NILE-SEC
NILE BASIN INITIATIVE
INITIATIVE DU BASSIN DU NIL

NBI Technical Reports: Water Resource Management Series

Plastic Waste Transport from the Nile River and its Major Tributaries into the Marine Environment

WRM-2022-11

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

On behalf of:
Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety
of the Federal Republic of Germany

Document Sheet

This Technical Report series publishes results of work that has been commissioned by the member states through the three NBI Centers (Secretariat based in Entebbe- Uganda, the Eastern Nile Technical Regional Office based in Addis Ababa - Ethiopia and the Nile Equatorial Lakes Subsidiary Action Program Coordination Unit based in Kigali - Rwanda. The content there-in has been reviewed and validated by the Member States through the Technical Advisory Committee and/or regional expert working groups appointed by the respective Technical Advisory Committees.

The purpose of the technical report series is to support informed stakeholder dialogue and decision making in order to achieve sustainable socio-economic development through equitable utilization of, and benefit from, the shared Nile Basin water resources.

Document	
Citation	NBI Technical Reports - WRM-2022-11
Title	Plastic Waste Transport from the Nile River and its Major Tributaries into the Marine Environment
Series Number	Water Resources Management 2022-11
Date	September 2022
Responsible and Review	
Responsible NBI Center	Nile-Secretariat
Responsible NBI	Dr Modathir Zaroug and Dr Michael Kizza
Document Review Process	Marine Pollution Regional Expert Working Group, May 2022
Author / Consultant	
Consultant Firm	Black Forest Solutions GmbH
Author	Tarun Shesh, Daniela Tavera, Gheed Asa'ad
Project	
Funding Source	German Federal Ministry for the Environment and Nuclear Safety (BMU)
Project Name	Marine Debris Framework - Regional hubs around the globe (Marine: DeFRAG)

Table of Contents

TABLE OF CONTENTS III

LIST OF FIGURES V

LIST OF TABLES VI

LIST OF ABBREVIATIONS IX

EXECUTIVE SUMMARY 1

1. INTRODUCTION 3

1.1. Plastic Pollution Context 3
1.2. Project Background 5
1.3. Project Objectives 6

2. METHODOLOGY 7

2.1. Overall Methodology 7
2.2. Waste Flow Diagram (WFD) 7
2.3. Case Study Country Methodology 8

3. WASTE MANAGEMENT STATUS QUO 9

3.1. Waste Management Flow of Nile Basin Countries 9
3.1.1. Burundi 12
3.1.2. DR Congo 13
3.1.3. Ethiopia 13
3.1.4. Kenya 14
3.1.5. Rwanda 16
3.1.6. South Sudan 17
3.1.7. Sudan 18
3.1.8. Tanzania 19
3.1.9. Uganda 20
3.2. Additional Findings and Identified Gaps 21

4. LEGISLATIVE FRAMEWORK 26

4.1. Legal System 26
4.2. Key Players 27
4.3. Implementation, Enforcement, and Penalties 28

5. MAIN CONTRIBUTORS 31

6. WASTE GENERATION HOTSPOTS 34

6.1. Identified Marine and Riverine Litter Hotspots 34
6.2. WFD – Ethiopia 41
6.3. WFD – Kenya 41
6.4. WFD – Rwanda 43

6.5. WFD – Sudan 43
6.6. WFD – Uganda 43
6.7. WFD – Conclusions 45
7. HOLISTIC OVERVIEW OF PLASTIC TRANSPORT WITHIN NILE BASIN 46
7.1. Nile Basin Hydrology 46
7.2. Macro and Micro Plastic Transport 48
8. RECOMMENDATIONS AND CONCLUSIONS 51
8.1. Recommendations 51
8.2. Conclusions 53
9. REFERENCES 55
10. ANNEXES 59
10.1. Annex A – Waste Management flow 59
10.1.1. Burundi 59
10.1.2. DR Congo 60
10.1.3. Ethiopia 61
10.1.4. Kenya 63
10.1.5. Rwanda 65
10.1.6. South Sudan 66
10.1.7. Sudan 68
10.1.8. Tanzania 71
10.1.9. Uganda 74
10.2. Annex B – Local Expert Reports 78
10.3. Annex C – Legislative Frameworks 79
10.4. Annex D – Main Contributors of Marine Litter 81
10.4.1. Ethiopia 81
10.4.2. Kenya 82
10.4.3. Rwanda 83
10.4.4. Uganda 84
10.5. Annex E – Marine Litter Hotspots 86
10.5.1. Ethiopia 86
10.5.2. Kenya 87
10.5.3. Rwanda 88
10.5.4. Sudan 90
10.5.5. Uganda 91
10.5.6. Nile Basin 93
10.6. Annex F – Country Case Study Reports 94
10.6.1. Ethipoa 94
10.6.2. Kenia 94
10.6.3. Rwanda 94
10.6.4. Sudan 94
10.6.5. Uganda 94

List of Figures

Figure 1.1: Sources of marine litter. Source: (Ayoub, 2018). 4

Figure 3.1: Financial constraints resulting in poor SWM services. Source: (Teshome, 2020)..... 12

Figure 3.2: Volumes of collected waste in different parts of the country in Kenya. Source: Local expert (Kenya). 15

Figure 3.3: Schematic representation of a typical MSWM in Kenya's urban areas with its subsystems or subsets. Source: Local expert (Kenya). 23

Figure 5.1: Non-recyclable plastic waste abandoned at Kitezi landfill, Uganda. Source: Local expert (Uganda)..... 32

Figure 6.1: Kenya plastic material flow 2018. Source: Local expert (Kenya). 42

Figure 6.2: Kampala drainage channel choked by plastics. Source: Local expert (Uganda). 44

Figure 7.1: Impact of the Nile River on all the countries in its catchment area. Source: (Nile Basin Initiative, n.d.-b). 46

Figure 7.2: The total flows of the Nile in billion cubic meters per year considering river flows, inflows, and evaporative losses. Source: (Onencan & Van de Walle, 2018). 48

Figure 7.3: Overview of the plastic leakage in the Mediterranean basin for macroplastics and microplastics. Source: (Boucher & Billard, 2020). 50

Figure 10.1: Map of Ethiopia with reference to the Nile. Source: (Austria Forum, 2014). 86

Figure 10.2: Potential marine litter sources in Kenya's LVDB. Source: Local expert (Kenya). 87

Figure 10.3: Hydrological map of Rwanda with a focus on the rivers constituting the Nile River in Rwanda. Source: Local expert (Rwanda). 88

Figure 10.4: Potential marine litter sources in Rwanda. Source: Local expert (Rwanda). 89

Figure 10.5: Potential marine litter sources in Sudan. Source: Local expert (Sudan). 90

Figure 10.6: Map of cities determined to be hotspots in relation to the Nile Basin. 91

Figure 10.7: Location of waste collection dumpsites in Kampala and parts of Kira Municipal Council. Source: Local expert (Uganda)..... 92

Figure 10.8: Mapping of all hotspots identified in the Nile Basin countries. Source: BFS. 93

List of Tables

Table 1.1: Comparison of mismanaged plastic waste quantities between coastal African countries and other significant global contributors. Adapted from: (Akan et al., 2021; Jambeck et al., 2015). 5

Table 3.1: Waste management flow summary for the Nile Basin countries. Source: BFS. 9

Table 4.1: Key institutional entities and relevant responsibilities participating in national MSWMS. Source: Local experts. 27

Table 4.2: National plastic bag bans in Africa. Source: Adapted from (Greenpeace Africa, 2020). 29

Table 6.1: Marine and riverine litter hotspots in the Nile Basin countries. Source: Local experts. 34

Table 6.2: Key conclusions from the WFD for Kenya. Source: Local expert (Kenya). 42

Table 6.3: Key conclusions from the WFD for Sudan. Source: Local expert (Sudan). 43

Table 6.4: Key conclusions from the WFD for Uganda. Source: Local expert (Uganda). 44

Table 7.1: Sub-basins of the Nile River. Source: (Nile Basin Initiative, n.d.-b). 47

Table 10.1: General information about Burundi regarding populations, country area and area in the Nile Basin and waste generation rate. Source: (Nile Basin Initiative, n.d.-a; World Bank, n.d.). 59

Table 10.2: Waste management flow in Burundi. Source: (CIA, n.d.). 59

Table 10.3: Waste management flow in Bujumbura. Source: (Manirakiza et al., 2020). 60

