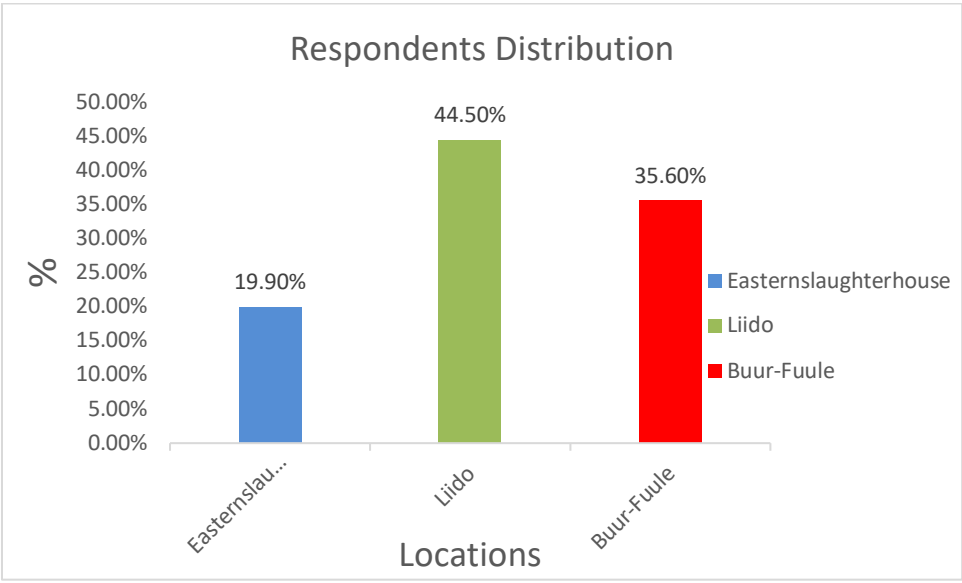


Figure 23: Respondents distribution in selected areas

On the other hand, gender balance is the key important issue in coastal pollution prevention and fishery sector. As indicated from results, 21.99% of total respondents were female in coastal areas, whether they work or they come for visiting, while 78.01% were male. As a matter of facts, 17.28% of the respondents were the female in coastal area of Liido Beach site, mostly of these females come to the beach for recreation and tourism, 3.14% were female from Buur-fuule site and 1.57% of the respondents were female from Eastern slaughterhouse site, who are clean workers. Furthermore, 27.23% of the respondents were the male fishermen from Liido Beach site, 32.46% of the respondents were male fish market workers or Hmarwayne slaughterhouse from Buur-Fuule site and 18.32% of the respondents were male workers from Eastern slaughterhouse site (Fig 24).

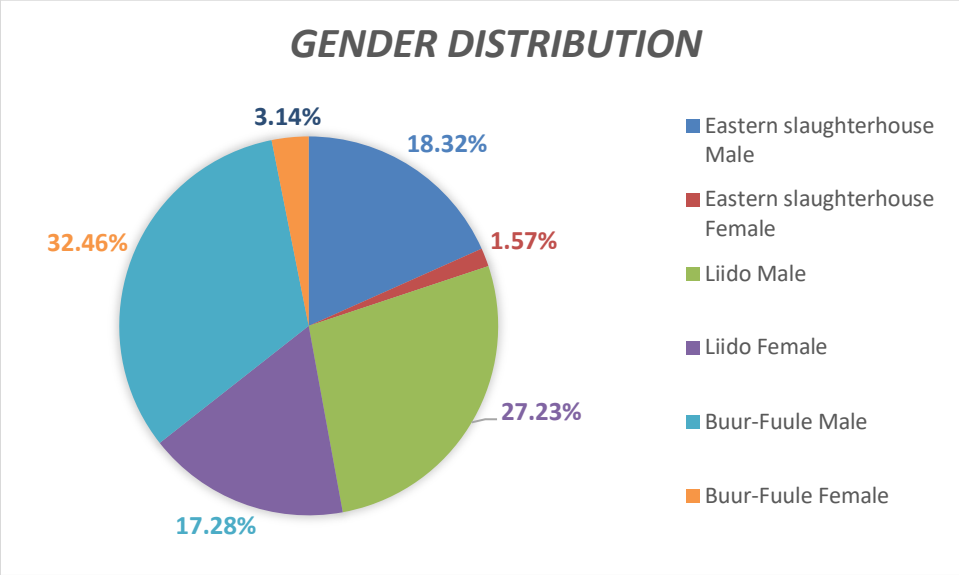


Figure 24: Gender distribution of the respondents by Irrigation site

The level of education of the fishermen play a vital role in the development of marine protection and production due to the facilitation of knowledge transfer and enhancing learning that help in an environment protection and shifting from subsistence marine to fully marine with technology (Freed, Dujon, Granek, & Mouhhidine, 2016). During this study, 16.23% of the respondents did not attend school and they did not have any basic knowledge on how to write and to read, whereas 24.08% of the respondents attended primary school; 29.32% of the respondents attended twelve years basic education (Secondary school) and 30.37% were the university graduate. Therefore, among of them, 2.62% of all respondents were the university

graduate from Eastern slaughterhouse site; while 3.66% of all respondents were the respondents from Eastern slaughterhouse site who attended twelve years basic education; on the other hand, 5.76% of the respondents were attended primary education from Eastern slaughterhouse site, while 8.38% of did not attend school. On the hand, 19.90% of the respondents were the respondents from Liido beach site were university graduate, 13.09% were attended secondary education whereas 8.90% attended primary education and 4.71% did not know how to read and write. Though at Buur-Fuule site, 7.85% of the respondents attended university studies, 12.57% attended secondary school, and 9.42% studied primary school and 3.14% did not know how to write and reading (Figure 25). Therefore, based on the findings, most people who participated in this study have good knowledge on writing and reading so, the knowledge transfer may be facilitated once they are being trained on coastal pollution prevention and development.

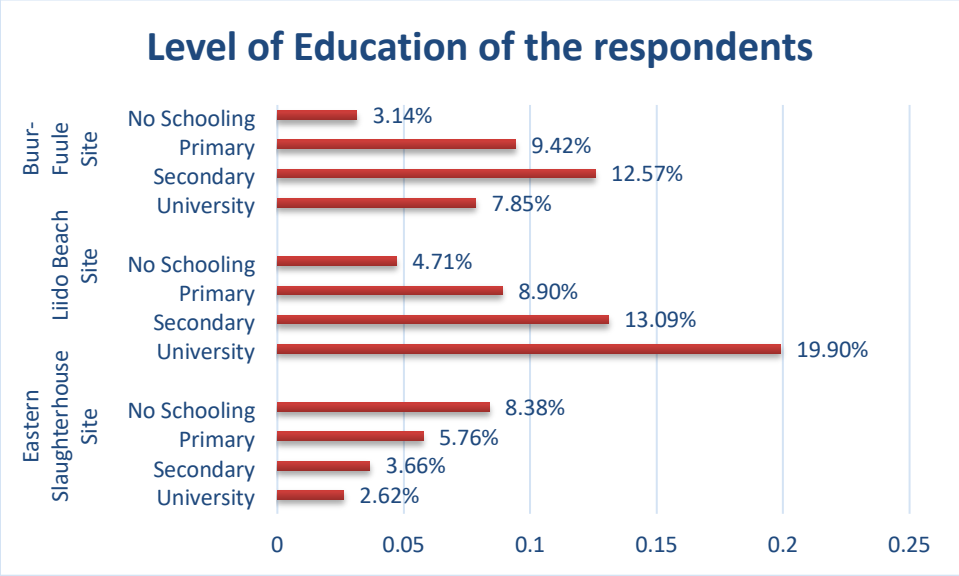


Figure 25: Level of education of the respondents for the areas under investigation

