THE EFFECT OF THE LITTER ON THE LAKE SHORELINE: A CASE OF NATIONAL RUBONDO ISLAND NATIONAL PARK, TANZANIA

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A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS IN NATURAL RESOURCES ASSESSMENT AND MANAGEMENT OF THE OPEN UNIVERSITY OF TANZANIA

2018

CERTIFICATION

The undersigned certifies that she has read and hereby recommends for acceptance by the Open University of Tanzania a dissertation titled: *"The Effect of the Litter on the Lake Shoreline*, A *Case of Rubondo Island National Park, Tanzania"*, in partial fulfillment of the requirements for the degree of Master of Arts in Natural Resources Assessment and Management of the Open University of Tanzania.

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Dr. Anna Ibrahim Wawa

(Supervisor)

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Date

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DECLARATION

I, **John, Ignase Gara**, do here by declare to the senate of the Open University of Tanzania that this dissertation for the Master degree in Natural Resource Assessment and Management is my own original work and it has not been presented and will not be presented for a similar or any other award at any other university.

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Signature

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Date

DEDICATION

This dissertation is dedicated to my beloved father the late John Gara and late Anastazia Simon, my beloved wife Yasinta and my Sons Isaac and Ivan who spends their time to encourage me as to ensure the goals of accomplishing my study is achieved.

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ABSTRACT

Shoreline littering has been found to cause adverse impact on coastal environment, human health, fishing industry and navigation. Rubondo Island National Park is facing littering problem along the shorelines. However its spatial litter distribution along the shorelines and effects to the environment for a long time was not known. This study was conducted at Rubondo Island National Park to assess the spatial litter distribution along the shorelines. Specifically the study examined sources of shoreline litter, evaluated its distribution and finally assessed the effects of litter on lake shoreline environment. Both quantitative and qualitative research was used to obtain quantifiable information for shoreline litter. Four shorelines were purposely established namely Northern, Southern, Eastern, and Western, four transects each having 100 meters length and 10 meters width were developed making a total of 16 transects in all sampled shorelines. On each transect, litters were collected, classified and quantified by weighing scale. Collected data were analyzed using graph pad tool box; IBM, SPSS and Microsoft excel computer software. Analyzed data were summarized through tables, graphs, and pie charts. Findings indicate that, fishing related activities was the major source of litter contributing 96.2% of all litter collected. Eastern shoreline of RINP received the largest amount of litter (68%) of all sampled shorelines. Plastics were the major component of all litter collected contributing 83.4%. Other components of litter were fishnets (8.4%), wood (5.0%), clothes (2.4%) and rubber (0.7%). On average, each transect recorded a total of 964 items of litter weighing 46,093.75g equivalent to 0.96 items/m^2 (46.09g/m^2). These litter deposited on the lake shores had a number of effects including causing death to various fauna found in RINP. Affected species included crocodiles, hippos, otters, fishes and birds mainly Cormorants, African fish eagles, and

African darters. Various measures are suggested to deal with litter along RINP and within Lake Victoria. Suggested measures include; education campaign to fishermen from park adjacent communities, routine patrols and litter collection in different shorelines of Lake Victoria.

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LIST OF ABBREVIATIONS

FZS	Frankfurt Zoological Society
IDEAL	International Decade for the East African Lakes Programme
FZS	Frankfort Zoological Society
FCSHWM	Florida Center for Solid and Hazardous Waste Management

LVBC	Lake Victoria Basin Conservation
LVFO	Lake Victoria Fisheries Organization
LVEMP	Lake Victoria Environmental Management Programme
LVCEEP	Lake Victoria Catchment Environmental Education Programme
NEAP	National Environmental Action Plan
NGOs	Non-governmental Organizations
RINP	Rubondo Island National Park
TANAPA	Tanzania National Parks
UNEP	United Nations Environmental Programs
USA	United States of America
WB	World Bank

CHAPTER ONE

INTRODUCTION

1.1 Introduction to Research Problem

Tourism is an economic sector increasingly becoming a method of boosting economies, gaining foreign exchange, reducing unemployment, and providing funds for investment in other sectors (Coffey, 1993). The sector is often invested in at the cost of the natural environment on which it depends, despite the inherent dependence of coastal tourism on healthy water, and a clean, safe natural environment (Hall, 2001). Failure on the part of local and national governments to prevent and mitigate shoreline littering has a direct impact on local tourist economies and global tourism flows, causing a shift in popular destinations globally. Litter in marine and coastal environments is one of the most serious environmental issues facing natural resource Managers and scientists (UNEP, 2005). However, it has only recently been treated as a complex scientific problem (Ivar do Sul and Costa, 2007).

Littering causes environmental degradation and is recognized as anti-social behavior that reduces societal benefits (Cialdini, 2003). Litter can be defined as 'any piece of glass, plastic, paper, metal, cloth, rubber, food, or food by-product' which is thrown away in public places outside waste collection containers (Schnelle *et. al*., 1980). A useful definition of littering is the "careless, incorrect disposal of minor amounts of waste" (Hansmann and Scholz, 2003). Behavior related to littering can be either active (the deliberate dropping of litter and not picking the litter) or passive (a beach visitor drops litter while seated and fails to notice, and then fails to take the litter with them when they leave) (Sibley and Lui, 2003.

The presence of plastics has been extensively reported in the marine environment (Derraik, 2002; Cole *et al*., 2011), but there is now an increasing focus on documenting plastic pollution in freshwaters. Plastic pollution in the Laurentian Great Lakes of North America has been well studied (Zbyszewski *et al*., 2014), and other freshwater habitats have also been subjected to investigation, e.g. Lake Hovsgol in Mongolia (Free *et al*., 2014), Lake Garda in Italy (Imhof *et al*., 2013) and the River Thames in the United Kingdom (Morritt *et al*., 2014). Lusher *et al*., (2013) and Biginagwa *et al*., (2015) found that plastics are being readily consumed by 10 species of fish dwelling in both pelagic, lake beds and sea floors in the English Channel.

Sanchez *et al*., (2014) similarly, reported that freshwater wild gudgeons (*Gobio gobio*) inhabiting French rivers are also ingesting micro-plastic debris. With increased monitoring in both marine and freshwater environments and fauna, micro-plastic pollution can be described as an issue of global concern, but information regarding the presence of plastics in some regions remains scarce. Only a handful of studies exist regarding the litter and the extent of plastic pollution in African waters. Madzena and Lasiak (1997) characterized plastic litter along the South African coastline, but to date there is little information on litter pollution in Africa's Great Lakes. The present study was conducted in Rubondo island national park located in Lake Victoria.

The shoreline wetlands are important ecosystems with numerous functions and render valuable services to society (Costanza *et al*., 1997). One of their key functions is the sustenance of a high diversity of living organisms (Denny, 1994). Shoreline wetlands are colonized by biotic communities consisting of varying proportions of terrestrial and aquatic organisms (Wetzel, 1990). The biological and chemical interactions of the wetland ecotone creates the most fertile habitats in the aquatic environment in terms of secondary production which provides an ideal environment for many grazers particularly juvenile fish (Denny, 1991).

One of the known functions of the wetlands is their role as fish feeding, spawning and nursery grounds (Mnaya and Wolanski, 2002). Closely connected with the food and nursery ground function is the use of shoreline wetlands by fauna as refuge from predation. A final function of shoreline wetlands is the regulation of fluxes of energy, water sediment and nutrients between the catchment and the open lake. In the wetland, a number of physical, chemical and biological processes are in operation that helps to purify inflowing water and buffer the lake from pollution (Jansson *et al*., 1998). Coastal marshes today are one of the most endangered ecosystems acting as incubators for fish and invertebrates; they also play a vital role as habitat for migratory waterfowl (Kearney, 1999).

The Lake Victoria basin has experienced increased human population and subsequent activities; the infrastructural developments along the basin impacting flora and fauna of the region (LVBC, 2011). Birds have suffered from drowning and getting entangled in fishing nets, loss of feeding roosting and breeding grounds through wetland destructions (LVBC, 2011). Additionally, Lake Victoria's wetlands have been affected by litter generated through human activities and its impact is not known and what ecological significance does the litter posed (Derraik, 2002).

UNEP (2005) describes shoreline litter management as an important component of the environment because of its adverse impact upon public health and environmental quality. Exposed litter is not only aesthetically displeasing but also attracts health hazards (Olokesusi, 1990). In Tanzania, policies and legislation has been formulated to manage the environment at central and local levels (National Environmental Action Plan (NEAP) 2013-2018 (2013).

Environmental Management Act 2004, Act No. 20 of 2004, Tanzania, provides for and promotes the enhancement, protection, conservation and management of the environment. It also gives mandate to the Local Government Authorities to involve the private sector and Non-governmental Organizations (NGOs) in solid waste management (Environmental Management Act 2004, No. 20 of 2004, Tanzania). The Local Government (Urban Authorities) Act No. 8 of 1982, Tanzania delegates to the local authorities to make waste management by-laws within their respective areas of administrative control (Local Government (Urban Authorities) Act No. 8 of 1982, Tanzania). Failure to comply with these by-laws it is taken as a criminal offense and if one found guilty is liable for fine or up to twelve (12) months jail or both (Lukambuzi, 2006).

1.2 Statement of the Research Problem

Shoreline litter is a pollution issue for the lake Victorian region damaging valuable natural resources such as wildlife and sensitive aquatic and coastal habitats which eventually affecting the quality of life of local inhabitants and visitors and the economic sustainability of the entire region. The ubiquitous presence of shoreline litter, coupled with its physical, ecological, cultural, and socio-economic complexities along the Rubondo Island, poses severe threats to the sustainability of the habitats, wildlife and people of the region, and indeed the world as a whole. According to Coffey, (1993) and

Hall, (2001) tourism economies, gaining foreign exchange, reducing unemployment, and providing funds for investment in other sectors.

Generally, the tourism sector is often depends much on healthy water, a clean and safe natural environment rather than the degraded environment. The coastal tourism has been affected by litter generated through human activities and its impact not known and what ecological significance does the litter pose (Derraik, 2002). But the implementation of litter management coupled with costs cause challenges to the ecosystems and natural habitats in the Lake Victoria, especially, along the shoreline of Rubondo Island National Park. This study aims to bridge this gap by assessing the effect of litter along shorelines of RINP and suggest possible mitigation measures to address the problem.

1.3 General Objective

To assess the spatial litter distribution along the shoreline at Lake Victoria Shorelines.

1.3.1 Specific Objectives

(i) To examine sources of shoreline litter around Rubondo island national park

(ii) To evaluate the distribution of shoreline litter around Rubondo island national park

(iii) To assess the effect of litter on the lake shoreline environment.

1.3.2 Research Questions

This research was based on the following Questions

(i) Is the litter collected along lake shorelines come from different sources?

(ii) Is there a significant difference in spatial distribution of litter along the shorelines in Rubondo islands national park?

(iii) Is the littering along Lake Shorelines has significant effects to both flora and fauna on the lake shoreline environment?

1.4 Significance of the Study

This study is focusing on the shoreline at Rubondo Islands National Park (RINP), in particular, the increased usage resulting in the need for improved understanding of the associated impacts on all natural and cultural resources. It is useful as it can provide information about ecosystems undergoing change, particularly the effect of the litter on the Lake shoreline. Therefore, understanding the science of change is critical to predict the future state of ecological systems and their services to society and informing, enhancing and assisting the park management of the parks' shoreline, and facilitating conservation of the beach environment and its associated species of concern.

Also the study provides an in-depth understanding of the stakeholders in the use of the beach and to proactively address issues such as policy changes surrounding visitor uses of the beach. With this respect, all district councils surrounding the park on issues related to developing fishing camps and the need to reduce litter generation and improve the litter management and protect the environment by engaging in more environmentally sustainable practices. Besides that, it is important as it provides recommendation to the responsible authority for the development process and the findings can also be used to identify more concrete reasons for sustainable shoreline litter management. Many gaps exist in the knowledge on shoreline litter generation around the Lake Victoria making it difficult to reach at the most critical interventions required at the different stages of restoration.

1.5 Conceptual Framework

Human activities generate litter such as plastics, rubber, fishing gears, clothing and fishing nets. The increased density and abundance of such litter affects the hydrology, landscape and sedimentation processes; ultimately affect the ecosystem structure such as species composition and abundance, invasive species expansion and declines in rare species and ecosystem functions.

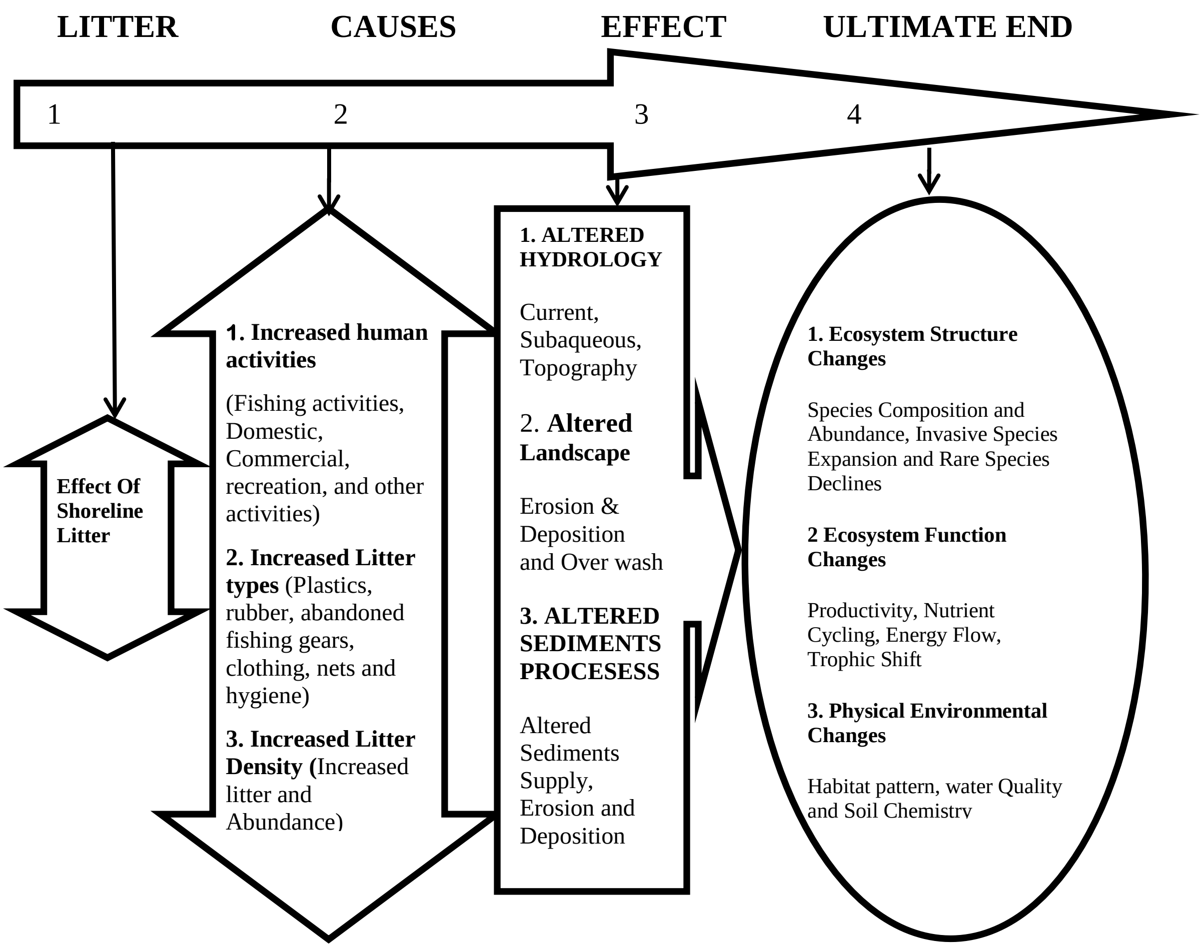

Figure 1.1: Conceptual Framework

Source: Researcher's construct based on literatures, July 2018)

Furthermore, the change in physical environment affects the ecosystem's productivity, nutrient cycling, energy flow, habitat pattern, and change in water quality and soil chemistry. All districts surrounding the park should control litter generation and improve the litter management by engaging in more environmentally sustainable practices. This model is based on the fact that without effective management of human activities around the Lake Victoria the human economic base and life supporting systems around the lake will decline.