Table 10.4: General information about DR Congo regarding populations, country area and area in the Nile Basin and waste generation rate. Source: (CIA, n.d.; Nile Basin Initiative, n.d.-a; World Bank, n.d.). 60

Table 10.5: Waste management flow in DR Congo. Source: (Scarlat et al., 2015). 61

Table 10.6: Waste management flow in Kinshasa. Source: (Antea Group, n.d.; *Kinshasa_EN*, n.d.). 61

Table 10.7: General information about Ethiopia regarding population, area and area in the Nile Basin and waste generation rate. Source: (Nile Basin Initiative, n.d.-a; World Bank, n.d.). 61

Table 10.8: Waste management flow in Ethiopia. Source: Local expert. 62

Table 10.9: General information about Kenya regarding population, area and area in the Nile Basin and waste generation rate. Source: (Nile Basin Initiative, n.d.-a; World Bank, n.d.). 63

Table 10.10: Waste management flow in Kisumu. Source: (Sibanda et al., 2017). 63

Table 10.11: Waste management plastic in Kenya. Source: (IUCN-EA-QUANTIS, 2020). 64

Table 10.12: General information about Rwanda regarding populations, country area and area in the Nile Basin and waste generation rate. Source: (Nile Basin Initiative, n.d.-a; World Bank, n.d.). 65

Table 10.13: Waste Management flow in Rwanda. Source: Local expert. 65

Table 10.14: General information about South Sudan regarding populations, country area and area in the Nile Basin and waste generation rate. Source: (Nile Basin Initiative, n.d.-a; World Bank, n.d.). 66

Table 10.15: Waste management flow in Juba City. Source: (Egypt Ethiopia Kenya South Sudan Uganda & Victoria Tekeze Atbara Bahr el Jebel Baro Akobbo Sobat Victoria Nile Lake Albert, n.d.; Japan International Cooperation Agency (JICA), 2018; Mier & Zhuo, 2020; NILE BASIN INITIATIVE, n.d.). 67

Table 10.16: General information about Sudan regarding populations, country area and area in the Nile Basin and waste generation rate. Source: (CIA, n.d.; Osman, 2020). 68

Table 10.17: Waste management flow in Sudan. Source: (Osman, 2020). 68

Table 10.18: Waste management flow in Khartoum State. Source: (Japan International Cooperation Agency, 2017). 69

Table 10.19: Waste management flow in Blue Nile State. Source: (Osman, 2020). 69

Table 10.20: Waste Management flow in River Nile (State). Source: (Osman, 2020). 70

Table 10.21: General information about Tanzania regarding population, area and area in the Nile Basin and waste generation rate. Source: (Vice President's Office of United Republic of Tanzania, 2020; Victoria Basin Water Board, 2021; World Bank, n.d.; World Development Indicators, n.d.). 71

Table 10.22: Waste management flow in Tanzania. Source: (Ntakamulenga, n.d.; Tanzania National Bureau of Statistics, 2021; World Development Indicators, n.d.). 71

Table 10.23: Waste management flow in Dar el Salaam. Source: (Joshua Palfreman, 2015; *UNITED REPUBLIC OF TANZANIA THE NATIONAL SOLID WASTE MANAGEMENT STRATEGY*, 2018). 72

Table 10.24: Plastic waste management flow in Tanzania. Source: (Joshua Palfreman, 2015; *UNITED REPUBLIC OF TANZANIA THE NATIONAL SOLID WASTE MANAGEMENT STRATEGY*, 2018). 73

Table 10.25: Plastic waste management flow in urban Mwanza. Source: (Joshua Palfreman, 2015; *UNITED REPUBLIC OF TANZANIA THE NATIONAL SOLID WASTE MANAGEMENT STRATEGY*, 2018)..... 74

Table 10.26: General information about Uganda regarding populations, country area and area in the Nile Basin and waste generation rate. Source: (Government of Uganda, n.d.; Nile Basin Initiative, n.d.-a; World Bank, n.d.; Yusuf et al., 2019). 74

Table 10.27: Waste management flow in Uganda. Source: Local expert. 75

Table 10.28: Waste management flow in Kampala. Source: Local expert. 75

Table 10.29: Waste management flow in Fort Portal, Jinja, Mbarara, Kasese, Mbale and Soroti. Source Local expert. 77

Table 10.30: Names of the supplementary country reports. 78

Table 10.31: Key legislative frameworks enacted in non-case study countries. 79

Table 10.32: List of institutions and organizations identified as marine litter contributors to Lake Tana, Bahir Dar. Source: Local expert (Ethiopia). 81

Table 10.33: List of institutions and organizations identified as marine litter contributors in Kenya. Source: Local expert (Kenya). 82

Table 10.34: List of institutions and organizations identified as marine litter contributors in Rwanda. Source: Local expert (Rwanda). 83

Table 10.35: Selective summary of major plastic manufacturing and recycling facilities in Uganda. Source: Local expert. 84

List of Abbreviations

BFS	BlackForest Solutions GmbH
BMUV	Federal Ministry for the Environment, Nature Conservation, Nuclear Safety, and Consumer Protection
CDA	Community Development Association
DAS	Directorate of Sanitation
DeFRAG	Marine Debris Framework - Regional Hubs Around the globe
EAC	East African Community
EPA	Environmental Protection Act
EMCA	Environment Management and Coordination Act
EPR	Extended Producer Responsibility
EU	European Union
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GKMA	Greater Kampala Metropolitan Area
GGGI	Global Green Growth Institute
HDPE	High Density Polyethylene
ISWA	International Solid Waste Association
IUCN	International Union for Conservation of Nature
JCC	Juba City Council
JICA	Japan International Cooperation Agency
KCCA	Kampala Capital City Authority
LVDB	Lake Victoria Drainage Basin
MEDD	Ministry of Environment and Sustainable Development
MoE	Ministry of Environment
MoTI	Ministry of Trade and Industry
MSME	Micro, Small, and Medium Enterprise
MSP	Ministère de la Santé Publique et la Direction de l'Hygiène
MSW	Municipal Solid Waste
MSWMS	Municipal Solid Waste Management System
NBI	Nile Basin Initiative
NEA	National Environment Act
NEMA	National Environment Management Authority
NGO	Non-Governmental Organization
PET	Polyethylene Terephthalate
PRO	Producer Responsibility Organization
REMA	Rwanda Environmental Management Authority
RURA	Rwanda Utilities Regulatory Authority
RWF	Rwandan Franc
SDG	Sudanese Pound
SUP	Single Use Plastic

SWM	Solid Waste Management
UMA	Uganda Manufacturers Association
USD	US Dollar
WFD	Waste Flow Diagram

Executive Summary

Due to several factors such as rapid urbanization and population growth, the amount of plastic consumption in Africa has been steadily increasing. When coupled with a weak waste management infrastructure, the result is an enormous amount of mismanaged waste. This could pose a concern especially for countries in the Nile Basin since mismanaged waste may often end up in the Nile River and subsequently, the Mediterranean Sea. Plastic pollution is known to have several severe negative environmental, social, and economic impacts.

Considering the need for action and a lack of research on the topic in the African context, the Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) in conjunction with the Nile Basin Initiative (NBI) employed BlackForest Solutions GmbH (BFS) to produce a sccoping report to establish the current level of plastic waste pollution transported by the Nile. A holistic approach was adopted to develop this report by considering all ten Nile Basin countries. Six countries were selected as case study countries where local experts were selected and deployed to collect primary data and utilize a waste flow mapping tool known as the Waste Flow Diagram (WFD). Egypt, as the country from which the Nile River flows into the Mediterrean Sea, is of particular relevance when researching the plastic pollution of the Nile and the flow into marine environment. As Egypt has frozen its participation in technical work but is still an NBI State, it was therefore agreed with NBI to prepare a separate report to complete the topic of plastic pollution of the Nile River.