The distribution of the traget population in the studied area, Coastal residents were the highest group who the researcher met with them; because they are the most valnurable group by marine pollution. About 46.07% of the respondents were residents of the coastal area, marine scientists were the second group of the target population as long as they are the experts who do research on the area and know more than others, 18.85% of the respondents were from marine

experts, 12.57% were Governmental officials, 12.57 were from civil society. Finally 9.94% were the respondents of fishermen and fisheries coperatives see figure 26.

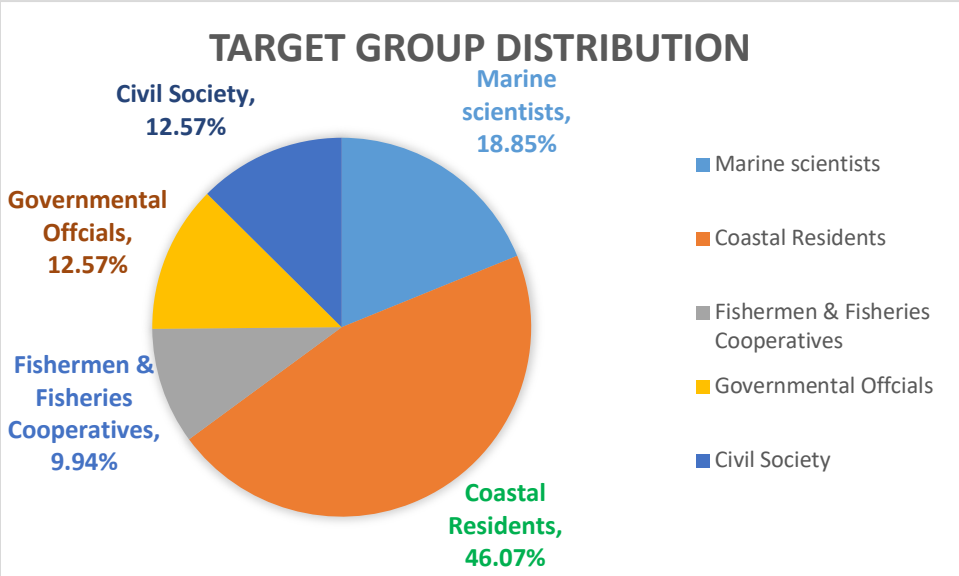


Figure 26: Target Group distribution

4.3.2 Coastal Pollution and its health effects in selected sites

During this study, the most dangerous location was L3 which is Buur-fuule. Fortunately, their knowledge of coastal pollution was very high (which is positive) and also their response of feeling of pollution mostly was yes, while 34% of the total respondents was yes, which is the highest number of all responses. The knowledge of pollution for slaughterhouse respondents (L2) was average while the high was 11% and low was 9.60%, while 32% of the total respondents declared their feeling of coastal pollution, which is the second highest number after Buur-Fuule. Finally the coastal pollution knowledge of Liido beach site respondents (L1) was low (12.4%), while the respondents with average experience and feeling coastal pollution was 18%. Therefore, Buur-Fuule and Eastern slaughterhouse are the most locations who experienced a huge coastal pollution which is very dangerous to the human health while Liido beach location is a normal site comparing with the other locations.

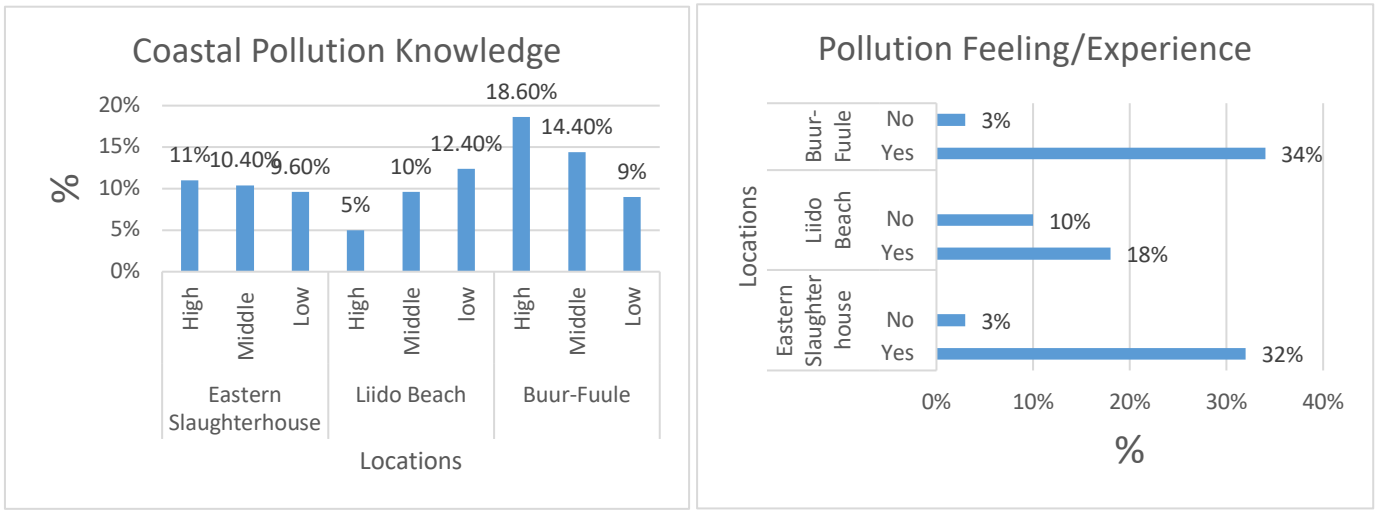


Figure 27: Coastal Pollution Knowledge and experience by the respondents of the areas under investigation