1.6 The Structure of the Study

This study has five chapters. Chapter one contains background of the research problem, statement of the research problem, objective of the study, conceptual framework and the structure of the study. Chapter two provides the review of different literature, which is related to the effect of the Litter on the Lake Shoreline. Chapter three contains study description, research design, population, sample size and sampling procedure, data collection methods, data analysis, data presentation, validity and reliability and ethical considerations. Findings and its discussions are outlined in chapter four. Chapter five is for conclusion and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Chapter Overview

Reviewing the literature on the effects of shoreline litter is important, because once the effects of shoreline litter are known; the measures to reduce effects of shoreline litter can be supported. This chapter presents theoretical Framework, litter distribution (the global perspective), sources of litter, composition, abundance and distribution and spatial variability.

2.2 Theoretical Framework on the Shoreline Litter Distribution

2.2.1 "The Tragedy of the Commons" Theory

This research is based on the Garrett Hardin, "*The Tragedy of the Commons"* in the peer-reviewed journal of Science in 1968. The metaphor of the commons can be applied to virtually any environmental resource. In the case of littering, some people find it more expedient to drop their litter on the ground or on the lake than to bother to transport it to a proper receptacle.

The tragedy of the commons occurs when individuals neglect the well-being of society in the pursuit of personal gain. The "*commons*," is more properly described as *open-access commons*, as there are some resources that are managed in common that do not suffer the tragedy because they are subject to community management of some form or other, but the central point stands. The tragedy of the commons has implications for the use of resources and sustainability.

2.2.2 The Value-Belief-Norm Theory of Environmentalism

This theory is also called Moral Norm Activation theory. According to S. H. Schwartz's (1972, 1977) norm-activation theory of altruism has been applied to pro-environmental behavior. The theory holds that pro-environmental actions occur in response to personal moral norms about such actions and that these are activated in individuals who believe that environmental conditions pose threats to other people, other species, or the biosphere (awareness of consequences) and that actions they initiate could avert those consequences (ascription of responsibility to self).

2.3 Empirical Literature Review

This part reviewed various literatures on the effect of litter on the various shorelines and general litter management practices globally, in Africa and in Tanzania context. Various literatures were reviewed and discussed in this part to point out the research gap on the effect litter on the lake shoreline and its management.

2.3.1 Global Shoreline Litter Distribution Perspective

Globally, the anthropogenic litter on the sea surface, seafloor and beaches has significantly increased over recent decades and commonly observed across all oceans (Ryan, 2015). They can be transported over long distances by prevailing winds and currents (Barnes *et al*., 2009). The global quantities are continuously increasing while plastic bags, fishing equipment, food and beverage containers are the most common items that constitute more than 80 % (Thiel *et al*., 2013). A large part of these materials decomposes only slowly or not at all and the accumulation rates vary widely and are influenced by many factors such as the presence of large cities, shoreline use, hydrodynamics and maritime activities. Even with standardized monitoring approaches, the abundance and distribution of anthropogenic litter show considerable spatial variability (Galgani *et al*., 2000). In surface waters, litter fragments have increased in the last few decades. From the first reports in 1972, the quantities of micro litter particles in European seas have grown in comparison to data from 2000 (Thompson *et al*., 2004).

By contrast, in some areas around Greece, the abundance of debris in deep waters has substantially increased over a period of eight years (Stefatos *et al*., 1999; Koutsodendris *et al*., 2008) and on the deep Arctic seafloor of the Hausgarten observatory over a period of ten years (Bergmann and Klages 2012). Interpretation of temporal trends is complicated by seasonal changes in the flow rate of rivers, currents, wave action, winds etc. Decreasing trends of macroplastics on beaches of remote islands suggest that regulations to reduce dumping at sea have been successful to some extent (Eriksson *et al*., 2013). However, both the demand and the production of plastics litter reached 299 million tons in 2013 and are continuing to increase (Plastics Europe, 2015).

In addition, most sediment-surface counts do not take buried litter into account and clearly underestimate abundance, which biases composition studies. However, raking of beach sediments for litter may disturb the resident fauna (Yoon *et al*., 2010; Kataoka *et al*., 2013). The intensity of the litter pressures is rising, being driven by the continuing rapid population rise and struggle of wetlands for greater economic prosperity (World Bank, 1996). The rapid population growth causes the expansion of towns and cities, increasing road construction, discharge of untreated municipal and industrial effluents and encroachment on wetlands (Kairu, 2001).

2.3.2 Sources of Shoreline Litter around Rubondo Island National Park

Shoreline litter consists of items that have been made or used by people and deliberately discarded on the seas, lake, rivers, or beaches; brought indirectly to such bodies via rivers or sewage by storm water or winds; accidentally lost (e.g. fishing gear, cargo) at sea in bad weather; or deliberately left by people on the beaches and shores (UNEP 2005). The different activities are responsible for shoreline litter generation such as fishing, recreation, domestic, agriculture related activities (Sheavly & Register, 2007).

According to Hammer *et al* (2011) most debris (80%) comes from land-based sources which include everything that is carried to the coast from inland by rivers and everything that is transported by wind or water level changes into the sea (Jambeck *et al.*, 2015). However, small plastic particles pose an even bigger threat to ecosystems than big pieces of plastic, as the so-called macroplastics (mostly described as smaller than 5 mm) are often bio-available and accumulate in the food chain (Wright *et al.*, 2013; Moore, 2008).

On the other side, other sources include the weathering down of bigger plastic debris into smaller and smaller fragments through solar radiation and wave movements etc. (Andrady, 2011; Mani *et al.*, 2015; Kershaw *et al*., 2011). Likewise, near the shorelines the photo-degradation and abrasion through wave action make plastic items brittle and ultimately increasing their fragmentation" (Barnes *et al.,* 2009). Additionally, plastic particles can also be derived directly from other sources like industry, cosmetic products or clothing in a very small size. Microplastics can also be found in several cosmetics such as toothpaste or facial cleansers where the particles are used for their scrubbing effect (Fendall & Sewell, 2009; Gregory, 1996). The particles enter the ocean with the wastewater because the microplastics are too small to be filtered out of the water at sewage plants (Browne *et al.*, 2011). According to Browne (2015), sources of litter can be characterized in several ways.

The litter sources can also be classified as either land based or ocean-based, depending on where the litter entered the water body. Some items can be attributed with a high level of confidence to certain sources such as fishing gear, sewage-related debris and tourist litter. Shoreline litter can be transported to the lake, sea, or ocean by rivers and other industrial discharges and run-offs or can even be blown into the marine environment by winds (Rech *et al*., 2014; Sadri and Thompson 2014).

Factors such as water current patterns, climate and tides, the proximity to urban, industrial and recreational areas, shipping lanes and fishing grounds influence the types and amount of litter that are found in the open lakes, seas and ocean or along beaches (Mouat *et al.,* 2010). Land-based sources include mainly recreational use of the coast, general public litter, industry, harbors and unprotected landfills and dumps located near the coast, but also sewage overflows, introduction by accidental loss and extreme events (Mouat *et al*., 2010). Marine and other shoreline litter can be transported to the sea and lakes by rivers and other industrial discharges and run-offs or can even be blown into the marine environment by winds (Rech *et al*., 2014; Sadri and Thompson 2014). Ocean-based sources of marine litter include commercial shipping, ferries and liners, both commercial and recreational fishing vessels, military and research fleets, pleasure boats and offshore installations such as platforms, rigs and aquaculture sites.

2.3.2.1 Composition of Shoreline Litter around Rubondo Island National Park

The analysis of the composition of litter is important as it provides vital information on individual litter items, which, in most cases, can be traced back to their sources. Sources of litter can be characterized in several ways (Browne, 2015). The composition of litter in different marine regions shows that "plastics", make up the largest proportion of overall litter (Pham *et al*., 2014). Packaging, fishing nets and pieces thereof, as well as small pieces of unidentifiable plastic or polystyrene account for the majority of the litter items recorded (Galgani *et al*., 2013). Marine litter found on beaches consists primarily of plastics (bottles, bags, caps etc.), aluminium (cans, pull tabs) and glass (bottles). Studies along the US west coast of the southern California Bight (Watters *et al*., 2010; Schlining *et al*., 2013) shown that ocean-based sources are the major contributors to marine debris in the eastern North Pacific with fishing gear being the most abundant debris (June, 1990).

Shoreline litter found on beaches consists primarily of plastics (bottles, bags, caps/lids, etc.), aluminium (cans, pull tabs) and glass (bottles) mainly originates from shoreline recreational activities but is also transported to water bodies by currents (Cheshire *et al.*, 2009). Some of this can take hundreds of years to break down or may never truly degrade (Barnes *et al*., 2009). In some cases, litter attributed to shipping, sometimes accounting for up to 95 % of all litter items originated from fishing activities (Van Franeker *et al*., 2011).

Investigations in coastal waters and beaches around the northern South China Sea in 2009 and 2010 indicated that plastics (45 %) and Styrofoam (23 %) accounted for more than 90 % of floating debris and 95 % of beached debris. In the Mediterranean, reports from Greece classify land-based (69 % of the litter) and vessel-based (26 %) waste as the two predominant sources of litter (Koutsodendris *et al*., 2008).

Aesthetically, a huge amount of trash accumulated on the beach shoreline affects the beach and thus effecting tourism earnings especially for countries that depend on beaches tourism (Ballance *et al*., 2000). It will reduce people's enjoyment of the beach landscape and scenery (Cheshire *et al*., 2009). There is little research done on how litter affects tourism revenue. However, there is a South African study that found out that a fall in beach cleanliness could reduce Tourism Avenue by a significant 52%. It also found out that the amount of litter repels tourists and 85% of beach go-ers will not visit a beach with 2 or more large items of debris/meter (Ballance *et al*., 2000).

Abandoned fishing gears such as fishing nets can continue to 'ghost fish' for a long period of time even after it is being abandoned for a long period of time (Mouat et al 2010). Not only does it add waste into the shoreline and ocean, it also affects commercial fishing as well. It acts as direct competition to commercial fisheries (Macfadyen *et al.*, 2009). It captures immature fish and thus reduces the reproductive potential of fishes.

Some items can be attributed with a high level of confidence to certain sources such as fishing gear, sewage-related debris and tourist litter. So-called use-categories provide valuable information for developing reduction measures (Galgani *et al*. 2011). Land-based sources include mainly recreational use of the coast, general public litter, industry, harbors and unprotected landfills and dumps located near the coast, but also sewage overflows, introduction by accidental loss and extreme events. Litter can be transported to the lake and sea by rivers (Rech et al. 2014; Sadri and Thompson 2014) and other industrial discharges and run-offs or can even be blown into the marine environment by winds.

Packaging, fishing nets and pieces thereof, as well as small pieces of unidentifiable plastic or polystyrene account for the majority of the litter items recorded in this category (Galgani *et al*., 2013). Some of this can take hundreds of years to break down or may never truly degrade (Barnes *et al*., 2009). In North Sea or the Baltic Sea, the large diversity and the composition of the litter recorded indicate that shipping, fisheries and offshore installations are the main sources of litter found on beaches (Fleet *et al*., 2009).

In some cases, litter can clearly be attributed to shipping, sometimes accounting for up to 95 % of all litter items in a given region, a large proportion of which originates from fishing activities often coming in the form of derelict nets (Van Franeker *et al*., 2011). In the North Sea, this percentage has been temporally stable (Galgani *et al*., 2011) but litter may be supplemented by coastal recreational activities and riverine input (Lechner *et al*., 2014; Morritt *et al*., 2014). Studies along the coast of the southern California Bight (Watters *et al*., 2010; Keller *et al*., 2010; Schlining *et al*., 2013) have shown that ocean-based sources are the major contributors to marine debris for example, fishing gear being the most abundant debris off Oregon (June, 1990). In the Mediterranean, reports from Greece classify land-based (69 % of the litter) and vessel-based (26 %) waste as the two predominant sources of litter (Koutsodendris *et al.* 2008).

2.3.3 he Distribution of Shoreline Litter around Rubondo Island National Park

2.3.3.1 General Abundance of Litter

Generally, proper classification and categorization by the type of material, function or both are important because it records the numbers, some the mass of litter and some do both (Galgani *et al*., 2013). Evaluations of shoreline litter reflect the long-term balance between inputs, land-based sources and outputs from export, burial, degradation and cleanups. Then, measures of stocks may reflect the presence and amounts of litter debris. In some cases, specific activities account for local litter densities well above the global average (Pham *et al*., 2014).

In some tourist areas, more than 75 % of the annual waste is generated in summer, when tourists produce on average 10–15 % more waste than the inhabitants; although not all of this waste enters the marine environment (Galgani *et al*., 2011b). Some factors influencing densities such as cleanups, storm events, rainfall, tides and hydrological changes may alter counts, evaluations of fluxes and, even if surveys can track changes in the composition of beach litter, they may not be sensitive enough to monitor changes in the abundance (Ryan *et al*., 2009).

This problem can be circumvented by recording the rate, at which litter accumulates on beaches through regular surveys that are performed weekly, monthly or annually after an initial cleanup (Ryan *et al*., 2009). This is actually the most common approach, revealing long-term patterns and cycles in accumulation, requiring nonetheless much effort to do surveys. However, past studies may have vastly underestimated the quantity of available debris because sampling was too infrequent (Smith and Markic, 2013).

Most studies have reported densities in the Items /m^2, High concentrations of up to 37,000 items per 50-m beach line (78.3 items m^2) were recorded in Bootless Bay (Smith 2012) because of specific local conditions, following typhoons (3,227 items m^2; Liu *et al*., 2013) or flooding events (5,058 items m^2; Topçu *et al*., 2013). Large data sets have already been held by institutions (Ribic *et al*., 2010) or NGO's such as the Ocean Conservancy through their International Coastal Cleanup scheme for 25 years, or the EU OSPAR marine litter monitoring program, which started over 10 years ago and covers 78 beaches (Schultz *et al*., 2013).