To mitigate the plastic pollution problem, it is important to understand existing municipal solid waste management systems (MSWMS) and practices, driving legislative frameworks, and sources of waste generation. This report is organized in the following chapters to achieve the goals outlined:

- Chapter 2 highlights the methodology used by the local consultant and BFS to gather primary and secondary data.
- Chapter 3 provides an overview of the waste management status quo to identify underlying issues and gaps in the waste management value chain.
- Chapter 4 covers the underlying legislative and regulatory frameworks focusing on the enforcement and implementation mechanisms.
- Chapter 5 summarizes the key plastic waste generating stakeholders and geographical locations.
- Chapter 6 maps the major waste generating hotspots relevant to the Nile River regarding the Waste Flow Diagram (WFD) utilized to map municipal solid waste (MSW) flows.
- Chapter 7 details plastic transport mechanisms within the Nile Basin accounting for hydrological factors.
- Finally, Chapter 8 presents overall recommendations and conclusions for future work.

Based on primary and secondary data collection, despite progressive developments in a few countries, the waste management sector in most countries was characterized by a lack of legislative frameworks with concrete targets, marginalization of the informal sector, inadequate private sector involvement, lack of enforcement of existing regulations, low collection rates, illegal waste dumping, and lack of funding. Several plastic pollution hotspots were identified based on-site visits, literature review, GIS assessment, economic activity analysis, and proximity to the Nile Basin. Due to lack of data, there are potentially many more hotspots that could not be identified.

Several recommendations were provided based on the gaps identified in the waste management sector and existing regulatory frameworks. These recommendations mainly addressed the issues of sparse data availability on macro and microplastic waste generation and transport, strengthening legislative frameworks and enforcement authorities, encouraging stakeholder participation in the waste management sector, and a list of desirable future research.

While the purpose of the sccoping report is simply to detail the current status quo, the gap analysis conducted here will be addressed in a policy brief in the next phase of the project. The policy brief will consist of best practice recommendations targeting the gaps identified in the scoping report tailored to the local context.

1. Introduction

1.1. Plastic Pollution Context

Ensuring the provision of sufficient collection and disposal services for municipal solid waste (MSW) is a global challenge, particularly in low- and middle-income countries. Current estimates suggest that approximately 2 billion people globally do not have access to waste collection services, and the waste of 3 billion people is managed in an environmentally unsound manner (Wilson et al., 2015). Inadequate solid waste management (SWM) services and waste mismanagement adversely impact human health and the environment. A rapidly emerging and undesirable by-product is plastic pollution.

Over 6,300 million tonnes of plastic have been produced since the 1950s, with global production of plastic reaching 348 million tonnes in 2017 (Geyer et al., 2017; Lyons et al., 2020). The plastic production volume is expected to double over the next twenty years. Almost 79% of plastic waste generated accumulates in landfills or the natural environment, while only 9% is recycled and 12% is burned or incinerated (Geyer et al., 2017). Plastic pollution currently causes and has the potential to cause severe danger to flora and fauna, blocks drainage systems, canals, and other waterways resulting in floods, degrades landscapes, and is ubiquitous in the environment, even in the food chain (Akan et al., 2021; Geyer et al., 2017). In addition to negative environmental impacts, plastic pollution has an enormous socio-economic impact, with estimates suggesting that globally, 13 billion USD worth of economic damage could be done to marine ecosystems (Lyons et al., 2020).

Marine litter can be defined as “any persistent, manufactured, or processed solid material that is discarded, disposed of, or abandoned in the marine and coastal environment (UNEP, 2009).” Marine litter poses a severe challenge to society in terms of environmental, economic, social, political, and cultural impacts (Vlachogianni, n.d.). Plastic-based items comprise the largest and most harmful component of marine litter (Lyons et al., 2020). As a result of the mismanagement of plastic waste, approximately 8 – 13 million tonnes of plastic have been estimated to be released into marine ecosystems annually in addition to other marine debris (Alimi et al., 2021; Lyons et al., 2020).

Marine litter typically originates from two sources, as shown below in Figure 1.1:

Figure 1.1: Sources of marine litter. Source: (Ayoub, 2018).

- Land-based sources include littering beaches and coastal areas, untreated municipal sewerage, industrial outfalls, discharge from storm water drains, and landfills.
- Sea-based sources include the fishing industry, shipping and marine transportation, offshoring mining and extraction, and illegal dumping.

Seas and oceans inevitably serve as a major sink for plastics as approximately 80% of marine litter are estimated to originate from land-based sources (Eunomia, 2016). The accuracy of this estimate is questionable because the magnitude of marine litter pollution via sea-based sources is poorly understood and quantified (Gilardi et al., 2020). Inadequate waste collection infrastructure and weak waste management practices, especially within low- and middle-income settings, contribute to this phenomenon in terms of macroplastics leakage. Rapid rates of urbanization and increasing resource consumption further exacerbate these issues by placing an additional burden on an already weak infrastructure. Macroplastic and larger microplastic items undergo further degradation in marine ecosystems, resulting in secondary microplastics that are challenging to control. Thus, it is necessary to tackle the issue of plastic pollution at its source before entry into aquatic ecosystems.

Information on marine litter-related plastic pollution in the Mediterranean and Africa remains sparse even though the Mediterranean Sea is widely accepted to be one of the most affected seas worldwide (Vlachogianni, n.d.). Between 1990 and 2017, approximately 86.1, 31.5, and 230 million metric tonnes of primary polymers, plastics, and plastic components, respectively, were

imported into Africa, from which 17 million metric tonnes were mismanaged (Akan et al., 2021). As shown in Table 1.1, Egypt is one of the major contributing nations to marine debris. Less populated African countries such as Burundi, Gambia, and Cape Verde generate and mismanage lower waste volumes (approximately 3 – 6 metric tonnes in 2015) (Akan et al., 2021; Vlachogianni, n.d.). Effective measures to tackle marine litter have been hampered by a lack of reliable data, ineffective regulations, poor monitoring, and slow adoption of beneficial practices by governments. This has led to an increase in plastic volumes in Africa.

Table 1.1: Comparison of mismanaged plastic waste quantities between coastal African countries and other significant global contributors. Adapted from: (Akan et al., 2021; Jambeck et al., 2015).

World ranking	Country, population (2010)	Waste generation rate (kg/person per day)	% of Waste that is Plastic	% Mismanaged waste	Plastic waste (million metric tonnes per year)	% Mismanaged plastic waste	Marine debris (million metric tonnes (MMT) per year)
1	China – 1,368,810,615	1.10	11	76	8.82	27.7	1.32 – 3.53
7	Egypt, 82,761,235	1.37	13	69	0.97	3.0	0.15 – 0.39
9	Nigeria – 158,503,197	0.79	13	83	0.85	2.7	0.13 – 0.34
11	South Africa – 51,216,964	2.0	12	56	0.63	2.0	0.09 – 0.25
12	India – 1,234,281,170	0.34	3	87	0.60	1.9	0.09 – 0.24

1.2. Project Background

Since July 2020, the Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) Marine Litter Project has been supporting the Federal Ministry for the Environment, Nature Conservation,Nuclear Safety and Consumer Protection (BMUV) in the implementation of the funding program "Marine Debris Framework - regional hubs around the globe (DeFrag)". The funding program addresses the support of developing and emerging countries in their efforts to establish appropriate waste collection and recycling systems to avoid marine litter.

The GIZ Marine Litter Project provides the BMUV with needs-based advice. For this project, the GIZ supports consultation in initiating first measures with innovative and transferable solutions to tackle marine litter. Thus, the project intends to cooperate with the Nile Basin Initiative (NBI) to explore ways to collaborate in mitigating plastic pollution to reduce plastic waste transported by the Nile. Given the high scarcity of data for the Nile Basin, a critical initial step is compiling and analyzing secondary data. Therefore, the GIZ employed BlackForest Solutions GmbH (BFS) to aid

in the development of a scoping report that indicates the current level of plastic waste pollution transported by the Nile and the key catchment source areas based on secondary data.

BFS proposed a methodology for data and information collection which was improved and cleared by the NBI. The methodology covered all Nile Basin countries but focused on six case studies, Egypt, Ethiopia, Kenya, Rwanda, Sudan, and Uganda, to produce the sccoping report. Hence, local consultants with experience and knowledge about the municipal waste management sector, relevant legislation, packaging industry, fishing sector, and circular economy initiatives were utilized to gather information in the selected case study countries.

1.3. Project Objectives

The main objective of this project was to achieve a comprehensive understanding of the current level of plastic waste pollution transported by the Nile Basin. Such analysis served as the basis for a scoping report.

The specific objectives of the assignment were:

- To establish the current level of knowledge on plastic (macro and micro) waste transport by the Nile River to the Mediterranean Sea.
- To prepare a scoping report on the source and volume of plastic waste entering the Nile River from various catchment areas.
- To raise awareness through an NBI policy briefing with recommendations on key areas for further activities.