Coastal pollution causes many diseases like various kinds of cancer, skin disease, infectious disease and genetic mutation. Once the coastal residents are fully involved in management, planning and decision makers, the pollution will be less. Therefore, during this study, the different categories of the stakeholders involving in the protection of polluted locations, but it depends on the intensity of pollution. Some need the intervention from the Government which has high intensity and mostly comes from external ships. Others are protected by the trained fishermen, coastal residents, skilled professional campaigners from environmental organizations and NGOs. This pollution has low intensity and mostly is local pollution. Therefore, most of the people in the selected areas are experienced some diseases who were caused by coastal pollution. In Eastern slaughterhouse location, 34% have experience of diseases while only 1% did not experience any disease related to the coastal pollution. In Liido beach, where the pollution in this location is lower than the other locations, 24% are experienced the diseases caused by coastal pollution and 4% are not experienced any diseases of coastal pollution, in Buur-Fule location, where is the most dangerous location among other locations, 36% of the interviewee or respondents are experienced coastal pollution diseases while only 1% are not experienced. On the other hand, during this study, residents were asked the most frequent disease in the selected areas, while skin diseases and infectious diseases are the most abundant diseases in the area, cancer and genetic mutation was low in the locations comparing with the other diseases. At Eastern Slaughterhouse, skin disease were 20%, infectious diseases were 16%, cancer was 3.20% and genetic mutation was 1.40%, while in Liido beach, skin disease were 9.20%, infectious diseases were 7.10%, cancer was 0.30% and genetic mutation was 0% At Buur-Fuule location, skin disease were 22.40%, infectious diseases were 18%, cancer was 1.30%,

and genetic mutation was 0.30%, which makes this location the most and highest risk location among the other locations. This shows that the anthropogenic effects which were caused by human affected the coastal pollution in Mogadishu, Buur-Fuule location became the most populated location in the selected areas, while Eastern slaughterhouse is the second most populated location but Liido beach is a normal location comparing the other locations (Figure 29). Once the stakeholders are well trained on coastal pollution prevention, management and intervention of the government, will reduce the effect of pollution, increase and enhance the marine production.

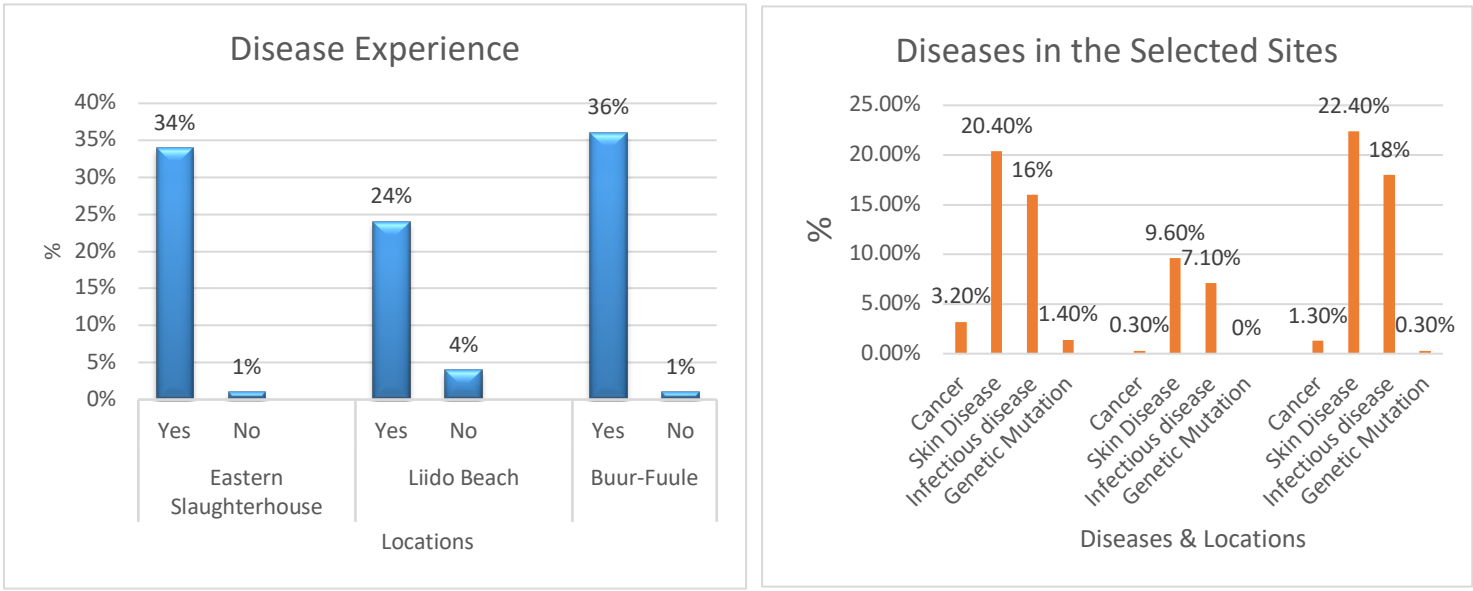


Figure 28: Diseases in the areas under investigation

The environmental impact of shipping includes air pollution, water pollution, acoustic, and oil pollution. External pollution resulted by foreign ships in Somali maritime. Ships and their pollution to the marine environment are responsible for more than 64% of coastal pollution in Somalia which causes diseases who are related to the marine pollution through burying solid wastes, nuclear wastes and others. Those pollutants may cause some diseases such as cancer, skin disease and genetic mutation to the Somali people (Figure 29). On the other hand the internal pollution is the second factor which causes disease to the Somali people, internal pollutions are responsible for more than 26% percent of coastal pollution in Somalia. The internal pollution is resulted by the direct discharge of the sewage to the marine environment and local small boats for fishing, while natural factors such as El Niño, La Niña and Tsunami are less than 10% of causes coastal pollution and diseases related to marine pollution

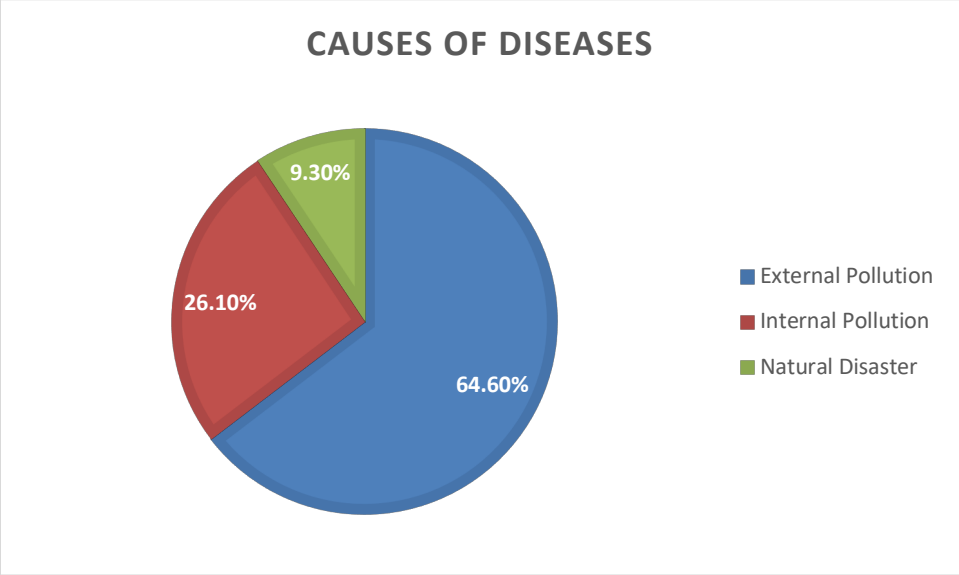


Figure 29: Causes of Diseases in the areas under investigation

There are significant and various forms and types of marine pollution in Somali marine environment such physical, chemical and biological pollution are all existing in Somali maritime zone. They are still unknown tanks who were buried in Somali seas by foreign ships, those tanks may contain hazard wastes such as nuclear wastes, the history of that burying started from the collapsing of Somali government in 1991, the respondents agreed that the chemical pollution (44.10%) and biological pollution (42.30%) in Somalia is the most types they notice mostly.