At local scales, concentrations of specific items may be largely driven by specific activities or new sources. For example, 41 % of the total debris from beaches in California was of Styrofoam origin, with no other explanation than an increased use of packaging, which degrades very easily (Ribic *et al*., 2012b). Small-sized items may form an important fraction of debris on beaches. For example, up to 75 % of total debris from the southern Black Sea was smaller than 10 cm (Topçu *et al*., 2013). Small-sized particles include fragments smaller than 2.5 cm (Galgani *et al*., 2011b), the so-called meso-particles or mesodebris, which is, unlike macrodebris, often buried and not always targeted by cleanups.

Little attention has been paid to sampling design and statistical power even though optimal sampling strategies have been proposed (Ryan *et al*., 2009). Densities of small-sized debris were found to be very high in some areas where, in addition to floating debris, they can pose a direct threat to wildlife, especially to birds that are known to ingest plastic (Kühn *et al*., 2015; Lusher 2015).

2.3.3.2 Spatial Variability of Shoreline litter

The sea currents distribute particles all around the globe, though in varying concentrations (Derraik, 2002; Sherman & van Sebille, 2016). The role of rivers as transporters of plastic is significant as well because they carry their plastic load from inlands to the oceans (Claessens *et al*., 2011). As most debris comes from inland, most plastic particles can be found near the cost and in the so-called ocean-gyres (Cole *et al*., 2011). These are vast patches in between the continents where ocean currents concentrate floating particles due to their flow conditions (Cole *et al*., 2011). The most commonly known one of these gyres is the Great Pacific garbage patch in between North America and Southeast Asia (Kaiser, 2010). In below the flows of plastic debris from the sources to the sinks are depicted.

Decreasing trends of macro plastics on beaches of remote islands suggest that regulations to reduce dumping at sea have been successful to some extent (Eriksson *et al*., 2013). However, both the demand and the production of plastics reached 299 million tons in 2013 and are continuing to increase (Plastics Europe, 2015). Little is known about trends in accumulation of litter in the shoreline along the Rubondo Island National Park.

Litter disposition in the lake shoreline wetlands are thought to influence Lake Ecosystem dynamics in multiple ways. Sediments can profoundly affect the chemical and biological processes within a lake by binding and transporting nutrients, plastics, heavy metals and other micro pollutants (Harper, 1992). In the Laurentian Great Lakes, the re-suspension of sediments has introduced fluxes of nutrients to the water column that are much greater than the sum of fluxes from all other sources (Eadie and Robbins, 1987). Very little is known about the litter and sediments on the shoreline of the Rubondo national Park and Lake Victoria mainly because, unlike the wetlands, they have not been intensively investigated. A number of studies that looked at sediments were carried out under the IDEAL (International Decade for the East African Lakes) programme (Johnson, 1993). However, the objectives of IDEAL were to enhance understanding of the paleoclimatology, paleohydrology and paleolimnology of the East African lakes. Hence, the studies did not investigate sediments and litter per se but used the sediment record to make inferences on other subjects of interest (Verschuren *et al*., 2000, 2002).

Marine debris is commonly found at the sea surface or washed up on shorelines, and much of the work on marine litter has focused on coastal areas because of the presence of sources, ease of access/assessment and for aesthetic reasons (McGranahan *et al*., 2007). Shoreline-litter data are derived from various approaches based on measurements of quantities or fluxes, considering various litter categories, and sampling on transects of variable width and length parallel or perpendicular to the shore. Studies record the numbers, some the mass of litter and some do both (Galgani *et al*., 2013).

Factors influencing densities such as cleanups, storm events, rain fall, tides, and hydrological changes may alter counts, evaluations of fluxes and, even if surveys can track changes in the composition of beach litter, they may not be sensitive enough to monitor changes in the abundance (Ryan *et al*., 2009). It is unfeasible to review the hundreds of papers on beach macro-debris, which often apply different approaches and lack sufficient detail (Hidalgo-Ruz and Thiel, 2015). Information on sources, composition, amounts, usages, baseline data and environmental significance are often also gathered (Cordeiro and Costa 2010; Rosevelt *et al.*, 2013) as such data are easier collected. Sites are often chosen because of their ecological relevance, accessibility and particular anthropogenic activities and sources. Factors influencing the accumulation of debris in coastal areas include the shape of the beach, location and the nature of debris (Turra *et al.*, 2014). In addition, most sediment-surface counts do not take buried litter into account and clearly underestimate abundance, which biases composition studies.

However, raking of beach sediments for litter may disturb the resident fauna. Apparently, a good correlation exists between accumulated litter and the amount arriving, indicating regular inputs and processes. The experiments with drift models in Japan indicate good correlation of flux with litter abundances on beaches (Yoon *et al.*, 2010; Kataoka *et al.*, 2013). It appears that glass and hard plastics are accumulating more easily on rocky shores (Moore *et al.*, 2001a). Litter often strands on beaches that lack strong prevalent winds, which may blow them offshore (Galgani *et al.*, 2000; Costa *et al.*, 2011).

Abundance or composition of litter often varies even among different parts of an individual beach (Claereboudt, 2004) with higher amounts found frequently at high-tide or storm-level lines (Oigman-Pszczol and Creed 2007). Because of this and beach topography, patchiness is a common distribution pattern on beaches, especially for smaller and lighter items that are more easily dispersed or buried (Debrot *et al.*, 1999). It is very difficult to compare litter concentrations of various coastal areas (with different population densities, hydrographic and geological conditions) obtained from various studies with different methodologies, especially when the sizes of debris items that are taken into account are also different. Nevertheless, common patterns indicate the prevalence of plastics, greater loads close to urban areas and touristic regions (Barnes *et al*., 2009).

2.3.4 The Effect of Litter on the Lake Shoreline Environment

Litter is an anthropogenic environmental issue and tends to be higher in urban areas where population density is higher (Chapman, & Risley, 1974). Environmental impacts of litter include dangers to wildlife, the pollution and obstruction of waterways, soil pollution, ecosystem disruptions, and potential human health issues. Abandoned fishing gears such as fishing nets can continue to 'ghost fish' for a long period of time even after being abandoned for a long period of time (Mouat *et al.,* 2010).

Economic impacts include the cost of cleanup, negative influence on tourism, and general negative impacts on business if consumers choose to shop elsewhere when an area is littered (Florida Center for Solid and Hazardous Waste Management, 2002). Plastic items in the oceans pose an often fatal risk to a growing number of aquatic species. Sea turtles, whale species and seals are reported to suffer most from getting entangled into debris objects which makes them starve, strangle or suffocate to death eventually.

Then, ingestion of plastic particles occurs most excessively for ocean-feeding birds and is probably known the longest for albatrosses that mistake plastic items for food and even feed plastics particles to their chicks (Lusher *et al*., 2013; Biginagwa *et al*., 2015). So zooplankton can ingest microplastics, small fish eat that plankton including the plastic particles, bigger fish eat the small fish, which is in turn eaten by other predators like marine birds and humans. Even turtles for instance seem to mistake plastic bags for their natural prey, jellyfish, so they feed on them (Hammer *et al*, 2012; Wright *et al*, 2013; Wilcox *et al*, 2015).

Hammer *et al*. (2012) estimate that 70% of all marine debris sooner or later sinks to the lake and sea floors. The impact of plastic accumulated on the lake and sea floors is a hindered gas exchange between the ground sediments and the water layers on top of it, which might lead to anaerobic milieus and affects the biota that live in and on the ocean bed (Moore, 2008). A further point of concern is the spread of invasive species via plastic items as biota encrusted to floating particles which can easily enter alien habitats (Gregory, 2009). Yet, plastics carry toxic additives that determine their properties for the intended use which can be transferred to marine biota through plastic ingestion (Engler, 2012).

Additionally, plastic particles adsorb chemical substances that the oceans contain in low concentrations and accumulate these on their surface "plastics and take up persistent, bio-accumulative, and toxic substances" (Seltenrich, 2015). Consequently, wildlife species that ingest plastic particles by mistake also take up these chemicals and humans are exposed to them with potentially accumulated concentrations of toxics when consuming seafood (Seltenrich, 2015).

Laws (2000) pointed out that damage to vessels from marine debris results from collision with floating objects, entanglement of debris in propeller blades, and clogging of water intakes for engine cooling systems. Takehama (1990) has estimated the annual cost of damage to Japanese fishing vessels caused by floating debris to be roughly 4 billion yen, which is about 0.2% of the total cost of operating the vessels. The fishing activities and the infrastructural developments along the Lake Victoria basin is expected to affect the flora and fauna along the shoreline of RINP. Thus, this research had a look into the effect of the litter generated on the shoreline caused by human activities.

2.4 Research Gap

There is little information on how litter affects shoreline and its effect on fishing and tourism activities. The Lake Victoria's wetlands have been affected by litter generated through increased human population and subsequent activities and its impact is not known and what ecological significance does the litter posed (Derraik, 2002, LVBC, 2011). Abandoned fishing gears such as fishing nets can continue to 'ghost fish' for a long period of time (Mouat et al 2010). Not only does it add waste into the shoreline and ocean, it also affects commercial fishing as well. For example, birds have suffered from drowning and getting entangled in fishing nets, loss of feeding roosting and breeding grounds through wetland destructions (LVBC, 2011).

Aesthetically, a huge amount of trash accumulated on the beach shoreline is displeasing and hence affecting the people's enjoyment of the beach landscape and scenery (Ballance *et al*., 2000, Cheshire *et al*., 2009). So far, there is little information documenting litter distribution and its impacts. However, there is a South African study that found out that a fall in beach cleanliness could reduce the number of tourists.
This study therefore intends to fill this gap by exploring litter distribution in shorelines of Lake Victoria and its impact to respective species and environment at large.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Chapter Overview

This chapter presents the research methodology to describe the Effect of the Litter on the Lake Shoreline, A Case of Rubondo Island National Park. It also contains the description on study area, the explanation regarding to study design, population, sample and sampling procedures, data collection techniques and the methods used for processing and analyzing.

3.2 Study Area

This study was conducted at Rubondo Island National Park (RINP) which is located in the south-west corner of Lake Victoria. Administratively RINP is located within Geita region and bordered by three regions of Kagera, Geita and Mwanza. The park headquarter at Kageye, is located between $2^{o}18'$ 10.3"and 31^{o} 51' 26.9". The park lies at an average altitude of 1,134 m above sea level, which is the normal height for Lake Victoria (*Figure* 3.1). The park covers a total area of 456.8 km^2 of which 236.8km^2 is dry land and 220 km^2 is water (FZS and TANAPA, 2003).

3.2.1 Justification for Selecting Rubondo Island National Park

The area of the park comprises of water and dry land habitat which forms an ecosystem important for feeding and breeding of variety of wildlife species. Apart from its ecological importance, RINP and its entire ecosystem support the adjacent local communities both economically and socially. The park provides a variety of habitats for different wildlife species with a combination and variety of landforms, vegetation types and the surrounding lake which create a uniquely scenic landscape that is both diverse and ecologically complex (FZS and TANAPA, 2003). This research could provide information about ecosystems undergoing change and by understanding the science of change is critical to predict the future state of ecological systems and their services to society and informing, enhancing and assisting the park management of the parks' shoreline, and facilitating conservation of the beach environment and its associated species of concern.

3.3 Study Design

The Quantitative research method was used to obtain quantifiable data about the litter on the shoreline, which can be presented in a numerical form, and analyzed through the use of statistics. It was also used to describe and to test the cause-and-effect of relationships.

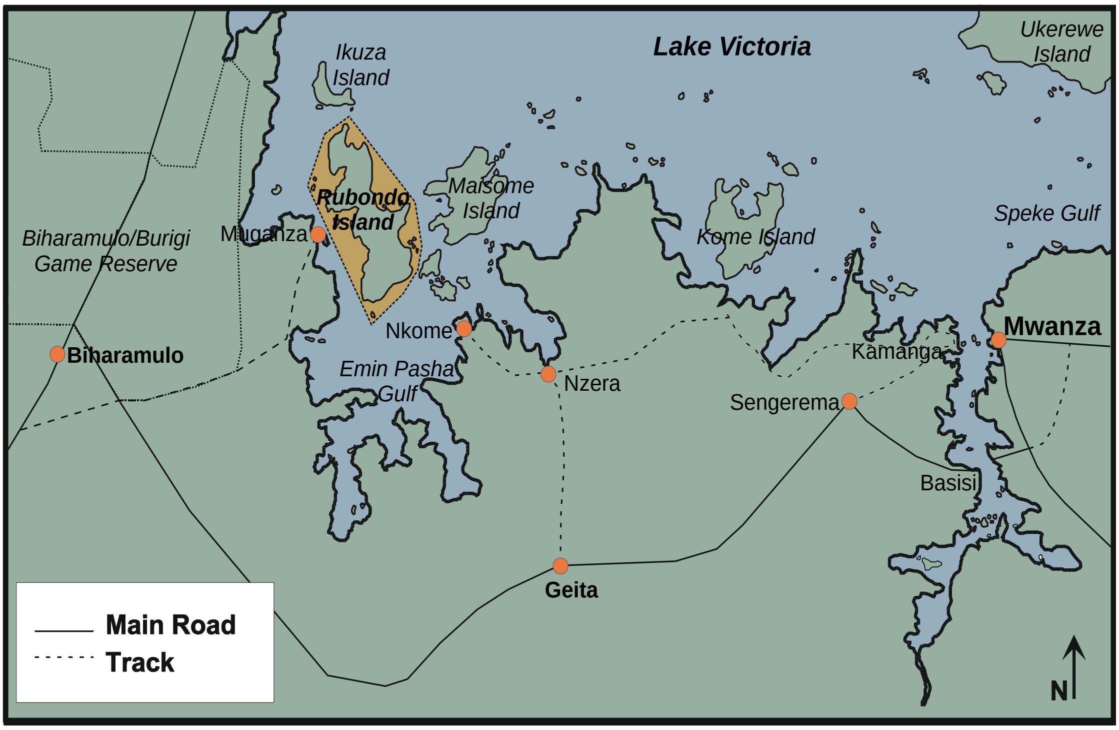

Figure 3.1: Location of Rubondo Island National Park and Surrounding Areas

Source: FZS and TANAPA (2003)

3.4 Materials and Methods

Numerous marine debris monitoring programs exist throughout the world. Most programs have unique objectives and employ a variety of region-specific methodologies; making across the board comparisons of debris estimates difficult (Barnes *et al*., 2009). For shorelines, some studies report number (or weight) of debris items per unit length of shoreline (Bowman *et al.,* 1998, Barnes and Milner, 2005) or strandline (Velander and Mocogoni, 1999). Likewise, the decisions related to sampling have a significant impact on the findings; and the size of the sample is considered and justified to ensure that it is sufficient to provide valid and generalizable results.

In this study the total of sixteen (16) transects were established in the south, south west, east, north-east, North, North-west and west (*Figure*.3.2). At each site small transects were established at 10m wide and 100m apart. Collected litter was identified and measurement was recorded in a data recording sheet, whereas every site should had at least one record per week. Thus, analysis of litter at individual sites was required, two or more survey records provided data to assess abundance of litter and characteristics at an individual site relative to other sites.