This scoping report addresses only the first two objectives mentioned above. The NBI policy briefing will be elaborated as a separate deliverable.

2. Methodology

2.1. Overall Methodology

The scope of the project necessitated extensive gathering, collation, and processing of secondary data supplemented by expert interviews. Six countries in the Nile Basin were selected as case studies based on time and budgetary constraints from the ten countries in the Nile Basin. An assessment matrix was developed to evaluate the Nile Basin countries based on waste management data availability, presence of waste management experts, geographical relevance, and marine and riverine litter data availability. The outcome was that Egypt, Ethiopia, Kenya, Rwanda, South Sudan, and Uganda were selected as the case study countries. This report covers all the Nile Basin countries except Egypt.

After selecting the case study countries, local experts were selected in a recruitment process based on their experience and knowledge, and subsequently deployed for primary and secondary data collection in their respective countries.

An elaborate data collection survey was developed by BFS to support the local experts in the data collection exercise. The data collection survey included parameters to collect information on the waste management system status quo, identified gaps in the system, potential sources of waste leakages and socio-economic impacts, regulatory frameworks, marine and riverine litter hotspots, and any initiatives to tackle the plastic pollution problem.

2.2. Waste Flow Diagram (WFD)

A modelling tool called the Waste Flow Diagram[1] was utilized as a rapid-assessment tool to map macrowaste flows in a Municipal Solid Waste Management System (MSWMS) at the city or municipality level. The WFD required the input of information related to:

- City or municipality demographics.
- MSW generation.
- MSW composition
- Disposal methods per waste fraction.
- Informal sector involvement.
- Visual observations of plastic waste leakage across the waste management value chain.

The WFD quantifies the sources and fates of any plastic pollution across the MSWMS. Since the WFD is a rapid-assessment tool, it trades detail and accuracy for quick, first-level approximations

[1] www.giz.de/expertise/html/62153.html

requiring fewer data points. There were other tools available apart from the WFD; however, these were more comprehensive, requiring extensive data collection. Local experts were trained by BFS on the usage of the WFD.

2.3. Case Study Country Methodology

Wherever possible, a mixed-methods research approach was utilized to obtain both qualitative and quantitative data from primary and secondary sources. Desktop research, field visits, and stakeholder consultations were relied on to gather information based on the data collection survey developed by BFS and GIZ.

Desktop research was primarily centred on mapping relevant stakeholders in the waste management value chain, gathering data related to MSW and plastic waste quantities, establishing the MSWM status quo, and analyzing prevailing legislative frameworks. Data collection focused on waste generation hotspots relevant to the Nile Basin.

Stakeholder consultations were utilized to seek information from relevant public-sector and industrial officials related to the intricacies of the MSWM value chain. Such interviews served as an aid in conducting a gap analysis.

Finally, a map of key waste generation hotspots along the Nile River was produced to demonstrate the linkages between waste generation, disposal, and potential flows of waste from sources to waterways and the possibility of transport.

3. Waste Management Status Quo

This chapter aims to provide an overview of the Nile basin countries´ related waste management information. Local experts and BFS collected data for case study countries and non-case study countries, respectively.

3.1. Waste Management Flow of Nile Basin Countries

Table 3.1 summarizes the waste management flow of the Nile Basin countries (Burundi, DR Congo, Ethiopia, Kenya, Rwanda, South Sudan, Sudan, Tanzania, and Uganda).

Table 3.1: Waste management flow summary for the Nile Basin countries. Source: BFS.

Country	MSW Generation	Waste Collection	Waste Disposal	Recycling
Burundi	➢ 1.87 million tonnes/year (2002) (*The World Factbook - The World Factbook*, n.d.).	➢ The collection occurs once a week. ➢ Door-to-door collection by private associations.	➢ Solid waste is disposed in unregulated dumpsites.	➢ Information not available.
DR Congo	➢ 4.64 million tonnes/year (2012) (Scarlat et al., 2015).	➢ Information not available.	➢ Uncontrolled dumping of waste in urban spaces and landfills.	➢ Information not available.
Ethiopia	➢ 0.23 – 2.03 kg/person/day. ➢ 6 million tonnes/year (2015) (Tassie et al., 2019; Teshome, 2020; *The World Factbook - The World Factbook*, n.d.).	➢ Door-to-door waste collection by informal sector. ➢ Curbside collection is the second most commonly used collection system operated by city administration units. ➢ Set out collection system is used. ➢ Residents deposit their trash into pushcarts and	➢ Uncontrolled dumping of waste in urban spaces and landfills.	➢ Dumpsite pickers collect recyclables and reusable materials at landfills and sell them to intermediaries or recycling companies.

Country	MSW Generation	Waste Collection	Waste Disposal	Recycling
		take it to the transport truck.		
Kenya	➢ 11 kg/person/year (plastic waste) (Sibanda et al., 2017).	➢ Mix of public, informal, and privatized SWM models. ➢ Average collection rate of 27%.	➢ Illegal, unsanitary landfills which are often operating over capacity.	➢ 7% of the generated plastic waste is recycled. ➢ Recycling sector is largely informal in nature.
Rwanda	➢ 0.4 – 0.7 kg/person/day. ➢ 232,870 tonnes/year (REMA, 2021).	➢ SWM is privatized and managed by several waste collection companies. ➢ Waste collection fee charged based on economic status of households.	➢ Collected waste transported to uncontrolled landfills and open dumpsites managed by private companies and selected by municipalities. ➢ Most landfills are uncontrolled. ➢ Most waste is openly dumped or burned.	➢ Minimal formal-sector recycling activities. ➢ Recycling activities are informally performed by private companies with some waste (PET bottles) sent to Uganda and Tanzania. ➢ Recycling rate is approximately 10%.
South Sudan	➢ 0.65 kg/person/day in Juba City (Japan International Cooperation Agency (JICA), 2018; NILE BASIN INITIATIVE, n.d.).	➢ Information not available.	➢ Uncontrolled Illegal disposal sites. ➢ Controlled disposal: Rejaf Panam sanitary landfill.	➢ Recycling is non-existent.
Sudan	➢ 7.67 million tonnes/year	➢ Collection rate is less than 40%.	➢ Most waste is illegally	➢ Minimal and mostly carried

Country	MSW Generation	Waste Collection	Waste Disposal	Recycling
	(Japan International Cooperation Agency, 2017; Osman, 2020).		disposed in open dumpsites (67%). ➢ While landfills are uncommon, existing landfills are uncontrolled.	out by the informal sector.
Tanzania	➢ 12.1 – 17 million tonnes per year (Ntakamulenga, n.d.; Tanzania National Bureau of Statistics, 2021; World Development Indicators, n.d.).	➢ Waste is collected via trucks with rear and side loaders.	➢ More than 90% of MSW are disposed of in open and poorly operated dumpsites across the country.	➢ Recycling activities mainly limited to the informal sector.
Uganda	➢ 0.4 – 0.6 kg/person/day (Government of Uganda, n.d.; Yusuf et al., 2019)	➢ Maximum collection rate is 40%. ➢ Private waste collectors licensed in Kampala to service affluent areas. ➢ No private collectors in other cities with waste collection responsibility lying with the government.	➢ Landfilling is the most common disposal method. ➢ Managed by city, municipal, or town councils. ➢ Open burning of waste prevalent in rural areas.	➢ Organic waste is composted at home, burned, or used as mulching material. ➢ Plastic recycling plants located only in Kampala.

Solid waste management is one of the major challenging issues in developing countries. As briefly presented in Table 3.1, inadequate coverage, limited waste recycling activities, and inadequate landfill management can also be identified as significant causes of poor waste management in the NBI countries. The causes of poor waste management also largely lie at financial constraints partly

explained in constrained budgetary allocation, poor financial planning and low economic status of households as shown in Figure 3.1.

The upcoming subchapters summarize the waste management flow and the current waste management situation in the Nile Basin countries.

Figure 3.1: Financial constraints resulting in poor SWM services. Source: (Teshome, 2020).

3.1.1. Burundi

Burundi is one of Africa's most densely populated countries with high poverty rates. As a result, the amount of solid waste is increasing rapidly and poses many sanitation and environmental problems, mainly in Bujumbura, the capital. None of the cities in Burundi have an appropriate MSWM as the institutional framework of the solid waste sector is not clear. According to statistics in 2002, approximately 1.9 million tonnes of waste were generated in Burundi annually.