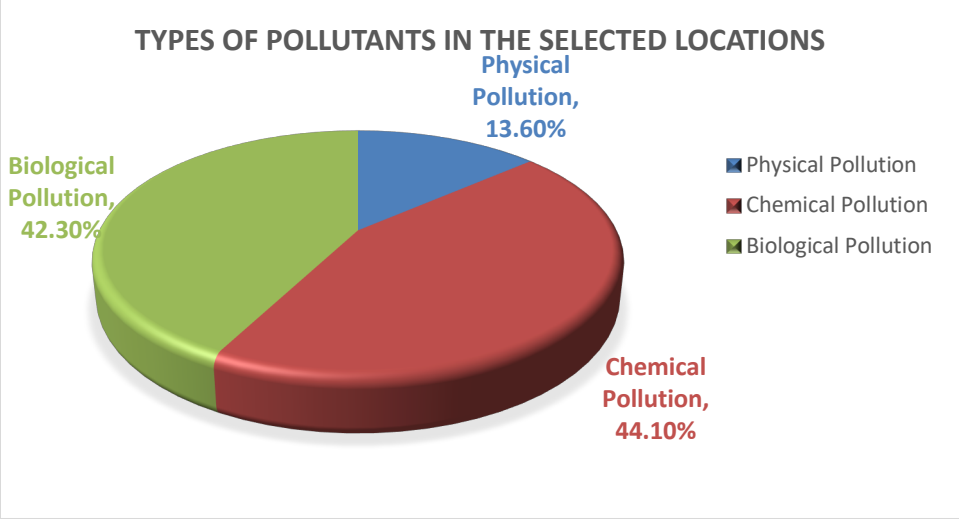


Figure 30: Types of Pollutants in the areas under investigation

4.3.3 Policy Implementation on the Coastal Pollution

During this study, the researcher investigated how is the situation of policy implementation in this country through the different stakeholders of marine issues by districting for them questionnaires, the next chapter will talk more on Somali policy related to marine issues including coastal pollution. Most the stakeholders witnessed that they got trainings and participated meetings when the government (Ministry of Fisheries & Marine Resources, Ministry of Ports & Marine Transportation and SMRRC) formulate policies related to marine issues. Respondents mentioned the existing of rules and regulations related to marine issues including coastal pollution prevention, which is the maritime code in 1989 (before the collapsing of the central government of Somalia), but that law or code needs to upgrade and make a code which can correspond with the modern codes in the region and even in the world. During the interviewing of different target groups and different stakeholders about the policy related to the marine, they declared that they have a good relationship between them and working together in terms of projects related to the marine issues. However, the relationship between the FGS and FCs is weak, which may damage the protection actions of coastal pollution whether from the international or local polluters. Also all of them showed that the federal government of Somalia is responsible for accountability and monitoring of foreign ships existing in the country and also punish them at the case of the assault on the Somali territorial sea, but unfortunately as the federal republic of Somalia is weak, the foreign ships do unwanted actions in the Somali maritime zone. The fishermen and FCs declared that they do not get a compensation neither from the FGS nor foreign ships in the case of an assault on the fishermen by foreign ships. The FCs, fishermen and other stakeholders claimed that the possible challenges that they face mostly are foreign ships who are responsible of coastal pollution, illegal fishing and overfishing. The most strategies that the different stakeholders proposed to enhance fishery performance and pollution prevention in Somalia were increase the awareness and strong accountability of foreign ships. On the other hand, Fishermen showed that they get sometimes trainings from the fishery cooperatives (FCs) and some independent marine experts but not too much. The marine experts in Somalia transfer their knowledge on this issue through town-hall meetings, trainings and awareness.

Figure 31: Policy issues related to Marine Issues including: Relationships b/w Different Stakeholders, Challenges in the Selected Locations, their Solutions, Compensation and Ways of Knowledge Transferring

5 SOMALI POLICY RELATED TO THE COASTAL POLLUTION

5.1. Introduction

Somalia is preparing its national water policy by adapting it to all mutations born from changes as well as marine environmental issues, health and economic needs as well as a perception of the real situation of marine water and the economic consequences. Since 1989, Somalia has embarked on a new maritime law, known the “Somali Maritime Law – Law No. 5 of 26 January 1989" with support MARPOL and UNCLOS to guarantee their valorization and sustainability. This new policy is based on a set of institutional reforms and new instruments that are based on different stakeholders. Somali is implementing the basic components of this new policy similar to other countries who are implementing this.

This new policy has three basic components which are:

1. **Economy:** This economy will be done by the fight against the overfishing and illegal fishing by national and international ships, as well as preventing any activity which can cause tourism loss, as well as by raising the awareness of coastal residents and other stakeholders about the use of this resource of marine environment.
2. **Ecology:** the marine environment is a sensitive area and a collective good to protect against any form of pollution.
3. **Universality:** anybody can navigate through the Somali territorial water but no harm to it.

There are other policies related to marine issues. During this study, the researcher investigated the existing of different policies related to this issues and identified the federal government of Somalia (FGS) did not formulate any new policies related to coastal pollution after 1991 (after the collapse of the central government of Somalia) as well as the government did not review the existed policies between 1960-1991 such as LAW NO. 37 OF 10 SEPTEMBER 1972 and Somali Maritime Law – Law No. 5 of 26 January 1989. The Ministry of Energy and Water Resources (MoEWR) is preparing currently the national water policy of the country but it did not mention any policy related to coastal pollution, also MoEWR prepared the national water law and approved by the two houses (Parliaments and senates). The directorate of Environment and Climate Change (DoECC), under the office of the Prime Minister (OPM) prepared the National Environment Policy and approved by the cabinet but they did not mention any policy or strategy related to marine issues except fishery sector. The Ministry of Fishery and Marine Resources (MoFMR) did not conduct much about coastal pollution prevention actions and did not form any policy related to how to tackle this issue. Therefore the absence and weakness of national marine

policy caused unwanted action from the local people by their direct discharge of sewage to the sea and dumping the solid and liquid wastes in the marine environment as well as foreign ships by dumping hazardous and nuclear wastes in the Somali sea and doing illegal and over fishing in the Somali territorial water.