During a litter collection, assistants were spread out across a shoreline area, collecting and tallying all visible litter that they can find. Each survey record contained habitat and site details (e.g. name, date, coordinates), the count of each litter type, length of shoreline covered (km), and approximate weight of the litter collected (kg). A range of treatments were applied to gather information about the composition, distribution, and drivers of litter.

The testing of the hypothesis was made to allow determining the methods of data collection used and a number of ethical challenges arising in determining data collection were overcome.

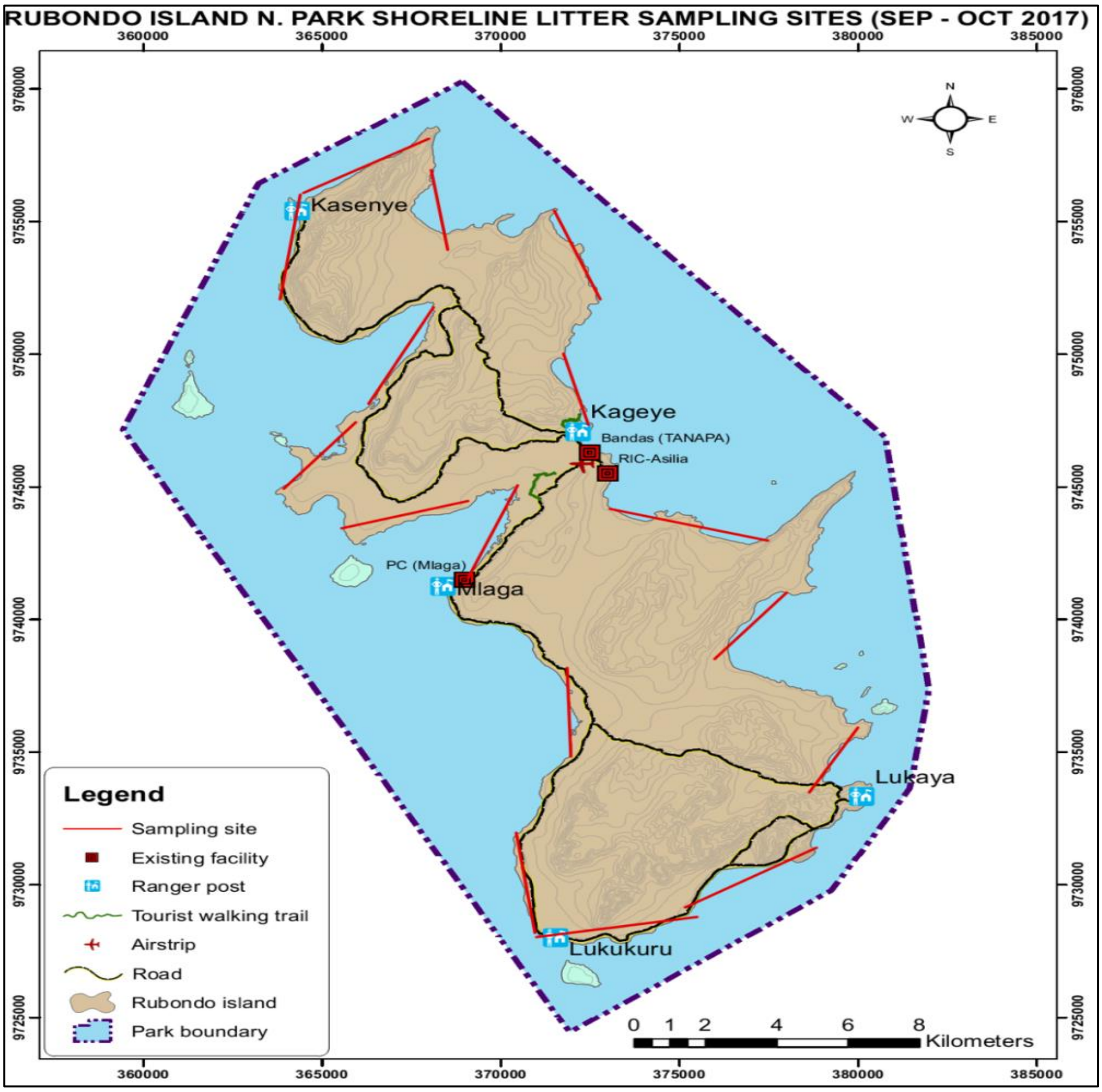

Figure 3.2: Location of Rubondo Island National Park Showing Sampling Transects

Source: (FZS and TANAPA, 2003)

3.5 Classification Basing on the Source of Litter

Litter grouping by categories was developed and the categories were: Fishing, Domestic, Industrial, Commercial, Agriculture, Individual, Recreational related medical/personal hygiene, clothing related and other. This provided the potential sources of litter and whether those were land-based or water-based for comparing the results (Hoellein, *et al*., 2015). Large and tiny litter items were classified as plastic or non-plastic. The percentages of large and tiny litter made of plastic at each site was calculated and mean was determined for each transect. The percentage of plastic from records falling within each study habitat was also determined.

3.6 Litter Composition Analyses

Litter composition analyses were carried out at all sixteen different sites of the research. Samples used for litter composition analyses were collected from sixteen different transect. In most cases the composition of the litter included Plastics, Fishnet, Wood, Clothes, Rubber, Glass, Metal and Others. This approach is recommended by SWA-tool (European Commission, 2004). The graph pad toolbox Software and SPSS computer software were used for litter composition analysis. Analyzed data were summarized and presented in tables, pie charts and bar graph for easy interpretation.

3.7 Spatial Abundance of the Litter Analysis

Weights of litter were recorded and analyzed separately and comparison of the density/concentration (number items per unit area (No. m^{-2}) and its density (weight per unit area (g m^{-2})) among the sixteen transects were also calculated. Determination of density/concentration of litter adopted method applied in Blittler *et al.* (2017) in similar study. In the study by Blittler et al (2007), concentration/density was obtained using the equation below:

$c = n / (lw)$ Where

c=denotes to concentration of litter *(No.* m^{-2} *or mass.* m^{-2}*).*

n= Number of items of litter

l= Length of transect

w= width of transect

Similar equation was used in determination of weight of litter per unit area. The interaction between habitats and transects, one-way ANOVA was used to compare litter density in each transect and among the sixteen transects. A spatial pattern of litter density and litter mass in all collection was analyzed using repeated measures ANOVA. The graph pad toolbox Software was used for data analysis.

3.8 Spatial Distribution of Litter/Debris Analysis

The distributions of survey records were analyzed from each transect. The graph pad toolbox was used to calculate the mean, minimum, and maximum litter density values located with each study area. Finally, relative standard deviation was calculated to assess the variability of density values between study areas.

3.9 The Effect of Litter on the Shoreline Analysis

A personal interview was conducted to boat operators working in RINP, on the effect of litter leftovers in water whether the leftover causes the impacts to fauna and/or boats propellers. The SPSS computer software was used for analyzing the effect litter leftover. Analyzed data was summarized and presented in table for easy interpretation.

3.10 Reliability and Validity Test

The research methods can be assessed and evaluated to gain confidence on the results and three principles for content validity will be adopted: (1) use of abroad sample of content rather than a narrow one, (2) emphasize important material, and (3) measure the appropriate skill.

3.11 Ethical Issues

The standard convention for citation and referencing was adopted and each significant contribution to, and quotation in, this report from the work, or works, of other people was attributed, cited and referenced. Permission was sought to conduct research in Rubondo Island National Park from Tanzania National Parks Head Quarters. The study presented minimal risk to participants pertaining to any treatment or exposure to physical or psychological harm. Respective to Rubondo Island National Park where the study was conducted, the authority was consulted for permission to conduct this study. The following were ethical issues kept under consideration during the research process:

Permission letter and any other written approval were provided when needed. The purpose of study was to obtain and give information from the field and to the respondents in order to make them understood all the aspects objectives and outcomes of this research. The privacy of the participants was well thought out to the maximum with regard to the laws.

3.12 Quantitative Data Analysis

The graph pad toolbox was used for data analysis and the following considerations were taken: Frequency distribution and summary statistics, Relationships and confounding variables, Sub-group analysis, Statistical generalizing from samples to populations.

3.13 Data Presentation Formats

Analyzed data were summarized and presented in both textual and visual formats (such as diagrams, maps, graphs, tables). Organizing and displaying the data in visual formats is useful in identifying trends and forecasts.

CHAPTER FOUR

FINDINGS AND DISCUSSION

4.1 Chapter Overview

This chapter presents findings and discussions of collected data. It involves classification of litter basing on the source of litter which was; recreational, domestic, industrial, and fishing. The chapter also explains litter composition analyses, spatial abundance and distribution of litter including litter density values located within each study area.

4.2 Sources of Shoreline Litter around Rubondo Island National Park

4.2.1 General Litter Sources in RINP

Findings on the classification of litter basing on the source of litter, indicated that fishing related activities dominated all sources of litter collected by contributing to 96.2%, followed by domestic related ones that contributed 3.8% of all litter sources (Table 4.1). This might have been contributed by the fact that, in the Lake Victoria, fishing is the major economic activity undertaken by the communities living in the neighboring islands. Findings in Table 4.1 further indicated that neither in all study shorelines there was industrial, commercial, agricultural nor recreational related sources of litter found.

Considering information gathered from each shoreline, findings further indicates that the Eastern shoreline alone contributed a total of 386 kgs (100%) of litter, out of which 385.5kg (99.9) came from fishing related activities. Likewise, in the southern shoreline a total of 68kg (100%) of litter were collected in which all (100%) came from fishing related activities (Table 4.1).

Table 4.1: Litter Collection by Source (Weight in kg) in the Four Shorelines of RINP

Litter source	Eastern shoreline	%	Southern shoreline	%	Western shoreline	%	Northern shoreline	%	Total	%
Domestic	0.5	0.1	0	0.0	6.5	38.2	21	7.8	28.0	3.8
Industrial	0	0.0	0	0.0	0	0.0	0	0.0	0.0	0.0
Commercial	0	0.0	0	0.0	0	0.0	0	0.0	0.0	0.0

Fishing	385.5	99.9	68	100	10.5	61.8	245.5	92.2	709.5	96.2
Agriculture	0	0.0	0	0.0	0	0.0	0	0.0	0.0	0.0
Individual	0	0.0	0	0.0	0	0.0	0	0.0	0.0	0.0
Recreational	0	0.0	0	0.0	0	0.0	0	0.0	0.0	0.0
Total	**386**	**100**	**68**	**100**	**17**	**100**	**266.5**	**100**	**737.5**	**100**

Source: field shoreline data, (2018)

Park wise, field findings further indicated that from all sampled shorelines in RNIP a total of 737.5kgs (100%) were collected out of which 705.9kg (96.2%) came from fishing related activities while the rest 28.0kg (3.8%) come from domestic related activities (Table 4.1). This concludes the fact that litter collected from all sampled shorelines in RNP came from two major sources namely fishing and domestic related activities.

4.2.2 Sources of Litter in Different Shorelines

Findings from study of the shorelines indicated that the eastern shoreline had much litter (52.3%) than the rest of shorelines, followed by Northern shoreline with 36.1% and Southern shoreline with 9.2% and lastly was western with 2.3% (Table 4.2).

Table 4.2: Litter Collected from all Study Shorelines at RINP

Study Shorelines	**Weight Collected in Kg**	**%**
Eastern	386	52.3
Southern	68	9.2
Western	17	2.3
Northern	266.5	36.1
Total	**737.5**	**100**

Source: Field Survey Data (2018)

This might have been attributed by wind movement where wind has been blowing from highly inhabited fishing camps at Maisome Island located eastward of the Park. Such wind has been bringing in a lot of litter from the Maisome Island towards the Park.

As previously stated, all litter collected in all sampled shorelines came from two sources mainly fishing (709.5kg) and domestic (28.0kg) related activities. Considering fishing related activities alone, a total of 709.5kg (100%) of fishing related litter were collected from all sampled shorelines, out of which 285.5kg (54.33%) came from eastern shoreline, 68kg (9.58%) came from southern shoreline, and 245.5kg (34.6%) came from northern shoreline while 10.5kg (1.48%) came from western shoreline (Table 4.3).

The domestic related activities were the second activities that contributed a total of 3.8% of all shorelines litter (Table 4.1). The Northern shoreline dominated by contributing 75%, followed by western shoreline contributing 23% whereas eastern shoreline contributed 2% and finally Southern shoreline contributed 0% (Table 4.3).

Table 4.3: Fishing and Domestic Related Litter between Shorelines Compared

Shorelines	**Fishing related**		**Domestic related**	
	Weight in Kg	**%**	**Weight in Kg**	**%**
Eastern	385.5	54.33	0.5	2
Southern	68	9.58	0	0
Western	10.5	1.48	6.5	23
Northern	245.5	34.60	21	75
Total	**709.5**	**100**	**28**	**100**

Source: Field Surveys Data (2018)

Similarly, out of 28kg (100%) of domestic related litter collected from all sampled shorelines, 21kg (75%) came from northern shoreline, 6.5kg (23%) came from western shoreline while 0.5kg (2%) were collected from eastern shoreline. No domestic related litter was collected from southern shoreline (Table 4.3). The reasons for Eastern shoreline having more fishing related litter by the fact that, in the lake, fishing is the major economic activity being undertaken by the communities living in the neighboring islands and those living to the adjacent villages.

The reason for Northern shoreline contributing more domestic related litter might have been attributed by the settlements on Ikuza Island where apart from fishing activities, agricultural activities have been taking place which in turn generated much domestic related litter. This is different from litter generated on Maisome Island located in the Eastern side of the Park whose main economic activities was fishing which ultimately lead to generation of fishing related litter.

Western shoreline was the second to receive more domestic related litter (23%) after Northern shoreline (75%), this might have been attributed by proximity to Nyabugera and Mwerani villages in which various economic activities are conducted including fishing, crop production and livestock keeping which in turn generate more domestic related litter. However less litter quantity was received in western shoreline as compared to the northern one mainly because of effect of wind that has been blowing from East to West depositing more litter away from the Park.

Similarly, wind effect contributed significantly to make southern shoreline receive no domestic litter despite being close to Kikumbaitare and Kichangani villages located southward of the Park. The findings further indicated that, Eastern shoreline had the highest amount of litter of all study shorelines (52.3%). The reason for Eastern shoreline having a large quantity of litter compared to other shorelines is presumably caused by the wind movement effect. Wind has been blowing towards the Island from east to west bringing in with a lot of litter from Maisome Island which is highly populated and it's fishing camps of Migongo, Kabiga, Bugombe and Kensambi. Maisome Island is located about 15km Eastern side of Rubondo Island National Park (RINP). Presence of highly populated fishing camps at Maisome Island, contributed to a greater extent to litter deposition in the Eastern shoreline.