Waste is collected weekly from households by private operators and micro-enterprises who are paid by the households with a price agreed between the two parties. The collected waste is taken to undeveloped disposal sites where the waste is deposited in bulk. Despite the national plastic bags ban in 2018, positive impacts downstream of the value chain have not been realized and plastic waste is still disposed of in the environment.

For detailed information regarding the waste management flow in Burundi and Bujumbura, please refer to Annex 10.1.1.

3.1.2. DR Congo

The civil war in DR Congo, which lasted until 2003, had a negative impact on the country. The economic mismanagement, lack of infrastructure maintenance, and solid waste management led to pollution and uncontrolled waste disposal. As a result, the Congolese capital Kinshasa is sinking with waste. With virtually non-existent transit stations or managed landfills, waste collection and treatment rates are low. Kinshasa is in a state of abject squalor, where the waste generation rate is 0.7 kg/person/day. The municipal waste contains approximately 65% organic material and 15% plastic (*PPIAF Assistance in the Democratic Republic of Congo*, 2011).

Under the terms of Article 56 of legislation on protecting the environment in DR Congo, good management of waste to protect the environment and health is an obligation incumbent on the Congolese state. However, the provision is not always taken into consideration throughout the country. The 003/2013 Edict of 9 September 2013 focuses on the sanitation and protection of the environment and several provincial by-laws related to waste management in Kinshasa (*Kinshasa_EN*, n.d.; *PPIAF Assistance in the Democratic Republic of Congo*, 2011). There is a lack of regulations on plastic pollution.

At the central level, the Ministry of Environment and Sustainable Development (MEDD) is responsible for waste management through the Directorate of Sanitation (DAS). Thus, they are responsible for regulating the solid waste sub-sector.

The final disposal sites were built by the European Union (EU) and are located 35 km east of the city centre. The amount of waste collected by RASKIN is approximately 1,500 tons/day (estimated), and some waste is transported directly by the waste generators to the landfill.

For detailed information regarding the waste management flow in DR Congo and Kinshasa, please refer to Annex 10.1.2.

3.1.3. Ethiopia

Ethiopia has started source segregation of solid wastes in a number of regions including in Addis Ababa though it is at an infant stage. The rate of municipal waste generation exceeds its management capacity. However, there are different collection approaches at the household and industrial level. Regarding household waste, micro, small, and medium enterprises (MSMEs) are primarily in charge of door-to-door waste collection, and it is the most common approach. The second collection method used is the curbside collection system. City administrations place containers on street corners and crossings, and residents deposit their waste using baskets or plastic bags.

Additionally, informal waste collectors use the door-to-door approach in most Ethiopian cities, including Addis Ababa and Bahir Dar. However, the collection system does not reach all houses, commercial centres, and institutions, particularly those outside the major city centres. Based on

an interview with two licensed waste collectors, the collection service is less frequent in areas outside of Ethiopia's major cities. The lack of labourers and the low wage enhance this problem.

Inability to manage waste has led to the uncontrollable and illegal disposal of solid waste into roadsides, open spaces, riverbanks, and drainage channels. The government in Ethiopia does not regulate or control informal sector activities due to market forces or other socioeconomic factors. Additionally, there is a lack of awareness; city dwellers throw carelessly and litter the areas around the containers, resulting in an unclean and unsightly appearance and attracting scavengers. The lack of advanced technology for plastic recycling schemes to implement circular economy towards managing plastic waste needs attention.

For detailed information regarding the waste management flow in Ethiopia, please refer to Annex 10.1.3.

3.1.4. Kenya

Kenyan towns and cities operate with a mix of public, informal, and private waste management models. Municipal authorities are responsible for the provision of waste management services in public areas while private spaces (residences, industries, institutions, commercial buildings, schools, etc.) contract private entities or rely on local community initiatives. The private sector typically operates in areas where their services are affordable. The public sector struggles to provide adequate waste management services due to poorly established municipal management systems, weak implementation capacities, and insufficient equipment and infrastructure. As a result, low-income areas have dysfunctional waste collection systems provided by the informal sector. In general, low levels of waste collection or non-existent collection is the norm as shown in Figure 3.2.

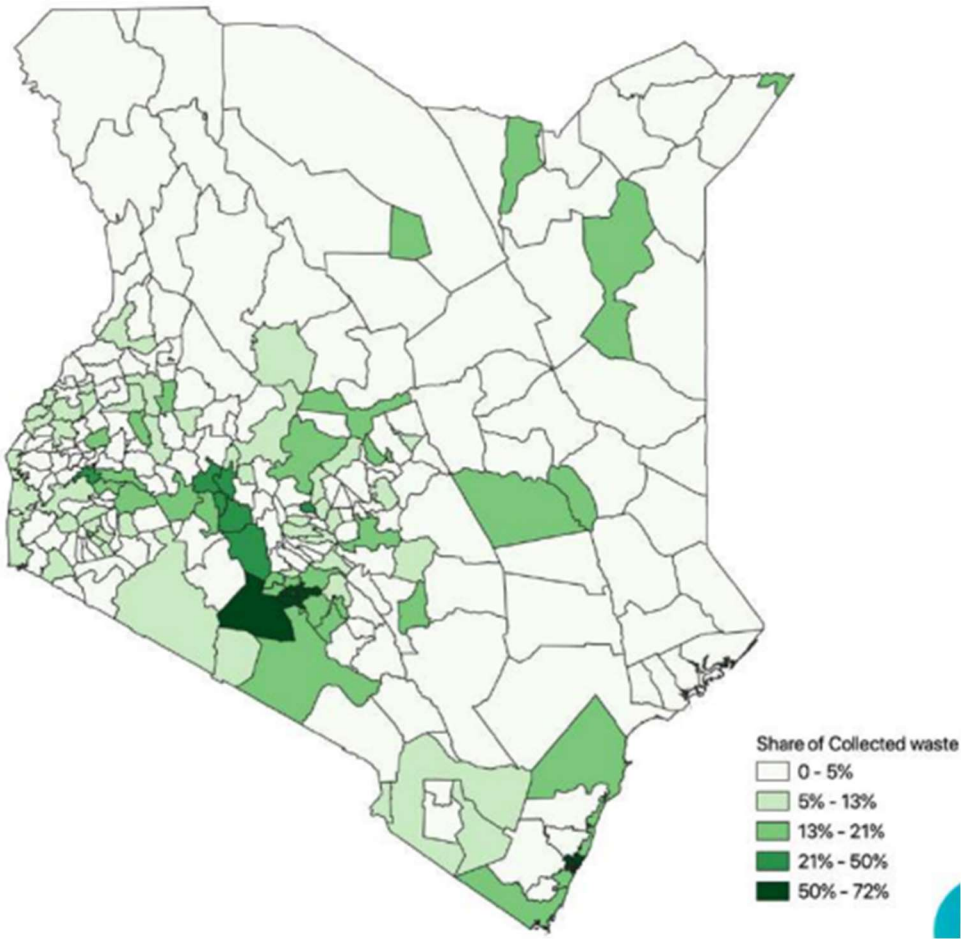


Figure 3.2: Volumes of collected waste in different parts of the country in Kenya. Source: Local expert (Kenya).

Some waste generators such as households, businesses, and institutions are not subscribed to SWM services in the absence of any legal requirements. In Kisumu city, for example, only 38% of households are subscribed to SWM services. Furthermore, there is a lack of performance standards for waste collectors (both private and informal sector) mandated by law.

Waste treatment prior to disposal or containment systems for waste in urban areas are absent. In some cases, disposal sites are non-existent and where disposal sites are available, they are full beyond capacity, and are unsecured and unmanaged. Whether disposal sites are available or not, a lot of waste is disposed in back streets, along roadsides and in open spaces, in abandoned quarry pits, inside drainage systems, in low-lying areas outside the city, on the riverbanks, along the beaches, which eventually leaks to the water bodies such as rivers and Lake Victoria.

Very little waste is recycled in spite of the great potential for waste recovery and recycling. Waste recovery and recycling consists of an unstructured system where waste pickers, itinerant waste

buyers, and a few processors of waste to products are the main actors. Approximately 7% of the roughly 500,000 tonnes/year of plastic waste generated is recycled.