However, Somalia is improving now all these policies and trying to recap that gap but lack of implementation is still existing in the field. Currently DoECC is preparing the national climate change policy, as well as the related ministries are recovering and trying to cover this gap. The government must understand the importance of marine resources especially in country like Somalia and its impact in environmental, health and economic field

5.2. Environment:

Because of the outdated policies and laws and the absence of the law and order more than three decades in Somalia, coastal pollution affected on the Somali marine environment. According to (Goudie & Viles, 2013) oceans are the largest water bodies on the planet Earth. Over the last few decades, surplus human activities have severely affected marine life on the Earth's oceans. Ocean pollution, also known as marine pollution, is the spreading of harmful substances such as oil, plastic, industrial and agricultural waste and chemical particles into the ocean. Since oceans provide the home to wide variety of marine animals and plants, it is the responsibility of every citizen to play his or her part in making these oceans clean so that marine species can thrive for a long period of time. The effect of external pollution by foreign forces through dump their waste into Somali territorial water while the Somali people faced lack of authority and currently, they are facing huge problems such as health, economic, and environmental issues, in addition to that weak government cannot protect its water.

Under Article 25 of Somali Provisional Constitution, the primary responsibility rests on the Government. The provisions oblige the Government to provide a safe environment, protect the citizens from problems arising from pollution and other harmful materials as well as the preservation of the natural resources from excessive exploitation. The element of rational utilization of the natural resources is important and it implies that the natural resources shall be managed in such a way that it benefits both the current and future generations while incorporating general protection and sustainable development.

Furthermore, the Constitution declares the obligation of the Government to prioritize the protection, conservation, and preservation of the environment against anything that may cause

harm, but it also imposes a duty on the citizens to safeguard and enhance the environment. Accordingly, citizens are required to participate in the development, execution, management, conservation and protection of the natural resources and environment.

The above provisions contain two important aspects. First, the requirement of an obligatory environmental protection is introduced and, secondly, it does not limit the sources that can harm the environment. Therefore, the Constitution places a clear obligation on the Government to protect the marine environment from pollution resulting from offshore explorations.

Similarly, the Constitution introduces a series of obligations on both levels of the Government, federal and regional. It obliges both to take measures to clean any hazardous waste dumped on the land or in the waters of Somalia, enact national legislation that regulates the dumping of waste in accordance with international laws and also take urgent measures to prevent future dumping. In addition, seek compensation from those responsible for any dumping of waste and to take measures to reverse the environmental damage.

It is apparent that the Provisional Constitution addresses the issue of dumping of wastes more specifically and the reason behind this is that there have been numerous reports of illegal dumping of hazardous waste in the sea and coastline of Somalia in the early 1990s when the country was still at the peak of the civil war (Ajibo, 2016).

The Constitution obliges the Federal Government to ensure that issues related to the protection of the marine environment and prevention of erosion affecting federal member states territories are regularly discussed at the highest levels of the regional governments including the presidents of the federal member states.

In respect to mineral rights and hydrocarbon explorations, the Constitution remains ambiguous. In accordance with Article 44, the allocation of natural resources shall be negotiated and agreed between the Federal Government and the federal member states. Accordingly, on 18 May 2019, the House of the People of the Federal Parliament approved the Revenue Sharing Agreement which was negotiated between the Federal Government and the federal member states. Key elements of this agreement and how it addressed the issues of ownership, sharing and managing the natural resources are discussed in this chapter.

The Petroleum Law of Somali (2008) is the primary legal document responsible for managing and regulating the oil and gas activities in Somalia both onshore and offshore. The

Petroleum Law also regulates environmental responsibilities on the licensee conducting oil and gas activities. Under Article 28, the licensees are required to prevent pollution, damage to the ecological environment, oil spills, develop emergency clean-up plans and procedures as well as to conduct an environmental impact assessment before any major exploration activity. In addition, an obligation to conform to good oilfield practice in the restoration of the environment at the closure of the exploration activity. On 20 May 2019, the House of the People of the Federal Parliament approved the Petroleum Bill which seeks to amend the 2008 Petroleum Law of Somalia and later on approved by the upper house of the country.

(SML, 1989) mentioned that the program includes the authorities of Democratic republic of Somalia to control their territorial water zones such as coastal areas, inland water, continental shelf, exclusive economic zone (EEZ) and demersal (below water). Moreover, this law can be implemented in open ocean of Somalia if the vessels and operation ongoing can harm or cause a risk of pollution to the Somali territorial water zones. In order to establish a program of prevention marine pollution by the vessels, the minister of fisheries and marine transport will review and make decision through MARPOL Protocol which also known as "Protocol of 1978" which indicates the International Convention for the Prevention of Pollution from Ships (MARPOL). The MARPOL Convention was adopted on 2 November 1973 at IMO. After enforcement of this program anyone who violates will be punished to pay a penalty not exceeds Shs.So. 1.000.000 or jail not exceeds 5 years or both. The above penalties will be applied equally the Somali vessels and foreign vessels.

5.3. Health

According to (Abdel-Shafy & Mansour, 2016), animals from impacted food chain and then eaten by humans affects their health as toxins from these contaminated animals that in turn will cause health problems of people and lead to cancer. (Melidis & Sylaios, 2017) Argued that the pollution in marine coastal areas is considered from point and non-point land-based sources, such as rivers, drainage ditches, submarine outfalls and coastal cities. Various uncertainties in physical, hydrodynamic, chemical and biological characteristics of the marine environment influence the health of marine environments and organisms.

The Constitution of Somalia contains relevant provisions relating to environmental regulation and management. Article 25 the Constitution forms the basis of environmental protection in Somalia. The provisions of this article grant every Somali citizen the right to an environment that is not harmful to their health and well-being, to be protected from pollution, the right over the

natural resources of the country and sets the obligation of protecting these resources from excessive exploitation.

Infectious diseases can be spread through contaminated water in the case of swimming and fishing. Some of these water-borne diseases are Typhoid, Cholera, Paratyphoid Fever, Dysentery, Jaundice, Amoebiasis and Malaria. During the investigation, researcher noticed all of these disease and the respondents mentioned about them. Somali Maritime Law – Law No. 5 of 26 January 1989 prioritized the human health and safety, as well as legislative degree of 31 February 1959 n. 1 rep. declared the health and the safety of the Somali citizen are the prioritized than the other issues.

5.4. Economy

Each year, Somalis take around 124 million trips to coastal areas. In fact, beaches, rivers, and lakes constitute the top vacation destinations in the nation. Yet waters provide more than just recreation—vacationers spend millions annually during these coastal trips. In 2010, the nation's shoreline-adjacent regions contributed an estimated $2m toward the nation's gross domestic product and 1.5 million jobs. Economic activity directly associated with the ocean pumped more than $22m into the Somali economy in 2009. Nutrient pollution has diverse and far-reaching effects on the Somali economy, impacting tourism, property values, commercial fishing, recreational businesses and many other sectors that depend on clean water.