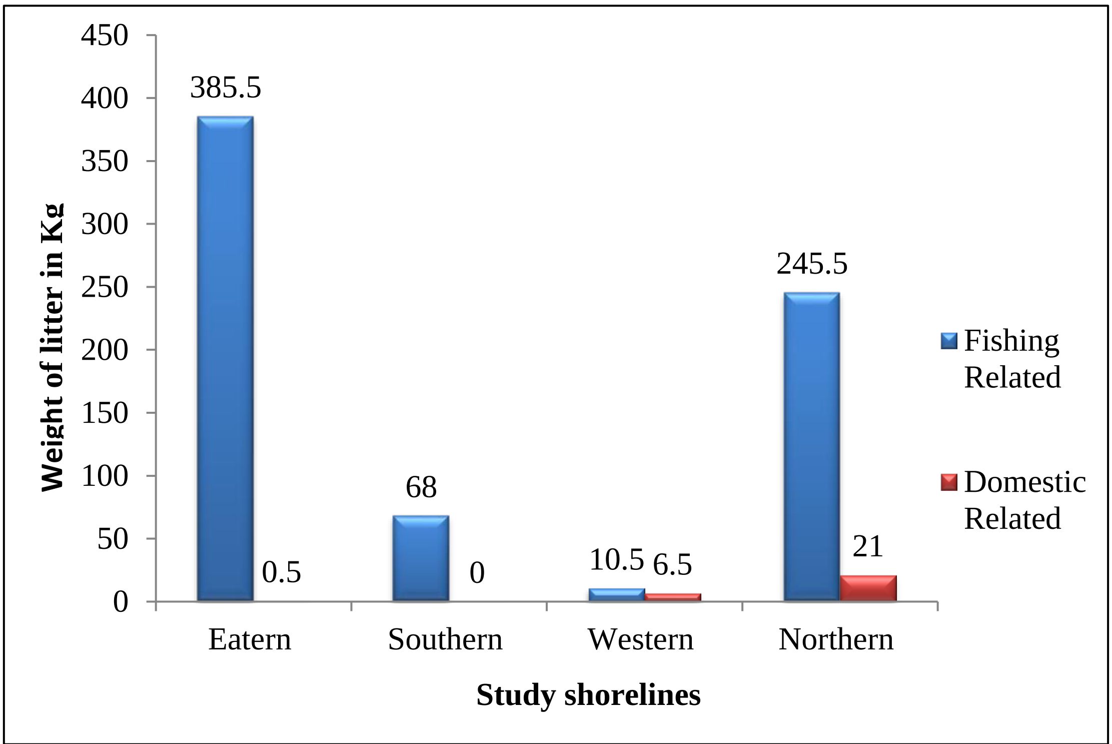

Figure 4.1: Summary of Sources of Litter (kgs) in Four Shorelines of RINP

Source: Field Survey data (2018)

The reason for having fishing related products as being the larger source of litter (76.8%) than domestic ones (23.2%) is presumably attributed by the presence of fishing communities in villages of Kikumbaitale, Mwerani and Nyabugera.

The reason for western shoreline receiving less litter compared to other study shorelines is presumably linked to the wind movement effect. While in the western shorelines, wind has been blowing away from the shorelines towards shorelines outside the park. The wind has been blowing from Southwest to Northwest direction.

As previously explained, in all study shorelines, fishing related activities were the main source of litter deposited in RINP shores (96.2%). In comparison, eastern shoreline received the highest quantity of fishing related litter (52.34%) followed by Northern shoreline (36.14%), southern shoreline (9.22%) and western shoreline (2.31%) (Table 4.3).

Interestingly, since RINP is a recreational center receiving tourists both local and international ones, one would expect litter collected in all study shorelines to be recreational related. However, fishing related litter dominated in all litter collected and no recreational related litter was collected. The reasons for this observation include RINP receiving fewer tourists compared to other National parks and effective implementation of TANAPA policy and tourism guidelines on litter control that uses the slogan of "*Trash In Trash Out*" where every tourist entering the park with any sort of litter must ensure he/she leaves the park with all litter he/she came with (TANAPA, 1994).

4.2.3 Litter Composition in Study Shorelines of RINP

The research findings indicated that plastics, wood and clothes were found in all study shorelines while rubber was lacking in southern and western shorelines. Additionally, fishnets were available in three study shorelines and lacking in western shoreline (Table 4.4).

Table 4.4: Litter Composition by Weight (kg) in the Four Shorelines of RINP

Litter type	Eastern shoreline	%	Southern shoreline	%	Western shoreline	%	Northern shoreline	%	Total	%
Plastics	330	85.5	54	79.4	14	82.4	214.5	80.5	**612.5**	**83.05**

Fishnet	43	11.1	2	2.9	0	0.0	17	6.4	**62**	**8.41**
Wood	10.5	2.7	1.5	2.2	0.5	2.9	25	9.4	**37.5**	**5.08**
Clothes	2	0.5	10.5	15.4	2.5	14.7	5	1.9	**20.0**	**2.71**
Rubber	0.5	0.1	0	0.0	0	0.0	5	1.9	**5.5**	**0.75**
Glass	0	0.0	0	0.0	0	0.0	0	0.0	**0**	**0.0**
Metal	0	0.0	0	0.0	0	0.0	0	0.0	**0**	**0.0**
Others	0	0.0	0	0.0	0	0.0	0	0.0	**0**	**0.0**
Total	**386**	**100**	**68**	**100**	**17**	**100**	**266.5**	**100**	**737.5**	**100**

Source: Field Survey Data, (2018)

Note: All values are in Kilograms

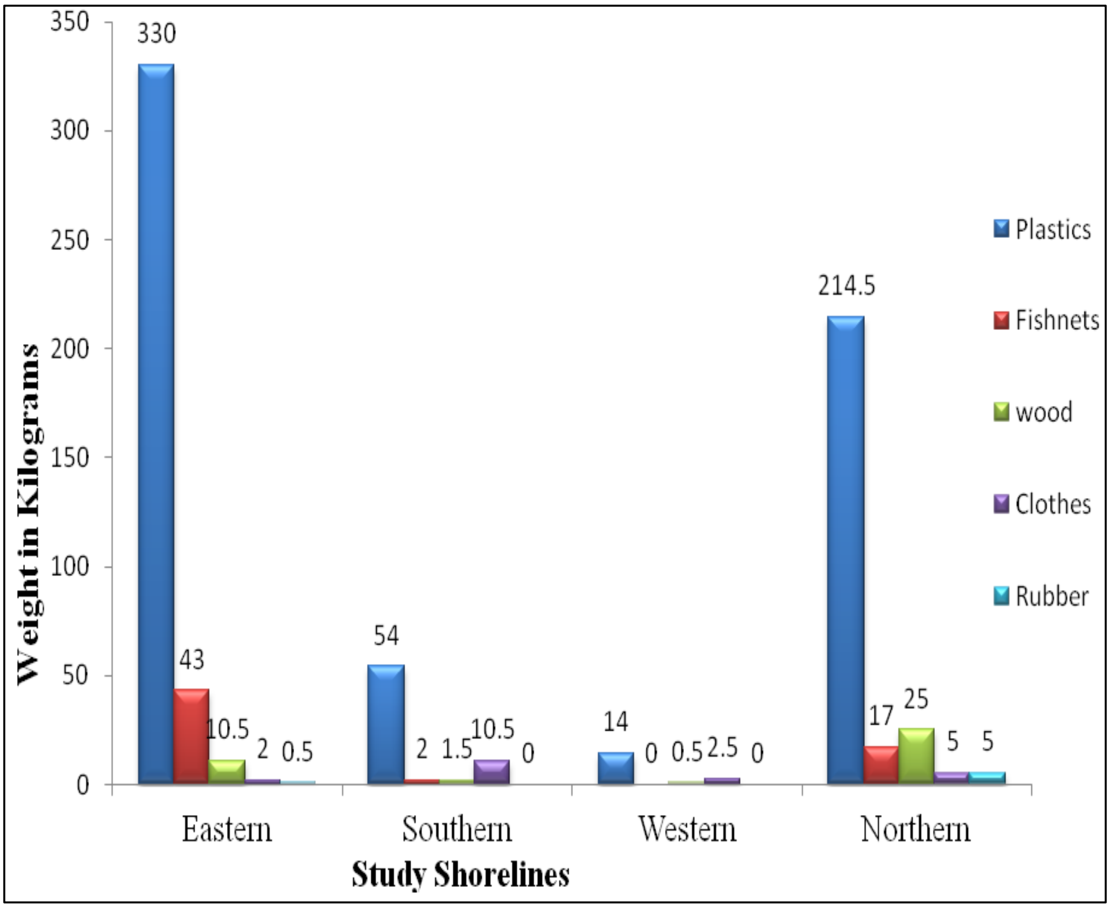

Figure 4.2: Litter Composition by Weight (kg) in all Study Shore Lines in RINP

Source: Field Survey Data (2018)

Field findings from all study shoreline indicated that plastics was a dominant litter type that accounted 83.05% of all litter collected followed by fishnets (8.41%), wood (5.08%), clothes (2.71%) and glass that only accounted 0.75% (Table 4.4 & Figure 4.3).

Comparing all study shorelines, plastics were found to dominate in all sampled shorelines in RINP where eastern shore line was leading by possessing 330kg (85.5%) of plastics followed by Northern shoreline that recorded 214.5kg (80.5%), Southern shore line with 54kg (79.4%) and Western shore line with 14kg (82.4%) were plastics (Figure 4.3).

Most of plastic litter collected came from fishing related activities. Fishing activities in the Lake have been using varieties of plastics (including drinking water bottles, gallons, and the like (Plate 4.1) acting mainly as buoys to their fishing nets.

Planet 4.1: Plastics Composed Most Litter Collected in Study Shoreline

Source: Field Survey Data (2018)

Few plastics came from domestic related activities, which mainly originated from residents residing in park nearby fishing camps brought on the Island by wind and wave effects. No plastics collected were related to recreational activities taking place at RINP. This was attributed by the fact that, RINP management have been emphasizing

TANAPA litter management policy while in the Island of "Trash in Trash Out" in addition to RINP being less visited by tourists.

Apart from fishermen living in nearby islands, the park is adjacent to growing towns of Muganza and Chato to the western side of RINP and towns of Nkome and Geita to the southeastern side of the park. Towards the eastern side of the Lake there are big town centers of Sengerema, Kahunda and Mwanza City, the litter from fishing and domestic activities is presumably washed by water and deposited into various islands in Lake Victoria. Different kinds of litter including plastics, fishnets, wood, rubber and clothes from growing fishing centers are carried out by water waves and winds and finally deposited in RINP's shorelines.

These findings are similar to studies conducted in various beaches worldwide assessing litter composition that found plastics being the major composition of all litter collected. To mention a few, The global quantities are continuously increasing while plastic bags, fishing equipment and beverage containers are the most common items that constitute more than 80 % (Thiel *et al*., 2013). Lamprecht (2013) in Table Bay Cape Town South Africa, found plastics to have the largest proportion (93%) of all debris collected.

Johansson (2014) in Port Phillip Bay in San Francisco, USA found similar results in which plastics composed 83.7% of all debris collected. The study conducted by Himans (2013) in four beaches of Ghana found plastics leading the composition. According to Himans (2013), in four beaches of Sakumono, La Pleasure, Mensah Guinea and Korle Gonno, the composition of plastics was 62.40%, 65.48%, 68.47% and 71.80% respectively. Comparing Himans's study to this study, it shows that the compositions of plastics at RINP shorelines are slightly higher than those observed in Himans's study.

For Eastern, Western, Northern and Southern shorelines of RINP; field findings indicated that composition of plastics was 85.5%, 82.4%, 80.49% and 79.4% respectively. The higher composition of plastics in shorelines of RINP might have been attributed by nature of economic activities undertaken by communities living adjacent to RINP, which is mainly fishing deploying many plastics materials during fishing exercise.

These litter apart from reducing beauty of good beaches at RINP for tourists' enjoyment, are likely going to have ecological impacts on wildlife resources in RINP and fish resources in the Lake. RINP is known for being a good habitat of many resident and migratory birds. Some bird species feeding on fish resources like African fish eagles are at risk of being affected by litter concentration in the Lake especially plastics. Already some studies worldwide on fish, sea turtles, and fish eating birds, reptiles and aquatic mammals have demonstrated that plastics really affect them. Such animals' gastro intestinal systems have been found to be clogged with plastics (Burton, 2017).

In summary, litter collected on RINP shorelines mainly comes from two major sources namely fishing and domestic economic activities. Collected litter was mainly composed of plastics (83.05%). Plastics dominated all study shorelines, which was mostly attributed by fishing activities in the lake. Such plastics are used for various uses by fishermen including acting as buoys to their fishing gears (fishing nets, hooks etc) %) (Figure 4.4).

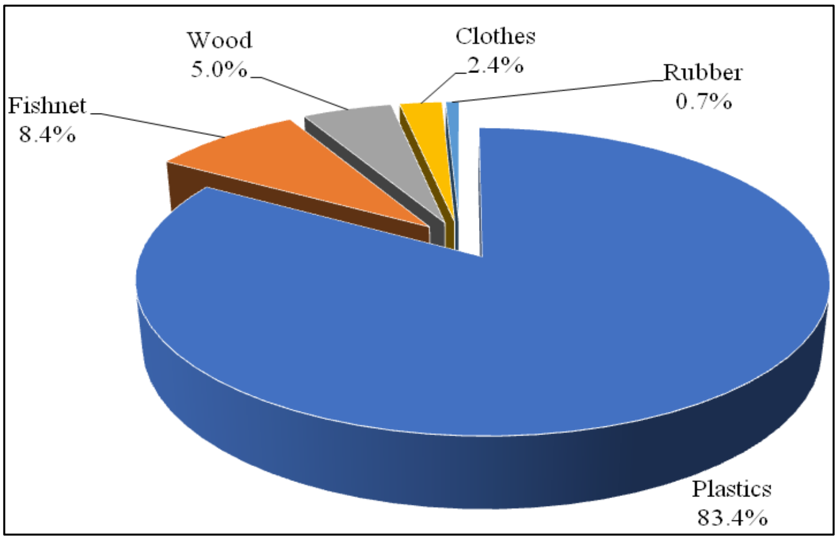

Figure 4.3: Summary of Litter Composition in % Collected from all Study Shorelines

Source: Field Survey Data (2018)

Some of the plastics were brought on the Island from nearby fishing camps and from nearby growing town centers to the Island. However, no litter collected on RINP shorelines were related to recreational activities by tourists on the Island. This was attributed by the fact that, RINP receives small number of tourists annually and most of beaches on the Island are not well developed to attract tourists for recreational activities. In addition, the Park management has been emphasizing "Trash in Trash out" as means to control litter on the Island.

4.3 The Distribution of Shoreline Litter around Rubondo Island National Park

In this section an overview of general litter abundance and spatial shoreline litter distribution on the whole Island is discussed. Additionally, concentration of litter from each sampled shoreline was determined and compared. This is from the assumption that, distribution of litter in sampled shorelines was not the same leading to different litter concentration.

4.3.1 General Litter Abundance on RINP

Weight or number of Items/unit area was determined in all study shorelines (16 transects) using the collected field data. Field findings indicate that a total of 15,430 items were collected in which plastic was a leading litter component with 15,313 items (99.24%) followed by wood with 39 items (0.25%), rubber with 37 items (0.24%), clothes with 24 items (0.16%) and fishnet accounted 17 items (0.11%) (Table 4.5). Basing on these findings, the overall concentration of litter in RINP was found to be 0.96 items/m^2 in which plastics constituted the overall average litter concentration (0.96 items/m^2) while other components had negligible values (Table 4.5).