For detailed information regarding the waste management flow in Kenya, Kisumu and other findings, please refer to Annex 10.1.4.

3.1.5. Rwanda

Over the last 20 years, Rwanda has embarked on a journey towards cleanliness earning credit for Kigali to be named as the cleanest city in Africa. This was achieved through a series of initiatives towards the management of MSW in Kigali and other parts of Rwanda. The local administrative entities, namely the city of Kigali, districts, and sectors play a key role in the procurement of waste management services and development of waste management infrastructure.

Urban centers continue to be centers for waste generation and municipalities continue to be the primary actors when it comes waste management. The SWM systems outside of cities are not as developed. The SWM sector in Rwanda is entirely privatised and managed by several waste collection companies. The private sector operators provide the waste management services such as collection, transportation, recycling, and disposal. These companies sign contracts (1 – 5 years) with municipalities to provide collection services to households paying a monthly fee for weekly collection services. Private companies have requested that contract periods be extended to provide incentives for investing heavily in equipment and other requisite infrastructure.

Tariffs paid by households were set in 2012 by the Rwanda Utilities Regulatory Authority (RURA) following the Ubudehe category (an economic welfare classification system in Rwanda). Following this system, the highest earning households pay RWF 5,000 – 11,200 (5 USD – 11 USD) per month, the middle-income households pay between RWF 3,700 – 7,500, and the lowest-income households pay between RWF 1,700 – 2,300. Several households designated as very poor in each sector by the local authorities are identified and exempted from paying this fee and waste collection companies are required to serve them too as form of corporate responsibility.

Commercial areas and markets use communal containers (sizes of containers are 60, 120, 240, 660, and 1100 liters) or walled collection bays from which waste is collected daily. The transport is done either through modern compactor trucks or normal trucks. While governments require operators to use modern compactor trucks, operators state that the investment barrier is high and would require adequate financial support from the government.

The collected waste is transported to landfills and open dumping sites selected by the municipalities and managed by private companies where the informal sorting activities are carried out to recover some valuables/materials (papers, metals, plastics, and organics) for recycling. Based on site visits, it was observed that there is no appropriate sanitary landfill in Rwanda and several of them are uncontrolled with no fences. However, the city of Kigali is working on reengineering the existing Nduba dumpsite into a modern sanitary landfill which receives

between 100 and 150 trucks per day. This initiative is being implemented by the Global Green Growth Institute (GGGI) in partnership with the Rwandan (MoE) to champion the waste-to-resources practices in the country. There are also other informal recycling initiatives being undertaken by innovators and operators at dumpsites on plastics, papers, and organic wastes. To ensure the health and safety of the waste collectors and pickers, they are given a tetanus vaccine, health insurance and the personal protective equipment during their work following guidelines set by the cities and other regulators but such equipment is not regularly replaced.

Prior to COVID-19 and border closures, recovered valuables such as metals and plastics were taken to Uganda and Tanzania for recycling. Since COVID-19, local recycling and circular economy initiatives were set up in Rwanda to deal with this waste. For example, plastics are being used to produce roof tiles and pavers. The Rwandan government has created a vibrant infrastructure to deal with e-waste management; an e-waste recycling facility was established in Bugesera contributing a lot to effective management of e-wastes in Rwanda in 2017. Set up of this facility has resulted in it becoming a source of employment for many youths and women. Following the laws prohibiting plastic bags and single-use plastics (SUPs) production enacted in 2008 and 2019 respectively, there are no primary plastic bags produced with many companies now involved in recycling plastics into new products such as trash bags, sheeting, agricultural tubing/polythene bags, pavers, tiles, silage bags, rubbish bags, sacks, plastic tubing, chairs, etc.

3.1.6. South Sudan

Juba is the capital and largest city of the Republic of South Sudan. The city is located on the White Nile and is divided into five administrative districts: Muniki Block Council, Juba Block Council, Kantor Block Council, Luri Count, and Rejaf County. Three districts were chosen for the waste amount survey in Juba conducted by Japan International Cooperation Agency (JICA) (Japan International Cooperation Agency (JICA), 2018). Regarding solid waste management in Juba, JICA functions as a consultant for the Juba Administration, such as the Juba City Council (JCC) in solid waste management.

Juba city generates approximately 950 tonnes of waste daily, and there is no recycling market. Most of the streets in Juba are unpaved and inaccessible due to narrow and muddy streets. Approximately 95% of Juba's residential houses are excluded from waste collection services (Mier & Zhuo, 2020). Although there are many illegal disposal sites, JCC and JICA established the sanitary landfill of Rejaf Panam in 2012, which has an area of 25 hectares.

The JCC Environment and Sanitation Department is the main organization of SWM in Juba City. Mixed waste is brought to the main streets by residents without any sorting. The JCC is responsible for collecting the garbage along the streets and transporting it to the Juba Controlled Landfill Site.

It is important to mention that South Sudan suffers from political instability, which impedes previous economy and SWM efforts. The cooperation between JCC and JICA turned out to be

fruitful. However, new challenges appeared due to the lack of budget and rapid population increase in Juba:

- The low capability of administrative staff in performing their duties (e.g., organization of capacity development training to develop human resources).
- The insufficient technological capacity of engineers (e.g., monitoring the landfill and drawing survey map).
- Lack of the concept of "public service" (e.g., residents have no experience in receiving public service such as waste collection service at designated place and time).
- Insufficient infrastructure (e.g., unpaved roads).
- Political instability (e.g., waste transportations are escorted by police).
- No financial plan for solid waste management.

For detailed information regarding the waste management flow in South Sudan and Juba City, please refer to Annex 10.1.6.

3.1.7. Sudan

As shown in Table 3.1, approximately 67% of the solid waste remains uncollected annually, disposed of in residential areas. Approximately 33% of the generated waste are disposed of in open landfills and waste disposal sites where waste is burned. In Sudan, the highest waste generation was found in the Khartoum Locality with 1.53 kg/person/day, while the lowest was 0.52 kg/person/day in Umbadda Locality.

In Khartoum State, the waste is collected through a door-to-door and collection point approach. However, approximately 37% of the generated waste were uncollected and disposed of illegally. The Khartoum state has three landfills with a total area of approximately 1000 hectares.

The Republic of Sudan has made efforts to improve the waste management systems by adopting legislation and awareness raising campaigns. However, there are some challenges, such as inadequate waste management regulations to limit industrial and hazardous waste, poor infrastructure, lack of a waste sorting system, and high cost.

The quantity of unmanaged MSW is increasing due to rapid urbanization and inefficiencies in the MSWMS. Owing to low collection rates, waste is either disposed in open dumpsites or openly burned. There is a severe lack of waste-related data in Sudan due to absence of weighbridges at landfills, inadequate MSWMS, poor technical skills of waste staff, and financial constraints. The lack of data poses a significant challenge to accurately estimating waste generation.

Waste composition is mostly dependent on income level, rate of urbanization and consumption patterns. The 2006 Khartoum State Cleaning Project estimated that plastic waste comprised approximately 12.7% of all MSW generated. This value can be extrapolated nationally since Khartoum has both urban and rural sectors and rural-to-urban migration is increasing. Plastic

waste is dumped into water channels for agricultural irrigation, surface rainwater drains, or near water resources due to poor waste collection services. In some cities and areas, waste dump sites are on the Nile banks. Landfills in Sudan are not common with only Khartoum State, Gadaref, Fahshir, and El Obied having open uncontrolled landfills. Furthermore, only Khartoum has semi-controlled landfills albeit, without fences. Waste scattering by air is very common at landfill sites.

Due to a lack of formal recycling or segregation legislations, only informal plastic recycling is prevalent mainly in larger cities. Polyethylene terephthalate (PET) bottles and high-density polyethylene (HDPE) waste is collected by scavengers, then sold to local middlemen who further send it to processing facilities in Khartoum for cleaning and crushing. The processed materials are exported out of Sudan for final treatment. Only 10% of generated plastic waste is collected by the informal sector with the remaining 90% (mainly plastic films and packaging waste) remaining uncollected.

For detailed information regarding the waste management flow in Sudan, Khartoum State and other states, please refer to Annex 10.1.7.