Tourism losses; The tourism industry loses close to $18m each year, mostly through losses in fishing and boating activities, as a result of water bodies that have been affected by nutrient pollution and harmful algal blooms. Airborne nutrient pollution can also affect visibility at popular outdoor destinations like national forests. This kind of pollution can also damage buildings and other structures, especially those made of marble and limestone. Tourism almost $18m in tourism revenue is lost annually. Local economies that receive millions from tourists who like to visit reefs or engage in aquatic activities are being threatened by coral bleaching, algal blooms, and contaminated waters. Coastal tourism, attributable in part to clean beaches, generates substantial revenues for state and local governments as well as for businesses lining the coasts. Economists estimate that a typical swimming day is worth approximately $3 for each individual. Depending on the number of potential visitors to a beach, the loss of beach days due to warnings or closures can be quite significant. For example, one study estimated economic losses as a result of closing Mogadishu beach due to pollution could be as high as $3090 per day.

Commercial fishing and shellfish losses; Fishing and shellfish industries are hurt by harmful algal blooms that kill fish and contaminate shell fish. Annual losses to these industries from nutrient pollution are estimated to be in the tens of millions of dollars. Fisheries—Pollution and ocean acidification are damaging the $100m shellfish industry on Somalia`s coast. Coral bleaching has increased nearly fivefold in the past 40 years. The Ministry of Fishery and Marine Resources estimates the commercial value of Somali fisheries from coral reefs is more than $24 million.

Polluted water puts these revenues at risk. Fouled beaches result in a loss of utility for those who have planned to visit and swim in the water; this impacts local economies in the form of lost tourist dollars and the jobs they support.

6 CONCLUSION AND RECOMMENDATIONS

6.1. Conclusion

This study assessed the implications of water policy on coastal pollution, in Mogadishu city; the capital city of Somalia. The study focused on the Eastern slaughterhouse location of Kaaraan district; Liido beach location of Abdul-aziz district and Buurfuule location of Hamar wayne district. The specific objective of this study was to evaluate all pollutants of in front of Somali coastal, assessment of the effect of pollution on Somali marine environments, statistical treatment of data for water quality, survey and questionnaire with stakeholders (fishermen, local population, etc.) and policy makers (Ministry of fisheries and marine resources, SMRRC, etc.) and finally, investigate Policy implementation on coastal pollution for area under the investigation. This study focused on the interpretation of the physico-chemical and biological data of the year 2019 as well as distributing questionnaires to the different stakeholders to get their idea on this issue. Following the obtained results, we can conclude that the quality or situation of all locations is above the satisfactory level and recommended for the multiuse of human (fishing, swimming etc.) or marine organisms accept Liido beach location which is in the satisfactory level for usage. The results we obtained showed most of the results in location 1 and location 3 exceeded the acceptable and recommended standards or levels of WHO and EPA, this is harm for the human health which may cause waterborne disease for the human as well as its effects on the marine organisms in those locations.

Concerning the different policies related to marine issues, this study investigated the existing of different policies related to this issues, we obtained the federal government of Somalia (FGS) did not formulate any new policies related to coastal pollution after 1991 (after the collapse of the central government of Somalia) as well as the government did not review the existed policies between 1960-1991 such as LAW NO. 37 OF 10 SEPTEMBER 1972 and Somali Maritime Law – Law No. 5 of 26 January 1989. The Ministry of Energy and Water Resources (MoEWR) is preparing currently the national water policy of the country but it did not mention any policy related to coastal pollution, also MoEWR prepared the national water law and approved by the two houses (Parliaments and senates). The directorate of Environment and Climate Change (DoECC), under the office of the Prime Minister (OPM) prepared the National Environment Policy and approved by the cabinet but they did not mention any policy or strategy related to marine issues accept fishery sector. The Ministry of Fishery and Marine Resources (MoFMR) did not conduct much about coastal pollution prevention actions and did not form any policy related to how to tackle this issue. Therefore the absence and weakness of national marine policy caused unwanted action from the

local people by their direct discharge of sewage to the sea and dumping the solid and liquid wastes in the marine environment as well as foreign ships by dumping hazardous and nuclear wastes in the Somali sea and doing illegal and over fishing in the Somali territorial water. Some challenges encountered by the fishermen and the coastal residents are related to coastal pollution caused by themselves and the foreign ships, the foreign ships used to dump their wastes into Somali sea and forcing the Somali fishermen to avoid and go out of the sea.

6.2. Recommendations

1. To make and formulate an appropriate, strong and updated policy which can correspond with the other policies in the globe in order to prevent the local and foreign pollution to the Somali territorial water.
2. To establish strong centers who can monitor and do an accountability what the foreign ships do in the Somali territorial water.
3. To allow participation of the different stakeholders in the different processes of marine policy making in order to consider the policy their inputs, ideas and concerns.
4. Finally, to conduct a further study to examine the feasibility of coastal pollution situation in the selected locations, as well as the other locations around the capital city.

REFERENCES

Abdel-Shafy, H. I., & Mansour, M. S. (2016). A review on polycyclic aromatic hydrocarbons: source, environmental impact, effect on human health and remediation. *Egyptian Journal of Petroleum, 25*(1), 107-123.

Adams, M. (2016). *Food forensics: The hidden toxins lurking in your food and how you can avoid them for lifelong health.* Dallas: BenBella Books, Inc.

Agustini, S., & Yusya, M. K. (2020). The effect of packaging materials on the physicochemical stability of ground roasted coffee. *Current Research on Bioscences and Biotechnology, 1*(2), 66-70.

Ajibo, K. I. (2016). Transboundary hazardous wastes and environmental justice: Implications for economically developing countries. *Environmental Law Review, 18*(4), 267-283.

Alina, M., Azrina, A., Mohd Yunus, A. S., Mohd Zakiuddin, S., Mohd Izuan Effendi, H., & Muhammad Rizal, R. (2012). Heavy metals (mercury, arsenic, cadmium, plumbum) in selected marine fish and shellfish along the Straits of Malacca. *International Food Research Journal, 19*(1).

Almeida, C. M., Silvério, S., Silva, C., Paulino, A., Nascimento, S., & Revez, C. A. (2013). Optimization and validation of FTIR method with tetrachloroethylene for determination of oils and grease in water matrices. *Journal of the Brazilian Chemical Society, 24*(9), 1403-1413.

Aly, A. M. (2013). *Environmental assessment of rosetta area, mediterranean sea coast-egypt.*

Amina, K. (2018). *Water Pollution in Somalia.* San Francisco: Prezi.

Asamoah, D., & Amorin, R. (2011). *Research Journal of Applied Science and, 3*, 377.

Badr, N. B., Al-Qahtani, K. M., Alflaij, S. O., Al-Qahtani, S. F., & Al-Saad, M. A. (2020). The effect of Industrial and Sewage discharges on the quality of receiving waters and human health, Riyadh City-Saudi Arabia. *The Egyptian Journal of Aquatic Research*.

Barnes-Dabban, Harry, Koppen, V. K., & Tatenhove, J. P. (2018). Regional convergence in environmental policy arrangements: A transformation towards regional environmental governance for West and Central African ports? *Ocean & coastal management, 163*, 151-161.

Bassey, N. (2012). *To cook a continent: destructive extraction and the climate crisis in Africa.* Fahamu books and Pambazuka press.