Table 4.5: Concentration (Expressed in Number of Items/m^2 and Weight/m^2) of Litter in RINP Shorelines

Litter Composition	Weight 16 Transects) (g)	%	Av. WeightPer Transect (g)	Density (g/m2)	Number of Items (16-Transects)	%	Av. number of Items Per Transect	Concentration (Items/m^2)
Plastics	612500	83.05.00	38281.25	38.2813	15,313	99.24	957	0.96
Rubber	5500	0.75	343.75	0.34375	37	0.24	3	0
Fishnet	62000	8.41	3875.00	3.875	17	0.11	1	0
Wood	37500	5.08	2343.75	2.34375	39	0.25	3	0
Clothes	20000	2.71	1250.00	1.25	24	0.16	2	0
Total	**737,500**	**100**	**46,093.75**	**46.09**	**15,429**	**100**	**964**	**0.96**

Source: Field Survey data (2018)

Note: Transect area was 1000m^2 (i.e 100mx10m)

Concentration of items of litter was obtained by taking the average number of items per transect divided to the area in meters of the same transect. For this case the area of each transect was obtained by multiplying length of transect (100m) by width (10m) i.e. (100x10) = 1,000m^2. According to Table 4.5, the average number of items obtained was

964, therefore, the concentration of items was 964 items/1000m^2 =0.964items/m^2 which is approximated to be 1item/m^2. This is the methodology of determining concentration of items per unit area which is similar to the one applied by Van Dyck, (2016) and Sheavly, (2007).

Field findings indicated that, on average each transects had 964 items of litter (49,096.75g) equivalent to 0.96≈1 items/m^2 (46.096g/m^2) (Table 4.5). In other words, for every square meter there was one (1) item of litter that weighed about 46.096g. Findings further indicated that plastics was a leading component possessing an average number of items per transect of 957 (38,281.25g) equivalent to 0.96items/m^2 (0.96≈1 items/m^2) and (38.28g/m^2) (Table 4.5).

Comparison between the shorelines, field findings indicated that eastern shoreline recorded the highest concentration (density) of litter by possessing 8,276 items (386,000g) equivalent to 2,068 items (96,500g) per transect with concentration of 2.07items/m^2 (96.5g/m^2) (Table 4.4). Northern shoreline followed by possessing 5,434 items (266,500g) with average of 1,351 items (66,625g) per transect which was equivalent to concentration of 1.35item/m^2 (66.6g/m^2). Southern shoreline recorded a total of 1,365 items weighing 68,000g with an average of 341 items (1,700g) whose concentration was 17g/ m^2 (0.34items/m^2). Western shoreline had the least litter concentration that recorded a total of 354 items weighing 17,000g with an average of 81items (4,250g) per transect with concentration of 4.25g/m^2 (0.08 items/m^2). A relatively similar study by Himans (2013), in four beaches of Ghana had a considerably higher concentration of litter as compared to what was observed in this study around shorelines of RINP.

Himans (2013) in four beaches of Sakumono, La Pleasure, Mensah Guinea and Korle Gonno, found a concentration of litter was 5154 items/m^2 (6721g/m^2), 4423 items/m^2 (5788g/m^2), 4948 items/m^2 (9991g/m^2) and 3716 items/m^2 (7258g/m^2) respectively. This is far contrary to what was observed in four shorelines of RINP where Eastern, Sothern, Western and Northern shorelines recorded a concentration of 2.07items/m^2 (96.5g/m^2), 0.34items/m^2 (17g/m^2), 0.08 items/m^2 (4.25g/m^2) and 1.35items/m^2 (66.6g/m^2) respectively.

The discrepancy in litter concentration in four beaches of Ghana as described by Himan (2013), and those covered in this study might have been caused by the level of use of these beaches. The reason for RINP's shorelines not being frequently polluted by tourists, it is because the park receives the small number of tourists as opposed to those in Ghana which were developed and frequently visited by tourists.

Additionally, beaches at RINP are not well developed for recreational activities and making them less visited and prone to litter deposition. However, the TANAPA's policy on litter management emphasizes the slogan "*Trash in Trash Out*" which helps to reduce litter deposition in RINP shorelines. Litter generated in shorelines around RINP mainly come from fishing related activities which are carried out by waves and lake tides towards lake shores. Litter generated in four beaches covered in a study by Himans (2013) mainly come from recreational related activities. Litter pollution in RINP shorelines will only happen when existing shorelines would have been well developed to attract tourist's use for recreational activities, which currently are not developed for that purpose. Therefore, careful planning and deliberate efforts are needed to come up with possible mitigation measures to deal with litter/wastes in the park and those originating from outside RINP from various anthropogenic activities.

In all 16 transects, plastics had 15,313 (98.99%) items followed by wood that recorded 39 (0.25%) items, then rubber was 37 (0.24%), fishnets was 17 (0.11%), wood was 39 (0.25%) and clothes were 24 (0.16%) items which were collected from the Northern, eastern, western and southern shorelines of Rubondo National Park respectively. The total weight of litter was 737,500.00 (100%) (g) (in all 16 transects) in which plastics weighed 612,500(g) (83.1%), rubber 5500(g) (0.7%), fishnets 62,000(g) (8.4%), wood 37,500(g) (5.1%), and clothes 20,000(g) (2.7%) (Table 4.5).
Litter density was calculated and was found to be 46.09 (g/m$^{2)}$ in which density of plastics was 38.28125 (g/m$^{2)}$, rubber was 0.34375(g/m$^{2)}$, fishnets 3.875 (g/m$^{2)}$, wood 2.34375 (g/m^{2}) and clothes 1.25(g/m^{2}) Table 4.5). Comparatively, plastic materials dominated the total litter collected in all shoreline around Rubondo Island National Park. According to Thiel *et al*., 2013, Globally, Plastic bags, fishing equipment, food and beverage containers are the most common items that constituting more than 80 % in various seas and oceans.

4.3.2 Spatial Shoreline Litter Distribution

The litter distribution in the field study showed a total average of 184,375(g), whereby the eastern shoreline dominated with an average weight per transect of 96,500(g), followed by Northern shoreline with an average weight per transect of 66,625 (g), Southern shoreline had an average weight per transect of 17,000(g) and Western shoreline was the lowest with average weight per transect of 4,250(g) (Table 4.6).

Table 4.6: Distribution (Expressed in Number of Items/m^2 and Weight/m^2) of Litter in 4 Shorelines

Litter Source	Weight (4Transects) (g)	%	Av. Weight Per Transect(g)	Density (g/m^2)	Number of items (4transects)	Av. Number of Items Per Transect	%	Concentration (Items/m^2)
Eastern shoreline	**386000**	53	96,500	96.9	8,272	2,068	54	2.07
Southern shoreline	**68000**	9	17,000	17	1,365	341	9	0.34
Western shoreline	**17000**	2	4,250	4.25	354	81	2	0.08
Northern shoreline	**266500**	36	66,625	66.6	5,434	1351	35	1.35
TOTAL	**737,500**	100	**184,375.00**	**184.35**	**15,425**	**3,841**	100	**3.84**
AVERAGE	**184,375**		**46,093.75**	**46.087**	**3,856.25**	**960**		**0.96**

Source: Field Survey data (2018)

Note: Transect area was 1000m^2

The Eastern shoreline recorded the highest density of 96.9 g/m^2, followed by Northern shoreline that recorded 66.6 g/m^2, southern shoreline had the17g/m^2 and the western shoreline was the least with 4.25 g/m^2.

Globally, the anthropogenic litter on the sea surface and beaches has significantly increased over recent decades and commonly observed across all oceans, lakes rivers and they can be transported over long distances by prevailing winds and currents (Barnes *et al*., 2009; Costa *et al*. 2010; Ryan, 2015). With standardized monitoring approaches, the abundance and distribution of anthropogenic litter show considerable spatial variability (Galgani *et al*., 2000). Most fishermen are using poor fishing practices which annihilate the aquatic life cycle. The decline of fish has been observed recently where most of fishermen experience low productivity due to massive use poor fishing practices including poison, small nets, spears and many others (Nassor, 2016). This causes the increased litter density in the lake (Table 4.6).

The distribution of shoreline litter indicated that the Eastern shoreline had an average Number of 2,068 items per transect, followed by the distribution of litter in the Northern shoreline with an average number 1,351 items per transect, Southern shoreline with 341items per transect and lastly western shoreline had an average number of 81items Per Transect (Table 4.6).

Furthermore, concentration of litter showed that the eastern shoreline had 2.07items/m^2 followed by the Northern shoreline with 1.35items/m^2 and the Southern shoreline with 0.34items/m^2 and lastly western shoreline with 0.08items/m^2 (Table 4.6). However, with ever increasing in the concentration of litter particularly, fishing related gears (Fishing nets, wooden material and manila ropes), the most common type of incident observed was fouled propellers of the patrol boats, tourists and passenger boats suggest that these types of shoreline litter can pose disproportionately high health and safety risks.

Waste generation in sub Saharan Africa is roughly 62 million tonnes per annum (World Bank 2012). Per capita waste generation is generally low in this region, but spans a wide range, from 0.09 to 3.0 kg per person per day, with an average of 0.65 kg/capita/day (World Bank, 2012). Due to waste generated by the tourism industry and a more comprehensive accounting of all wastes produced, the countries with the highest waste generation per capita rates are islands.

The four sampled shorelines covered in this study are less or totally not used by tourists as recreational centers as opposed to those in Ghana which are frequently visited by tourists. Litter generated in shorelines around RINP mainl*y* come from fishing related activities which are carried out by waves and lake tides towards lake shores. Litter generated in four beaches of Sakumono, La Preasure, Mensah Guinea and Korle Gonno in Ghana covered in a study by Himans (2013) mainly comes from recreational related activities.

4.4 The Effect of Litter on the Lake Shoreline Environment

4.4.1 Effects of Litter to Fauna in RINP

Field finding indicated that, litter in the lake water has been found to have a profound effect to different fauna in RINP. A personal interview with ten boat operators working in RINP, they all (100%) accepted that leftover litter in water caused impacts to fauna in RINP. Affected species were mainly aquatic and semi aquatic ones. All interviewed boat operators reported to have encountered dead crocodiles (*Crocodilus nilotica)* and fishes being caused by fishnets left by fishermen in water (Table 4.7).

Table 4.7: Responses by Boat Operators on Effects of Litter to Lake Shore Environment

S/N	Effects of Litter on Environment	Responses		Percent Cases
		N	%	
1.	Litter in the Park caused death to crocodiles	10	21.3	100
2.	Litter along Park shores caused death to hippos	6	12.8	60
3.	Litter along Park shores caused death to otters	3	6.4	30
4.	Litter along Park shores caused death to fishes	10	21.3	100
5.	Litter along Park shores killed birds	8	17.0	80
6.	Litter along park shores entangled boats	10	21.3	100
	Total	**47**	**100**	

Source: Field survey data (2018) (N=Sample size)

Eight (8) boat operators (80%) reported to have encountered dead birds suspected to have been caused by fishing nets left in water. Affected bird species were; African fish eagles (1) cormorants (4) and African darters (3). Affected bird species had common characteristic of feeding on fish and swimming dipper in water. Birds have suffered from drowning and getting entangled in fishing nets, loss of feeding roosting and breeding grounds through wetland destructions (LVBC, 2011).

Planet 4.2: Hippopotamus Entangled into the Left Fishnet on the Shoreline of RINP

Source: Field photo (2018)

Abandoned fishing gears such as fishing nets can continue to 'ghost fish' for a long period even after being abandoned for a long period of time (Mouat *et al.,* 2010). Additionally, it was also reported that hippos and otter were found dead and their bodies were found wrapped by fishing net reported that hippos and otter were found dead and their bodies were found wrapped by fishing nets (Plate 4.2).

4.4.2 Effects of Litter on Tourism Activities

Sport fishing is one of the important tourism product offered at RINP. Personal interview with some of the boat operators who have been actively engaged in sport fishing complained their boat propellers being entangled by fishing nets left in water by fishermen as wastes (Table 4.6). Laws (2000) pointed out that damage to vessels from marine debris results from collision with floating objects, entanglement of debris in propeller blades, and clogging of water intakes for engine cooling systems.

Takehama (1990) has estimated the annual cost of damage to Japanese fishing vessels caused by floating debris to be roughly 4 billion yen, which is about 0.2% of the total cost of operating the vessels. Additionally, fish lures loaded on fish hooks have been reported to get entangled with fishnets during the sport fishing. Such events have been causing disturbances to tourists enjoying sport fishing. Sometimes tourists themselves have been participating in removing fishing nets on boat propellers to continue with their exercise.

Huge amount of litter on shoreline effects tourism earnings especially for countries that depend on beaches tourism (Ballance *et al*., 2000). Apart from interfering with tourists' activities, litter has been found to distort beautiful scenery view of the lake beaches (Plate 4.3). Sand beaches along shores of RINP have been acting as good tourist attraction, making the park unique among other Tanzania National Parks.

Planet 4.3: Appearance of Shorelines of RINP
Source: Field Photo (2018)

A tourist at Rubondo, enjoys both lake and terrestrial environment in which sand beaches along the lake shores decorates the park. However, some sand beaches at RINP sometimes have found covered by plastic litter thereby reducing its scenery beauty hence reducing people's enjoyment of the beach landscape and scenery (Cheshire *et al*., 2009).

4.5 Summary of Findings

This study assessed the spatial litter distribution along the shorelines. Specifically the study identified sources of shoreline litter around RINP; it also determined the distribution of litter and finally assessed effect of litter on Lake Shoreline environment. Generally, the findings shows that the fishing related activities dominated all sources of litter collected by contributing 92% of all litter collected. Eastern shoreline of RINP received the largest amount of litter (68%) of all sampled shorelines of RINP.

Plastics were the major component of all litter collected contributing 83.4%. Other components of litter were fishnets (8.4%), wood (5.0%), clothes (2.4%) and rubber (0.7%). followed by domestic related litter sources. This might have been contributed by the fact that, fishing is the major economic activity in the Lake Victoria, undertaken by the communities living in the neighboring islands. The water waves and winds were possibly transporting litter and depositing into the lake.

Moreover, the distribution of the litter indicates that eastern shoreline recorded the highest concentration (density) of litter by possessing 8,276 items (386,000g) equivalent to 2,068 items (96,500g) per transect with concentration of 2.07items/m^2 (96.5g/m^2). Northern shoreline followed by possessing 5,434 items (266,500g) with average of 1,351 items (66,625g) per transect which was equivalent to concentration of 1.35item/m^2 (66.6g/m^2). Southern shoreline recorded a total of 1,365 items weighing 68,000g with an average of 341 items (1,700g) whose concentration was 17g/ m^2 (0.34items/m^2). Western shoreline had the least litter concentration that recorded a total of 354 items weighing 17,000g with an average of 81items (4,250g) per transect with concentration of 4.25g/m^2 (0.08 items/m^2). Further, during sport fishing the boat propellers are being entangled by fishing nets left in water by fishermen as wastes.