3.1.8. Tanzania

Waste management is gradually becoming a serious concern in Tanzania due to limited sorting at source, improper storage, collection, transportation, treatment, and final disposal. Approximately 14.5 million tonnes per year on average of waste is generated. However, there is minimal waste segregation within the Central Business District Areas, industries, institutions and households, and informal sectors recycle a maximum of 10% of the generated MSW. More than 90% of MSW is disposed in open and poorly operated disposal sites. Nevertheless, eight municipalities since 2020, such as Arusha and Tanga, have improved landfills with lining and leachate collection systems.

One of the waste generation hotspots in Tanzania is Dar el Salaam, where the waste generation rate is 1 kg/day/household (average value for developing countries range from 0.4 – 0.6 kg/day/household).

In the last decade, Tanzania's economy grew significantly in the past decade, which can be seen in the rapid growth of the cities and the increase in waste quantities, especially plastic waste. To tackle plastic waste in Tanzania, the International Union for Conservation of Nature (IUCN) proposed in their study a shaping action to reduce plastic leakage and recycling (IUCN-EA-QUANTIS, 2020). Approximately 315,000 tonnes of plastic waste was generated in 2018, approximately 40% was collected, and only 4% was recycled. However, the plastic bags ban of 2019 has been effective. According to the Tanzania Daily News, published on May 19, 2021, the local government authorities are aware of plastic pollution in the region of Mwanza, located at Lake Victoria. The rapid increase of plastic production due to economic growth and littering waste

in the open by consumers leads to plastic pollution. Monthly city cleaning campaigns, including citizens and business people, should raise awareness and reduce waste littering on land.

A SWM case study among vendors at Majengo Marjet in Dodoma City shows that 56% of the vendors are unaware of SWM practices. The SWM services provided by the City Council are insufficient as the generated waste is disposed in containers without lids and is infrequently collected. Moreover, the established strategies for sustainable solid waste management at the market are not practised as control mechanisms for MSW generation, collection, storage, and disposal are ineffective (Nyampundu et al., 2020).

Tanzania is a member of the Nairobi Convention for the Protection, Management, and Development of the Marine Coastal Environment of the Western Indian Ocean. Through this, the Government of Tanzania is implementing the Strategic Action Program for the protection of the Western Indian Ocean from land-based sources and activities (WIOSAP). In Tanzania, the program is being implemented through demonstration projects. This is a one year program starting in June 2021. Furthermore, a national strategy to address marine and coastal environmental challenges was developed and implemented in 2008. This strategy is now under review to incorporate the emerging issues regarding environmental challenges.

For detailed information regarding the waste management flow in Tanzania, Dar el Salaam and additional information regarding plastic waste, please refer to Annex 10.1.8.

3.1.9. Uganda

With the high degree of urbanization due to the exponential population growth rate and lack of waste management infrastructure in urban areas, waste management in Uganda is considered a challenge. In Uganda, the waste generated from the rural areas is not considered municipal waste and the most common practices in these areas are composting and burning organic waste. The treatment and disposal of waste is mostly done through landfilling.

Specifically, in Kampala City, approximately 30% of the waste remains uncollected. Additionally, estimated 7.8% of the generated waste is plastic. The collected waste by private operators is then transported to the Kitezi landfill. Although the private waste generators are charged for collection services, the Kampala City government does not demand fees from other low-income areas. Approximately 38 tonnes/day of plastic waste remains uncollected due to inadequate access to the generation sources. The collectors and transporters manage to sort 25 – 40% of valuable waste before reaching the landfills. Afterwards, the segregated and sorted waste such as recyclable plastics and paper are sold to the recyclers.

Kampala Capital City Authority (KCCA) has a more elaborate system for waste management with dedicated staff for municipal waste management at dump sites and Kitezi landfill. It has invested largely in transport equipment and communication systems, and its records are also aligned to collection and arrival volumes at the landfill. The substantial increase in the number of transport

equipment deployed in Kampala has increased the volumes of waste transported to the landfill (from 40% generated in 2012 to 60% in 2021) compared to 40% performance in other municipalities that have reduced the number of transport equipment.

The waste management value chains in Fort Portal, Jinja, Mbarara, Kasese, Mbale, and Soroti were similar to Kampala's. The key difference is that the setup of composting plants reduced the quantity of MSW remaining at disposal sites.

The governmental and private sectors have different points of view regarding the core problem of plastic waste. The government believes that plastic bags are the most detrimental product to the environment while exempting plastic packaging materials from any bans. The private sector believes that the challenge posed by plastic bags has already been responded to by recycled and that plastic packaging material is a larger problem.

For detailed information regarding the waste management flow in Uganda, Kampala City and other cities, please refer to Annex 10.1.9.

3.2. Additional Findings and Identified Gaps

The purpose of this section is to provide an overview of the general trends and gaps identified in the MSWMS prevalent in the Nile Basin countries.

Typically, MSWMS were observed to be ineffective due to weak implementation capacities, insufficient facilities and equipment, improper maintenance, poor waste disposal practices, inadequate budgets, weak legislation, low public awareness, corruption, conflict, political instability, and a lack of political will (Godfrey et al., 2019). Absence of accurate data further exacerbates the highlighted issues. Most urban centers in the Nile Basin countries are witnessing high population growth rates and rapid urbanization. These factors place an additional burden on an already weak infrastructure. A lack of public awareness about available MSW services, particularly in secondary cities and rural areas, results in environmentally-unsound waste disposal. Furthermore, waste segregation at source is absent. Limited sources of revenue generation from SWM for municipal governments results in a lack of financial resources to promote a sustainable MSWMS by investing in capacity building and public awareness programs. A solid waste management case study among vendors at Majengo Marjet in Dodoma City, Tanzania, shows that 56% of the vendors are not aware of SWM. Even when progressive laws are in effect, low enforcement capacities negate the potential positive effects.

Coordination among stakeholders in the SWM value chain is low as is evidenced by the lack of oversight on informal sector activites. Due to this lack of oversight, informal waste collectors often illegally dump waste causing water and soil pollution as was observed in Ethiopia. An example of the linkages and waste process flows in urban centers can be seen in Figure 3.3 which depicts the net of all actions in the informal settlements of Kisumu, Kenya. The system diagram consists of seven distinct bundles or sets of actions based on which actors are involved:

- Waste generation of shops, markets, and households (gray).
- Everyday actions of households in and near their surroundings (red).
- Entrepreneurial actions of waste scavengers (green).
- Entrepreneurial actions of waste pickers or carts men and waste entrepreneurs (purple).
- Actions by community-based organizations (CBOs), NGOs, and neighborhood associations (brown).
- Actions by the city's Environment Department at transfer points, along mainroads, and at the dumpsites (yellow).
- Commercial actions by recycling entrepreneurs, middlemen, and national buyers of recyclables (blue).