Beri, R. (2011). Piracy in Somalia: Addressing the root causes. *Strategic Analysis, 35*(3), 452-464.

Best, J. W., & Kahn, J. V. (2016). *Research in education. .* Pearson Education India.

Bhateria, R., & Jain, D. (2016). Water quality assessment of lake water: a review. *Sustainable Water Resources Management, 2*(2), 161-173.

Bintanja, R., & Selten, F. M. (2014). Future increases in Arctic precipitation linked to local evaporation and sea-ice retreat. *Nature, 509*(7501), 479-482.

Boutayeb, A. (2010). *The burden of communicable and non-communicable diseases in developing countries.*

Brodie, J. E., Kroon, F. J., Schaffelke, B., Wolanski, E. C., Lewis, S. E., Devlin, M. J., et al. (2012). Terrestrial pollutant runoff to the Great Barrier Reef: an update of issues, priorities and management responses. *Marine Pollution Bulletin, 65*(4-9), 81-100.

Carbone, F., & Accordi, G. (2000). The Indian Ocean Coast of Somalia. *Marine Pollution Bulletin, 41*, 141-159.

Cooper, James, Lombardi, R., Boardman, D., & Carliell-Marquet, C. (2011). The future distribution and production of global phosphate rock reserves. *Resources, Conservation and Recycling, 57*, 78-86.

Cuce, E., Cuce, P. M., Wood, C. J., & Riffat, S. B. (2014). Toward aerogel based thermal superinsulation in buildings: a comprehensive review. *Renewable and Sustainable Energy Reviews, 34*, 273-299.

Daniels, C. L. (2012). *Somali piracy and terrorism in the Horn of Africa* (Vol. 1). Scarecrow Press.

Defo, B. K. (2014). Demographic, epidemiological, and health transitions: are they relevant to population health patterns in Africa? *Global health action, 7*(1), 22443.

Dent, P. (2013). *Advisory Committee on Pollution of the Sea.* Elsevier.

Dwarakish, G. S., & Vikas, M. (2015). *Coastal Pollution: A Review.* Mangalore: Elsevier.

Ezekwe, C. I., & Edoghotu, M. I. (2015). Water quality and environmental health indicators in the Andoni River estuary, Eastern Niger Delta of Nigeria. *Environmental Earth Sciences, 74*(7), 6123-6136.

Farrington, J. W. (2013). Oil pollution in the marine environment i: inputs, big spills, small spills, and dribbles. *Environment: Science and Policy for Sustainable Development, 55*(6), 3-13.

Fingas, M. (2012). *The basics of oil spill cleanup.* London: CRC.

Freed, S., Dujon, V., Granek, E. F., & Mouhhidine, J. (2016). Enhancing small-scale fisheries management through community engagement and multi-community partnerships: Comoros case study. *Marine Policy, 63*, 81-91.

Gao, Q., & Xu, Z. L. (2011). Effect of regional warming on the abundance of Pseudeuphausia sinica Wang et Chen (Euphausiacea) off the Changjiang River (Yangtze River) Estuary. *The Chinese Society of Oceanography, 30*(6), 122 - 128.

Gewert, B., Plassmann, M. M., & MacLeod, M. (2015). Pathways for degradation of plastic polymers floating in the marine environment. *Environmental Science: Processes & Impacts, 17*(9), 1513-1521.

Goudie, A. S., & Viles, H. A. (2013). *The earth transformed: an introduction to human impacts on the environment.* Hoboken: John Wiley & Sons.

Grünewald, F. (2012). Aid in a city at war: the case of Mogadishu, Somalia. *Disasters, 36*, S105 - S125.

Haid, V., & Timmermann, R. (2013). Simulated heat flux and sea ice production at coastal polynyas in the southwestern Weddell Sea. *Journal of Geophysical Research: Oceans, 118*(5), 2640-2652.

Hamblin, & Jacob, D. (2008). Gods and devils in the details: marine pollution, radioactive waste, and an environmental regime circa 1972. *Diplomatic history, 32*(4), 539 - 560.

Hawken, P., Lovins, A. B., & Lovins, L. H. (2013). *Natural capitalism: The next industrial revolution.* London: Routledge & CRC Press.

Höhne, M. V. (2015). *Between Somaliland and Puntland: Marginalization, militarization and conflicting political visions.* Nairobi: Rift Valley Institute.

Horton, A. A., Walton, A., Spurgeon, D. J., Lahive, E., & Svendsen, C. (2017). Microplastics in freshwater and terrestrial environments: evaluating the current understanding to identify the knowledge gaps and future research priorities. *Science of the Total Environment, 586*, 127-141.

Islam, M. S., & Tanaka, M. (2004). Impacts of pollution on coastal and marine ecosystems including coastal and marine fisheries and approach for management: a review and synthesis. *Marine pollution bulletin, 48*(7-8), 624-649.

Khatri, N., & Tyagi, S. (2015). Influences of natural and anthropogenic factors on surface and groundwater quality in rural and urban areas. *Frontiers in Life Science, 8*(1), 23-39.

Kumar, H. D., & Häder, D. P. (2012). *Global aquatic and atmospheric environment.* Springer Science & Business Media.

Lecompte, E. M. (2016). A Mixed Methods Study of the Factors that Enhance and Challenge Food Security, Fruit and Vegetable Access and Consumption, and the Uptake and Management of the Ottawa Good Food Box (Doctoral dissertation, Université d'Ottawa/University of Ottawa).

LeWinn, K. Z., Sheridan, M. A., Keyes, K. M., Hamilton, A., & McLaughlin, K. A. (2017). Sample composition alters associations between age and brain structure. *Nature communications, 8*(1), 1-14.

Lindley, A., & Hammond, L. (2014). Histories and contemporary challenges of crisis and mobility in Somalia. *Crisis and Migration*, 46-72.

Mann, K. H., & Lazier, J. R. (2013). *Dynamics of marine ecosystems: biological-physical interactions in the oceans.* Hoboken: John Wiley & Sons.

Mantzikos, I. (2011). Somalia and Yemen: the links between terrorism and state failure. *Digest of Middle East Studies, 20*(2), 242-246.

Marchal, R. (2013). *Islamic political dynamics in the Somali civil war. Islam in Africa South of the Sahara: Essays in gender relations and political reform.*

Matula, T. J., & Swalwell, J. (2013). *U.S. Patent No. 8,441,624.* Washington, DC: Patent and Trademark Office.

Melidis, P., & Sylaios, G. (2017). Assessment of Urban Pollution Footprint in a Typical Mediterranean Semi-Enclosed Gulf. *Environmental Processes, 4*(2), 421-437.

Messrs, S. K., Fowler, S., & Hamza, A. (1987). *Coastal and marine environmental problems of Somalia.* Mogadishu: UNEP.

Moncrieffe, J., & Eyben, R. (2013). *The power of labelling: How people are categorized and why it matters.* Earthscan.

Murphy, M. (2006). *Piracy and UNCLOS: does international law help regional states combat piracy?*

Naselli-Flores, L., & Padisák, J. (2016). Blowing in the wind: how many roads can a phytoplanktont walk down? A synthesis on phytoplankton biogeography and spatial processes. *Hydrobiologia, 764*(1), 303-313.