Additionally, fish lures loaded on fish hooks have been reported to get entangled with fishhooks during the sport fishing. Such events have been causing disturbances to tourists enjoying sport fishing. Sometimes tourists themselves have been participating in removing fishing nets on boat propellers to continue with their exercise. Apart from interfering with tourists' activities, litter has been found to distort beautiful scenery view of the lake beaches. Sand beaches along shores of RINP have been acting as good tourist attraction, making the park unique among other Tanzania National Parks.

Finally, the study found that deposited litter on the lake shores had a number of effects including causing death to various fauna found in RINP. Affected species included crocodiles, hippos, otters, fishes and birds mainly Cormorants, African fish eagles, and African darters. Various measures are suggested to deal with litter along RINP and within Lake Victoria. Suggested measures include; education campaign to fishermen from park adjacent communities, routine patrols and litter collection in different shorelines of Lake Victoria.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Generally, the research on the Effect of the Litter along the lake shoreline in RINP classified litter in into different sources categories. Two sources categories of litter were found; domestic and fishing-related sources. This answer the question that is the litter collected along the lake shorelines comes from different sources? Fishing related source was the dominant one which constituted 96.2%.

Likewise, the distribution of shoreline litter indicated that the Eastern shoreline was leading by recording highest concentration of litter (2.07 items/m^2) while the Southern shoreline recorded concentration of litter (0.34 items/m^2) while the western shoreline recorded the smallest concentration of litter (0.08 items/m^2)., and its effects varies within the locations. This answers the question that is there any significant difference in spatial distribution of litter along the shoreline in Rubondo islands national park and whether their effect varies within locations.

Similarly, with ever increasing of the concentration litter that is fishing related gears (Fishing nets, wooden material and manila ropes), brings effect to both flora and fauna. Animals such as crocodiles, fish, birds and Hippopotamuses have been reported to be affected by fishnets and fishing hooks. Huge amount of litter on shoreline affects tourism earnings especially for countries that depend on beaches tourism. Therefore the litter along the Lake Shoreline has significant effect to both flora and fauna on the lake shoreline environment.

5.2 Recommendations

This research recommends to the park management to conduct regular collection of litter which is relatively quick method of indicating status of the shoreline functioning and the information can be used for the informed decision in relation to beach use.

(i) The park management should establish information on the shorelines litter to determine its source. This information will help designing control measures at the source.

(ii) The research emphasizes to the park management the regular cleanups and determines the composition of shoreline litter inside the park for maintaining environmental health. This information will help knowing various types of litter and design the control strategy which could be stipulated in RINP General Management plan.

(iii) This research, further, recommends to the District Authorities on increasing efficiency in litter management in order to lower the amount of litter that enters the lake and island environment.

(iv) This research also recommends assessment of the effect of litter to both flora and fauna this information will help the District Authorities and Fisheries Department to educate the community living around the lake on the effect of litter on the fisheries industries in general and to create local awareness on the problem of the effect of the litter. This will also help the government to put more emphasis on the use of improved fishing gears and strict adherence to fisheries rules and regulation.

(v) This study recommends Environmental Impact Assessment (EIA) to various projects related to the local and national governments. This information will help to prevent and mitigate shoreline degradation in the form of littering caused by the use of both chemical and physical degradation which have direct impact on the ecology of the wetland, local tourist economies and global tourism.

(vi) This study recommends further intensive research, regular surveys and monitoring of the effect of tourism activities on the shoreline regarding to the litter generation and general wetland ecology (including shoreline ecology). Also the surveys and monitoring of the effect of fishing related litter on plants, birds, fish, reptiles, amphibians and mammals in the major four shorelines of RINP.

5.3 Suggested Further Studies

A further study on the effect of shoreline litter as is recommended; particularly studies on sources (recreational, fishing, domestic, and agriculture, industrial related and medical sources) and composition of the shoreline litter around Rubondo Island National Park. More Research is needed on the spatial and temporal distribution (density/concentration) of shoreline litter around Rubondo Island National Park.

REFERENCES

Anand, S., (2010). *Solid Waste Management in the World's Cities.* New Delhi: Published and printed by Krishan Mittal for Mittal Publications.

Armitage, N., and Rooseboom, A. (2000). The removal of urban litter from storm water conduits and streams: Paper1- The quantities involved and catchment litter management options. *Water South Africa 26(2)*, 181-188.

Ballance, A., Ryan, P. G., and Turpie, J. K. (2000). How much is a clean beach worth? The impact of litter on beach users in the Cape Peninsula, South Africa. *South Africa Journal of Science*. 96(2), 5210 - 5213.

Barnes, D. K. A., Galgani, F., Thompson, R. C., and Barlaz, M. (2009). Accumulation and fragmentation of plastic debris in global environments. *Philosophical Transactions of the Royal Society B. 364(3),* 1985-1998.

Bergmann, M., and Klages, M. (2012). Increase of litter at the Arctic deep-sea observatory HAUSGARTEN. *Marine Pollution Bulletin, 64(2),* 2734–2741.

Biginagwa, F. J., (2015). First evidence of microplastics in the African Great Lakes: Recovery from Lake Victoria Nile perch and Nile tilapia. *Journal of Great Lakes Res. 3(1),* 34 – 51.

Bowman, D., Manor-Samsonov, N., and Golik, A. (1998). Dynamics of litter pollution on Israeli Mediterranean beaches: a budgetary, litter flux approach. *Journal of Coastal Res. 14(2),* 418432.

Brown, J., and Macfadyen, G. (2007). Ghost fishing in European waters: Impacts and management responses. *Marine Policy 31 (4),* 488-504.

Browne, M. A., (2015). Sources and pathways of microplastic to habitats. In M. Bergmann, L. *Marine anthropogenic litter 2(1),* 229–244).

Chapman, L. J., Chapman, C. A., Nordlie, F. G., and Rosenberger, A. E. (2002). Physiological refugia: swamps, hypoxia tolerance and maintenance of fish diversity in the Lake Victoria region. *Comparative Biochemistry and Physiology Part A 133(5),* 421-437.

Chapman, L. J., Chapman, C. A., Schofield, P. J., Olowo, J. P., Kaufman, L., Seehausen, O., and Ogutu-Ohwayo, R. (2003). Fish fauna resurgence in Lake Nabugabo, East Africa. *Conservation Biology 17(2),* 500-511.

Cheshire, A. C., Adler, E., Barbière, J., Cohen, Y., Evans, S., Jarayabhand, S., Jeft ic, L., Jung, R.T., Kinsey, S. (2009). UNEP/IOC Guidelines on Survey and

Monitoring of Marine Litter. UNEP Regional Seas Reports and Studies, No. 186; IOC Technical Serious No. 83. Retrieved on 2nd May 2016 from: https:// www. nrc.govt.nz/media/10448/unepioclittermonitoringguidelines.pdf

Cheshire, A. C., Adler, E., Barbière, J., Cohen, Y., Evans, S., Jarayabhand, S., Jeftic, L., et al (2009). UNEP/IOC Guidelines on Survey and Monitoring of Marine Litter. UNEP Regional Seas Reports and Studies, No. 186; IOC Technical Serious No. 83. New York: USA.

Cialdini, R. B. (2003). Crafting normative messages to protect the environment. *Current Directions in Psychological Science, 12*(4), 105-109.

Cialdini, R. B., Reno, R. R., and Kallgren, C. A. (1990). A Focus Theory of Normative Conduct: Recycling the Concept of Norms to Reduce Littering in Public Places. *Journal of Personality and Social Psychology, 58(2),* 1015-1026.

Claessens, M., Meester, S. D., Landuyt, L. V., Clerck, K. D., and Janssen, C.R. (2011). Occurrence and distribution of micro plastics in marine sediments along the Belgian coast. *Marine Pollution Bulletin, 62(2),* 2199–2204.

Coe, J. M., and Rodgers, D. B. (eds) (1997). *Marine debris: sources, impacts and solutions. Springer-Verlag,* New York: Sage Publications.

Coffey, B. (1993). Investment incentives as a means of encouraging tourism development: The case of Costa Rica. *Bulletin of Latin American Research, 12(1),* 83-90.

Cole, M., P. Lindeque, *et al*. (2011). "Microplastics as contaminants in the marine environment: A review." *Marine Pollution Bulletin, 62(12),* 2588-2597.

Costanza, R., d'Arge, R., de Groot, R., Faber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S. et al (1997). The value of the world's ecosystem services and natural capital. *Journal of Nature, 387(2),* 253-260.

Debrot, A., Vinke, E., van der Wende, G., Hylkema, A., and Reed, J. (2014). Deep-water marine litter densities and composition from submersible video-transects around the ABC-islands, Dutch Caribbean. *Marine Pollution Bulletin, 88*(1-2), 361-365.

Denny, P. (1972). The significance of the pycnocline in tropical lakes. *African Journal of Tropical Hydrobiology and Fisheries* 2(2), 85-89.

Denny, P. (1973). Lakes of South-western Uganda II: vegetation studies on Lake Bunyonyi. *Freshwater Biology* 3(4), 123-135.

Denny, P. (1985a). Submerged and floating-leaved aquatic macrophytes (euhydrophytes). In the ecology and management of African wetland vegetation.

Denny, P. (1985b). The structure and functioning of African euhydrophyte communities: *The ecology and mmngt of African Wetland vegetation,* 125-152,

Denny, P. (1985c). *Wetland vegetation and associated life forms. In The ecology and*

Derraik, J. G. B. (2002). The pollution of the marine environment by plastic debris: a review. *Marine Pollution Bulletin* 44(2), 842-852.

Eadie, B. J., and Robbins, J. A. (1987).The role of particulate matter in the movement of contaminants in the Great Lakes. *Sources and fates of aquatic pollutants*. 3(1) 1 – 18.

Eisenreich, S. (1996). *Green Chemistry: An overview – ACS Symposium Series.* Washington, DC: American Chemical Society.

Engler, R. E. (2012). The complex Interaction between marine debris and toxic chemicals in the Ocean. *Environmental Science and Technology, 46(4)*, 12302–12315.

Eriksson, C., H. Burton, *et al*. (2013). "Daily accumulation rates of marine debris on sub Antarctic island beaches." *Marine Pollution Bulletin* 66(1–2), 199-208.

European Commission’s /DG Environment, (2011). Science for Environment Policy | In-depth Reports | Plastic Waste: Ecological and Human Health Impacts. The Science Communication Unit/ the University of the West of England, London, UK.

Fáilte, I. (2010). Visitor Attitudes Survey, CSO/Fáilte Ireland/TSB NISRA/Central Bank of Ireland.

Fleet, D., van Franeker, J. A., Dagevos, J., and Hougee, M. (2009). Marine litter. Thematic Report No. 38. In H. Marencic & J. Vlas, de (Eds.), Quality Status Report 2009. Wadden Sea Ecosystem No. 25. Common Wadden Sea Secretariat Wilhelmshaven, Germany, Trilateral Monitoring and Assessment Group.

Franeker, J. A. (2011). Monitoring plastic ingestion by the northern fulmar (Fulmarus glacialis) in the North Sea. *Environmental Pollution 159(2),* 2609–2615.

Free, C.M. (2014). High-levels of micro plastic pollution in a large, remote, mountain lake. *Marine Pollution Bulletin* 85(3), 156–163.

Galgani, F., Fleet, D.,van Franeker, J., and Katsanevakis, S., (2010). Marine Strategy Framework Directive Task Group 10 Report. Marine litter. London, UK.

Galgani, F., Hanke, G., Werner, S., Oosterbaan, L., Nilsson, P., Fleet, D., (2013). Monitoring guidance for marine litter in European Seas, JRC Scientific an Policy Reports, Report EUR 26113 EN, (p. 120).

Gregory, M. R. (2009). Environmental implications of plastic debris in marine settings entanglement, ingestion, smothering, hangers-on, hitch-hiking and alien invasions. *Philosophical Transactions of the Royal Society* 364(2), 2013 – 2025.

Hall, K., (2000). Impacts of Marine Debris and Oil: Economic and Social Costs to Coastal Communities. Prepared for the Shetland Islands Council. Environment & Transportation Department, New York, USA.

Hansmann, R., and Scholz, R. W. (2003). A Two-Step Informational Strategy for Reducing Littering Behavior in a Cinema, *Environment and Behavior. 35(2)*, 752-762.

Harper, D. M. (1992). *Eutrophication of freshwaters: principles, problems and restoration*. New York: Chapman & Hall.

Hidaidalgo-Ruz, V., and Thiel, M. (2013). Distribution and abundance of small plastic debris on beaches in the SE Pacific (Chile): A study supported by a citizen science project. *Marine Environmental Research,* 87(88), 12–18.

Hoellein, T. J., Westhoven, M., Lyandres, O., and Cross, J. (2015). Abundance and environmental drivers of anthropogenic litter on 5 Lake Michigan beaches: A study facilitated by citizen science data collection. *Journal of Great Lakes Research.* doi:10.1016/j.jglr.2014.12.015.

Holden, A. (2008). Environment and Tourism, Routledge, Oxon.Unwin Hyman, London. Imhof, H.K., Ivleva, N.P., Schmid, J., Niessner, R., and Laforsch, C. 2013. Contamination of beach sediments of a subalpine lake with microplastic particles. *Current Biology.* 23(19), R867-R868.

ICC, (2010). Trash Travels: From Our Hands to the Sea, Around the Globe, and Through Time available from: http://www.oceanconservancy.org/

Ivar do Sul, J. A., Santos, I. R., Friedrich, A. C. (2011). Plastic Pollution at a Sea Turtle Conservation Area in NE Brazil: Contrasting Developed and Undeveloped Beaches. *Estuaries and Coasts* 34(2), 814-823.

Jansson, A., Folke, C., and Langaas, S. (1998). Quantifying the nitrogen retention capacity of natural wetlands in the large scale drainage basin of the Baltic Sea. *Landscape Ecology 13(3)*, 249-262.

Jeftic, L., Sheavly, S., and Adler, E., (2009). *Marine Litter: A Global Challenge,* Washington DC: UNEP

Johnson, T. C. (1993). *IDEAL*: An *International Decade for the East African Lakes. Science and Implementation Plan. Bern*, Switzerland, PAGES Core Project Office.

Jones, M. M. (1995). Fishing debris in the Australian marine environment. *Mar. Pollut. Bul.30(2)*, 25-33.

June, J. A. (1990). Type, source, and abundance of trawl caught debris of Oregon, in the Eastern Bering Sea, and in Norton Sound in 1988. In R. S. Shomura & M. L. Godfrey (Eds.), Proceedings of the Second International Conference on Marine Debris, NMFSSWF-SC-154, US Department of Commerce, NOAA Technical Memo, 279–301.

Kaiser, J. (2010). The dirt on ocean garbage patches. *Science, 328(5985),* 1506-1506.

Kearney, M., Lawrence, W and Townshend, J. (1999). Coastal Marsh Project. Retrieved on 17 May 2007 from: http://www.geog.umd.edu/wetlands/index.htm

Koutsodendris A, Papatheodorou G, Kougiourouki O, Georgiadis M. (2008).Benthic marinelitter in four gulfs in GreecEastern Mediterranean: abundance, compositi on and source identification. *Es tuarine Coast Shelf Sci. 77(3),* 501-512.

Kühn, S., Bravo Rebolledo, E. L., and van Franeker, J. A. (2015). *Deleterious effects of litter on marine life. In M. Bergmann, L. Gutow & M. Klages (Eds.),* Marine anthropogenic litter Berlin: Springer.

Laegdsgaard, P. and Craig, J. (2001). Why do juvenile fish utilise mangrove habitats? *Journal of Experimental Marine Biology and Ecology* 257(2): 229-253.

Lamprech, A. (2013). The abundance, distribution and accumulation of plastic debris in Table Bay, Cape Town, South Africa. (Un published Masters dissertation).

Lind, E. M. and Morrison, E. S. (1974). *East African vegetation.* London: Longman Group.

Liu, T., Wang, M. W., and Chen, P. (2013). Influence of waste management policy on the characteristics of beach litter in Kaohsiung, Taiwan. *Marine Pollution Bulletin, 72,* 99–106.

Lukambuzi, L. (2006). Staff of the National Environment Council (NEMC) Tanzania. National Overview and Assessment on Marine Litter Related Activities in Tanzania (unpublished Final Consultancy Report, Dar-es-Salaam, Tanzania.

Lusher, A. L., Burke, A., O'Connor, I., and Officer, R. (2014). Micro plastic pollution in the Northeast Atlantic Ocean: validated and opportunistic sampling. *Marine Pollution Bulletin*. 88:325-333.

LVEMP, (2002). Integrated water quality/limnology study of Lake Victoria: Final technical report, COWI/DHI, Denmark.

LVEMP, (2002). Lake Victoria Environmental Management Project. The Lake Victoria Integrated Water Quality and Limnology Study. Dar-es-Salam, Tanzania.

Macfadyen, G., Huntington, T., and Cappell, R. (2009). Abandoned, lost or otherwise discarded fishing gear. UNEP Regional Seas Reports and Studies No. 185; FAO Fisheries and Aquaculture Technical Paper No. 523. Rome, Italy.

MacGranahan, G., Balk, D., and Anderson, B. (2007). The rising tide: Assessing the risks of climate change and human settlements in low elevation coastal zones. *Environmentand Urbanization, 19(2),* 17–37.

management of African wetland vegetation. Denny, P. (ed). Dordrecht: Dr. W. Junk Publishers.

Mnaya, B. and Wolanski, E. (2002). Water circulation and fish larvae recruitment in papyrus wetlands, Rubondo Island, Lake Victoria. *Wetlands Ecology and Management, 6(2),* 133-143.

Moore, C. J., Moore, S. L., Leecaster, M. K., and Weisberg, S. B. (2001). A Comparison of Plastic and Plankton in the North Pacific Central Gyre. *Marine Pollution Bulletin, 42(3),* 1297-1300.

Morritt, D., Stefanoudis, P. V., Pearce, D., Crimmen, O. A., and Clark, P. F. (2014). Plastic in the Thames: *Marine Pollution Bulletin, 78(3),* 196–200.

Mouat, J., Lozano, R., Bateson, H., (2010). Economic Impacts of Marine Litter. UN News Center, 2011. Trash in world's oceans threatens wildlife, economy and human health, UN warns, Geneva, Switzerland.

Oigman-Pszczol, S. S., and Creed, J. C. (2007). Quantification and classification of marine litter on beaches along Armação dos Búzios, Rio de Janeiro, Brazil. *Journal of Coastal Research, 23(2),* 421–428.

Palfreman, J. (2011). Waste Management and Recycling in Dar-es-Salaam. Retrieved on 13th February 2014 from: http://www.scribd.com/joshpalfreman.

Pham, C. K. (2014): Marine Litter Distribution and Density in European Seas, from the Shelves to Deep Basins. *PLoS ONE, 9(2),* 958 979.

Plastics Europe (2013). Plastics – the Facts 2013 An analysis of European latest plastics production, demand and waste data Plastics Europe (2015). Plasticsthe Facts. Retrieved on 11th May 2014 from: http://issuu.com/plasticseuropeebook/docs/final_plastics_the_facts_2014_19122

Rech, S., Macaya-Caquilpán, V., Pantoja, J. F., Rivadeneira, M. M., Jofre M. D., and Thiel, M. (2014). Rivers as a source of marine litter—A study from the SE Pacific. *Marine Pollution Bulletin,* 82(6), 66–75.

Ribic, C., Sheavly, S., Rugg, D., and Erdmann, E. (2012b). Trends in marine debris along the U.S. Pacifc Coast and Hawai'i 1998–2007. *Marine Pollution Bulletin,* 64(3), 994–1004.

Rosevelt, C., Los Huertos, M., Garza, C., and Nevins, H. M. (2013). Marine debris in central California: Quantifying type and abundance of beach litter in Monterey Bay, CA. *Marine Pollution Bulletin, 71*(1–2), 299–306.

Ryan, P. G. (2014). Litter survey detects the South Atlantic 'garbage patch'. *Marine Pollution Bulletin*, 79(3), 220–224.

Ryan, P. G. (2015). *A brief history of marine litter research. In M. Bergmann, L. Gutow & M. Klages (Eds.), Marine anthropogenic litter.* Berlin: Springer.

Sadre, S. S., and Thompson, R. C. (2014). On the quantity and composition of floating plastic Debris entering and leaving the Tamar Estuary, Southwest England. *Marine Pollution Bulletin,* 81(3), 55–60.

Schlining, K., Von Thun, S., Kuhnz, L., Schlining, B., Lundsten, L., and Jacobsen S. N. (2013). Debris in the deep: Using a 22-year video annotation database to survey marine litter in Monterey Canyon, central California, USA. *Deep-Sea Research* I, 79, 96–105.

Schnelle, J. F., McNees, M. P., Thomas, M. M., Gindrich, J. G. and Beagle G. P. (1980). Prompting behavior change in the community: use of mass media techniques. *Environment and Behaviour*, 12(3), 157–166.

Schulz, M., Neumann, D., Fleet, D. M., and Matthies, M. (2013). A multi-criteria evaluation system for marine litter pollution based on statistical analyses of OSPAR beach litter monitoring time series. *Marine Environmental Research,* 92*(1),* 61–70.

Seltenrich, N. (2015). New link in the food chain? Marine plastic pollution and seafood safety. *Environmental health perspectives*, *123*(2), 34 – 51.

Sheavly, S. B. (2007). National Marine Debris Monitoring Program: Final Program Report, Data Analysis and Summary. Prepared for U.S. Environmental Protection Agency by Ocean Conservancy, *Grant Number X83053401-02,* 76 – 94.

Shwartz,S.H (1977).Advances in Experimental Social Psychology, Edition:Vol.10, Publisher: Academic Press, Editors: Leonard Berkowitz, pp 221-271.

Sibley, C. G., and Liu, J. H. (2003). Differentiating Active and Passive Littering: A Two-Stage Process Model of Littering Behaviour in Public Spaces. *Environment and Behavior,* 35(2), 415-433.

Smith, S. D. A., and Markic, A. (2013). Estimates of marine debris accumulation on beaches are strongly affected by the temporal scale of sampling. *PLOS One,* 8(12), e83694.

Stefatos, A., M. Charalampakis, A. (1999). "Marine Debris on the Seafloor of the Mediterranean Sea: Examples from Two Enclosed Gulfs in Western Greece." *Marine Pollution Bulletin* 38(5), 389-393.

Thiel, M., I. A. Hinojosa, W. (2013). "Anthropogenic marine debris in the coastal environment: A Multi-year comparison between coastal waters and local shores." *Marine Pollution Bulletin,* 71(1–2), 307-316.

Thompson R. C., Olsen, Y., Mitchell, R. P., Davis, A., Rowland, S. J., John, A.W.G., McGonigle, D. and Russell, A. E., (2004). Lost at sea: where is all the plastic? *Journal of Science*, 304, 838.

Topçu, E. N., Tonay, A. M., Dede, A., Öztürk, A. A., and Öztürk, B. (2013). Origin and abundance of marine litter along sandy beaches of the Turkish Western Black Sea Coast. *Marine Environmental Research*, *85*(4), 21–28.

Turner, R. E. (1977). Intertidal vegetation and commercial yields of pen aerial shrimp. *Transactions of the American Fisheries Society 106(5),* 411-416.

Turra, A., Manzano, A., Dias, R., Mahiques, M., Silva, D., and Moreira, F. (2014). Three dimensional distribution of plastic pellets in sandy beaches: Shifting paradigms. *Nature Scientific Reports*, *4*, 4435.

United Nations Environment Programme (UNEP) (2005). *Marine Litter: An analytical overview*.

United Nations Environment Programme UNEP, (2005). *Solid Waste Management United Nations Environment Programme*, Geneva, Sage Publications.

Van Dyck, I. P., Nunoo, F. K. E., and Lawson, E. T. (2016). An Empirical Assessment of Marine Debris, Seawater Quality and Littering in Ghana. *Journal of Geoscience and Environment Protection*, 4(2), 21-36.

Van Franeker, J. A., Blaize, C., Danielsen, J., Fairclough, K., Gollan, J., Guse, N. (2011). Monitoring plastic ingestion by the northern fulmar Fulmarus glacialis in the North Sea. *Environmental Pollution*, 159(7), 2609–2615.

Verschuren, D., Johnson, T. C., Kling, H. J., Edgington, D. N., Leavit, P. R., Brown, E. T., Talbot, M. R., and Hecky, R. E. (2002). History and timing of human impact on Lake Victoria, East Africa. *Proc. R. Soc. Lond. 269(3),* 289-294.

Verschuren, D., Laird, K., and Cumming, B. F. (2000). Rainfall and drought in equatorial East Africa during the past 1,100 years. *Journal of Nature* 403(7), 410-414.

Watters, D. L., Yoklavich, M. M., Love, M. S., and Schroeder, D. M. (2010). Assessing marine debris in deep seafloor habitats off California. *Marine Pollution Bulletin*, 60, 131–138.

Wetzel, R. G., and G. E. Likens, (1991). *Limnological analysis – 2nd edition.* New York: Springer.

Wilcox, C., Van Sebille, E., and Hardesty, B. D. (2015). Threat of plastic pollution to seabirds is global, pervasive, and increasing. *Proceedings of the National Academy of Sciences*, 112(38), 11899-11904.

World Bank, (1996). *Project Document for the Lake Victoria Environmental Management Project.* Washington, DC: The World Bank.

Wright, S. L., Thompson, R. C., and Galloway, T. S. (2013). The physical impacts of micro plastics on marine organisms: a review. *Environmental Pollution, 178(3),* 483 492.

Yoon, J., Kawano, S., and Igawa, S. (2010). Modeling of marine litter drift and beaching in the Japan Sea. *Marine Pollution Bulletin,* 60(3), 448–463.

Zbyszewski, M., Corcoran, P. L., and Hockin, A. (2014). Comparison of the distribution and degradation of plastic debris along shorelines of the Great Lakes, North America. *Journal of Great Lakes Research* 40: 288-299.

APPENDICES

Appendix I: Data Collection Form 1: Sources of the Litter

Source of litter (kg)			Site name		Coordinates			
	Domestic	industrial	commercial	Fishing	Agriculture	Individual activities	Recreational	Other activities

Appendix II: Data Collection Form 2: Type of Litter

Categories of litter(kg)			Site name		Coordinates			
	Plastics (wt-kg)	Glass (wt-kg)	Wood (wt-kg)	Fishnets (wt-kg)	Rubber (wt-kg)	Clothes (wt-kg)	Metal (wt-kg)	Other (wt-kg)

Appendix III: Data Collection Form 3: Categories of the Litter

Source of litter (No. of items)			**Site name**		**Coordinates**			
	Domestic	industrial	commercial	Fishing	Agriculture	Individual activities	Recreational	Other activities

Appendix IV: Questions to selected TANAPA Boat Drivers

Do the wastes left in water and along lake shores have any effect to wildlife in RINP?

Yes

No

If the answer to the question above is YES, which effects have litter caused to wild animals (mammals, birds, reptiles, etc) in RINP?

Do litter have any effect to your boat when driving?

Yes

No

If the answer to question 3 above is YES, mention affects you have encountered with litter when driving?

Appendix V: Research Clearance

THE OPEN UNIVERSITY OF TANZANIA
DIRECTORATE OF, POSTGRADUATE STUDIES

Kawawa Road, KinondoniMunicipality,
P.O. Box 23409
Dar es Salaam, Tanzania
http://www.out.ac.tz

Tel: 255-22-2666752/2668445
Ext.2101
Fax: 255-22-2668759,
E-mail:drps@out.ac.tz

Date: 18th December 2017.

Our Ref: PG201609059

Director General,
Tanzania National Park,
P . o Box 3134,
Arusha.

RE: RESEARCH CLEARANCE

The Open University of Tanzania was established by an act of Parliament No. 17 of 1992, which became operational on the 1st March 1993 by public notice No. 55 in the official Gazette. The act was however replaced by the Open University of Tanzania charter of 2005, which became operational on 1st January 2007. In line with the later, the Open University mission is to generate and apply knowledge through research.

To facilitate and to simplify research process therefore, the act empowers the Vice Chancellor of the Open University of Tanzania to issue research clearance,on behalf of the Government of Tanzania and Tanzania Commission for Science and Technology,to both its staff and students who are doing research in Tanzania. With this brief background, the purpose of this letter is to introduce to you **Mr John Ignase Gara Reg No : PG201609059** pursuing **Master of Arts in Natural Resources Assessment and Management**. **(MANRAM**).We here by grant this clearance to conduct a research titled***"The effect of the Litter on the shoreline, A case of Rubondo Island National Park.''He*** will collect his data in Arusha Region From 18th December 2017 to 19th January 2018.

Incase you need any further information, kindly do not hesitate to contactthe Deputy Vice Chancellor (Academic) of the Open University of Tanzania, P.O. Box 23409, Dar es Salaam. Tel: 022-2-2668820.We lastly thank you in advance for your assumed cooperation and facilitation of this research academic activity.

Yours sincerely,

Prof HosseaRwegoshora
For: VICE CHANCELLOR
THE OPEN UNIVERSITY OF TANZANIA

Appendix VI: Permission to Conduct Research

TANZANIA NATIONAL PARKS
OFFICE OF THE DIRECTOR GENERAL
P.O.BOX 3134, ARUSHA - TANZANIA

Ref. No: TNP/HQ/E.20/08 B

Date: 21/01/2018

Director,
Open University of Tanzania,
P.O. Box 19,
ARUSHA.

Att: Prof. Hossea Rwegoshora

RE: RESEARCH CLEARANCE

This is in response to your letter Ref. No. PG201609059 dated 18th December, 2017 regarding the subject above.

I am pleased to inform you that free permit is hereby granted to Mr. John Ignas Gara (Master of Arts in Natural Resources Assessment and Management – MANRAM) to enter Rubondo Island National Park and conduct a research project titled ***"The effect of the litter on the shoreline, A case of Rubondo Island National Park"*** from 18th December, 2017 to 19th January, 2018.

All national park rules and regulations to be observed.

Yours sincerely,
TANZANIA NATIONAL PARKS.

Massana G. Mwishawa
For: **DIRECTOR GENERAL**

Copy: Chief Park Warden - Rubondo Island.