NEP. (2019). *National Environmental policy.* Mogadishu: Office of the Somali Prime Minister.

Overton, E. B., Wade, T. L., Radović, J. R., Meyer, B. M., Miles, M. S., & Larter, S. R. (2016). Chemical composition of Macondo and other crude oils and compositional alterations during oil spills. *Oceanography, 29*(3), 50-63.

Owa, F. W. (2014). Water pollution: sources, effects, control and management. *International Letters of Natural Sciences, 3*.

Pan, K., & Wang, W. X. (2012). Trace metal contamination in estuarine and coastal environments in China. *Science of the total environment, 421*, 3-16.

Petkova., Elisaveta, P., Jack, D. W., Nicole, H., & Kinney, P. L. (2013). Particulate matter pollution in African cities. *Air Quality, Atmosphere & Health, 6*(3), 603-614.

Rangabhashiyam, S., Anu, N., & Selvaraju, N. (2013). Sequestration of dye from textile industry wastewater using agricultural waste products as adsorbents. *Journal of Environmental Chemical Engineering, 1*(4), 629-641.

Robinson, O. C. (2014). Sampling in interview-based qualitative research: A theoretical and practical guide. *Qualitative research in psychology, 11*(1), 25-41.

Sekaran, U., & Bougie, R. (2016). *Research methods for business: A skill building approach.* Hoboken: John Wiley & Sons.

Sekerci, Y., & Petrovskii, S. (2015). Mathematical modelling of plankton–oxygen dynamics under the climate change. *Bulletin of mathematical biology, 77*(12), 2325-2353.

SML. (1989). *Somali Maritime Law.* Office of the Somali President: Mogadishu.

Tavakol, M., & Sandars, J. (2014). Quantitative and qualitative methods in medical education research: AMEE Guide No 90: Part II. *Medical teacher, 36*(10), 838-848.

Tornero, V., & Hanke, G. (2016). Chemical contaminants entering the marine environment from sea-based sources: a review with a focus on European seas. *Marine pollution bulletin, 112*(1-2), 17-38.

Uejio, C. K., Yale, S. H., Malecki, K., Borchardt, M. A., Anderson, H. A., & Patz, J. A. (2014). Drinking water systems, hydrology, and childhood gastrointestinal illness in Central and Northern Wisconsin. *American journal of public health, 104*(4), 639-646.

Uprichard, E. (. (2013). Sampling: Bridging probability and non-probability designs. *International Journal of Social Research Methodology, 16*(1), 1-11.

Verma, A. K., & Singh, T. N. (2013). Prediction of water quality from simple field parameters. *Environmental earth sciences, 69*(3), 821-829.

Vikas, M., & Dwarakish, G. S. (2015). Coastal pollution: a review. *Aquatic Procedia, 4*, 381-388.

Wilhelmsson, D., Thompson, R. C., Holmström, K., Lindén, O., & Eriksson-Hägg, H. (2013). *Marine pollution. Managing ocean environments in a changing climate: sustainability and economic perspectives. Elsevier, Burlington.*

Yousef, R. A. (2019). *Population Challenges in OIC Countries & the Potential of Islamic Finance: A Refugee Perspective.* Doha: Hamad Bin Khalifa University.

APPENDICES

PAN-AFRICAN UNIVERSITY INSTITUTE
OF WATER AND ENERGY SCIENCES
(including CLIMATE CHANGE)

Master's Thesis Proposal Budget

WATER POLICY

Submitted by:

Abdulrahman Mohamud Dirie

TITLE: Implication of National Water Policy on Coastal Pollution in Somalia; a Case of Mogadishu Coastal

SUPERVISORS' CONTACTS

Name: Prof. Dr. NADIA Badr El-Sayed

Hosting Institution/Department: Alexandria Univeristy

Official Designation: Professor and Head Department of Environmental Science (Faculty of Science)

February 2020

S/No.	Item	Unit	Quantity	Rate (Unit price)	Amount*	Link to Research Activity**	Comment*** (For Evaluator Only)
	(A) Material and Supplies						
1	Stationary (printing, scanning and photocopying)		4	45	180 USD	This includes the printing of the research data, reports, photocopying the data and scanning documents relating to the research work (submission of documents to PAUWES as well as scanning the data for further analysis.	
2	Internet Recharge		5	40	200 USD	For receiving & sending docs and literature documents downloading)	
	Sub Total				**380 USD**		
	(B) Special Activities						
1	Publications		1	200	200 USD	Publication of short article of the research (around 5 to 10 pages).	
	Sub Total				**200 USD**		
	(C) Data						
1	Purchasing of Coastal Pollution Data of Mogadishu Coast from Ministry of Fishery & Marine Resources and SMRRC		2	480	960 USD	The researcher requires purchasing a data, which was collected two different times; in order to compare them and compare it with the national water and environmental policy.	
2							
	Sub Total				**960 USD**		
	(D) Travel						
1	Taxi from Tlemcen to Algiers and from Algiers to Tlemcen		2	20	40 USD	The price of taxi is 15 $ and the luggage is 5$ and my flight is from Algiers.	
2	Flight ticket from Algiers to Mogadishu and from Mogadishu to Algiers		1	735	735 USD	The case study of this research is in Mogadishu-Somalia. The researcher need to travel from Tlemcen-Algeria to Mogadishu-Somalia for research purpose.	
3	Travel Insurance		1	60	60 USD	Since, I am traveling out of Algeria.	

	Sub Total				**835 USD**		
	(E) Contingencies (%)		2265 USD	10%	225 USD		
	Sub Total				**225 USD**		
	(F) Field Transportation (Questionnaire and survey)						
1	2 days of Field Transportation.	Eastern Slaughterhouse and Liido Beach.	2	100	200 USD	The researcher requires 2 days of field work, which I will travel from Bal'ad (My Resident) to Slaughterhouse and Liido beach (two sides of my four sides), the distance between them is more than 30km, the rent of the car with my staff is 50$, so go and back will be 100$/day (since I am working on two sides together) and the car will work for me whole the day.	
2	2 days of Field Transportation.	Puur-Fuule and Mogadishu seaport.	2	100	200 USD	The researcher requires 2 days of field work, which I will travel from Bal'ad (My Resident) to Puur-Fuule and Mogadishu seaport (two sides of my four sides), the distance between them is more than 40km, the rent of the car with my staff is 50$ (only one way), so go and back will be 100$/day (since I am working on two sides together) and the car will work for me whole the day.	
	Sub Total				**400 USD**		

TOTAL

A	Material & Supplies	4X5	45x4+40x5	380 USD
B	Special Activities	1	200	200 USD
C	Data	2	2x480	960 USD
D	Travel	2	(20x2)+735+60	835 USD
E	Contingencies (%)	10%	225	225 USD
F	Field Transportation (Questionnaire and survey)	2	200x2	400 USD
	Grand Total			**3,000 USD**