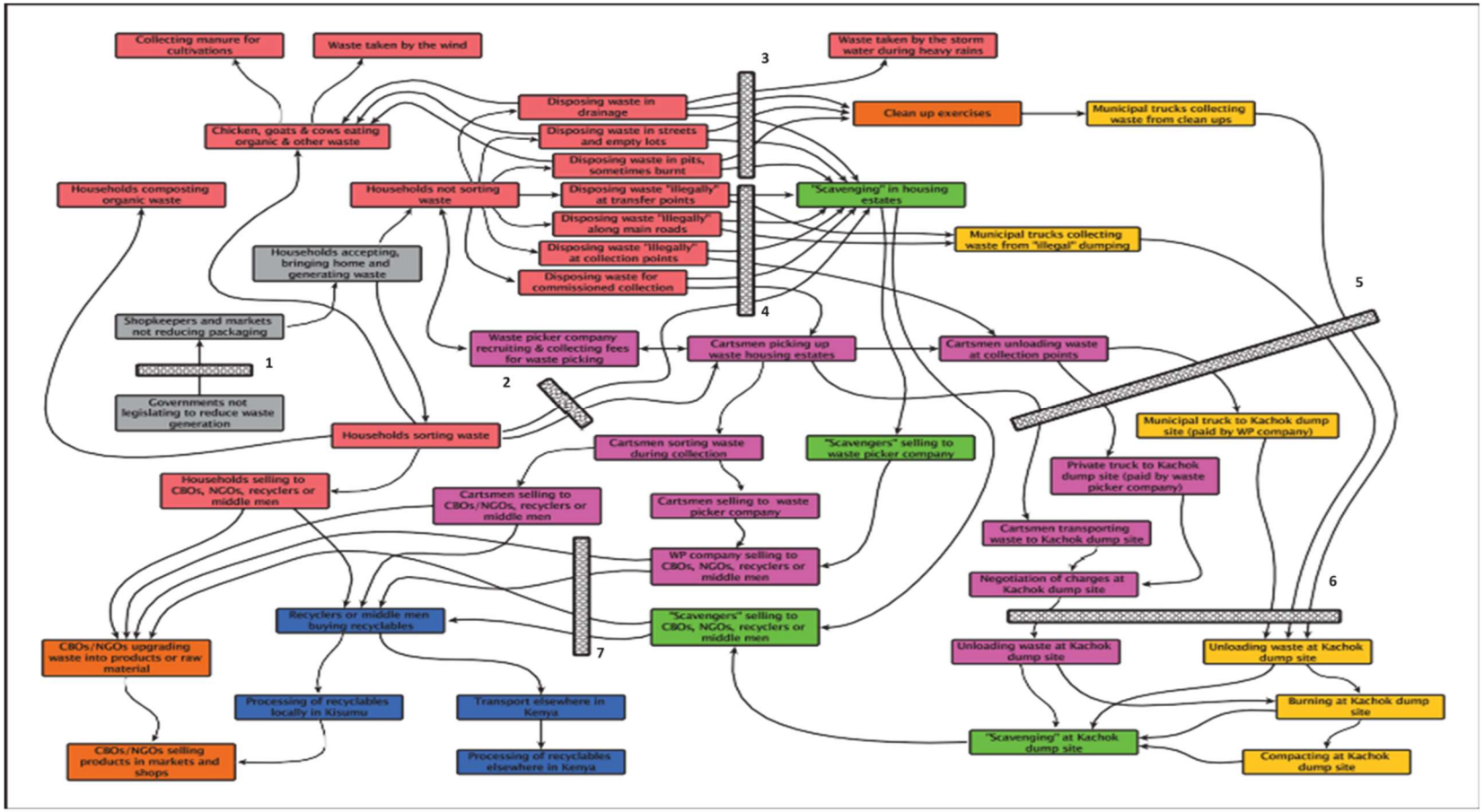


Figure 3.3: Schematic representation of a typical MSWM in Kenya's urban areas with its subsystems or subsets. Source: Local expert (Kenya).

Collection

- Collection rates were found to be either limited or non-existent as can be seen in Table 3.1 and Annex 10.1 (McAllister, 2015).
- While countries such as Kenya, Rwanda, and Uganda have attempted to license private waste collectors, such operators provide services mainly in affluent residential and commercial areas where their services are affordable. Particularly in Rwanda, private waste collectors indicated that contract lengths were too short (1 – 5 years) to justify heavy investments in equipment.
- Unaffordability of private collection services and dissatisfaction with the irregularity of public collection services means that households are unlikely to subscribe to existing MSWMS.
- Inadequate roads coupled with poor conditions not only make it difficult for collectors to reach households, but also damage equipment resulting in higher maintenance costs for operators.

Treatment and Disposal

- In most urban areas, disposal of waste in uncontrolled landfills and open dumpsites remains prevalent. Waste disposal in rural areas, on the other hand, is characterized by limited composting and open burning.
- Inadequate and faulty operations of existing landfills lead to uncontrolled dumping with a limited formal resource recovery sector.
- There is a lack of coordination among the local stakeholders in the waste recycling value chain.
- Insufficient initiatives, legislative backing, and technical and financial resources for circular economy practices have hampered the growth of a formal sector in this space. Additionally, existing regulatory frameworks typically do not cover all plastic types.
- Waste disposal from domestic and commercial activities in illegal dumpsites has not been curtailed. This is especially prevalent in the Lake Victoria Drainage Basin (LVDB).

In spite of the gaps identified in the MSWMS, stakeholders have been paying increased attention to SWM with collective measures being taken by various actors including individuals, households, community groups, municipal authorities, and private sector actors to transform SWM strategies. Households are improving their domestic waste management practices at rates varying from country-to-country. Municipal authorities have also made efforts to improve waste collection and disposal services through the recruitment of technical staff, increasing investments in equipment, and decommissioning dumpsites operating over-capacity.

Initiatives

Innovations in waste recycling initiatives are required to be developed and promoted at each level of the SWM value chain. Awareness-raising activities should also be promoted to help avoid the generation of marine and riverine litter, reduce plastic consumption, and to reinforce appropriate waste disposal methods. The objective of such awareness-raising programs is to increase collection rates and promote resource recovery. In Uganda, the Manugongo Marty's Day celebration served as an awareness campaign that targeted over 3 million pilgrims. This is a good example of utilizing large-scale gatherings to induce a positive paradigm shift. Since plastic bag and single-use plastic bans are in effect in many Nile Basin countries, awareness campaigns such as those in Uganda have had a very impact on bringing to light the negative impacts of such plastic products. Public-sector involvement in such programs is vital for successful enforcement.

Public-private partnerships are also crucial to facilitate the growth of recycling initiatives. The Ministry of Water and Environment in Uganda is collaborating with the National Environment Management Authority (NEMA), KCCA, Coca-Cola Beverages Africa, Mukwano Industries Uganda Ltd., the Uganda Water and Juice Manufacturers Association, and the GGGI to improve the sustainable management of PET plastic waste in the Greater Kampala Metropolitan Area (GKMA). PETCO Ethiopia and Coba Impact are also organizations in Ethiopia with a focus on improving PET and HDPE plastics recycling. Similarly, in DR Congo, a company called OK Plast, supported by the governorate of Kinshasa, has started a project in 2021 to collect 50 tonnes/day of plastic bottles.

A notable successful example of public-private partnership is Rwanda where plastics are recovered for recycling through private sector engagement. Working with communities, the government of Rwanda also organizes monthly events where people gather across the country to clean their neighborhoods and are educated on different government policies related to environmental protection. Similarly in Bujumbura, Burundi, collected plastic waste is also being increasingly recycled into products such as pavement tiles via the Greening Burundi Project. The government of Uganda has also made a deliberate effort to sensitize and educate relevant stakeholders on roles and responsibilities under the National Environment Act of 2019. In several countries, it was observed that volumes of plastic products disposed on sites was lower after the implementation of relevant legislations.

Non-Governmental Organizations (NGOs) and Community Development Associations (CDAs) also play a vital role in establishing sustainable MSWMS. As an example, clean-up activities in urban areas and beaches in addition to underwater clean-up activities have been promoted in Kenya with the support of individuals and various groups. Several NGOs in Burundi such as the Association Catholique pour la Protection de l'Environnement au Burundi focus on different waste-related aspects including waste accumulation, marine debris, and uncontrolled landfills.

More comprehensive information related to the MSWMS status quo can be found in the reports produced by the local experts (Annex 10.2).

4. Legislative Framework

4.1. Legal System

While several countries have focused on updating their SWM-related legislative frameworks, Burundi, Sudan, South Sudan, and Tanzania do not have comprehensive nationwide legal framework in place pertinent to SWM. There are however, either indirect references to SWM or partial provisions delineating SWM-related institutional responsibilities for example, the Environmental Protection Act (EPA) of 2001 enacted by the government of Sudan. In general, all countries have enacted regulations related to prevention of air, soil, and water pollution. Additionally, many countries lack explicit legislative frameworks that focus on plastic waste management. For example, Ethiopia has several laws governing SWM and has enacted a plastic bag ban; however, the legal framework could be further strengthened to become more effective if complementary laws dealing with plastic waste are implemented.

On the other hand, in 2020, Uganda passed the NEA No. 5 which includes provisions on waste management responsibilities, Extended Producer Responsibility (EPR), prohibition of waste import and export, and management of plastics and plastic products. The National Environment (Waste Management) Regulations, passed in 2020, seek to operationalise the NEA No. 5 by including provisions on SWM and EPR. Ethiopia and Sudan lack any regulations related to the Polluter Pays Principle or EPR. Similar to Uganda, Kenya and Rwanda have also invested heavily in policies and law enforcement in an effort to boost environmental stewardship in SWM.

In Kenya, The Environment Management and Coordination Act (EMCA), launched in 2021, defines the responsibility, role and tasks of authorities, producers, and the establishment of the Producer Responsibility Organizations (PROs). The government of Kenya has also set targets as part of its National Waste Management Strategy to achieve 80% waste recovery and recycling and 20% disposal of inert materials in a sanitary landfill (Kaudia & Erika, 2018). In addition to specific legislations on SWM, the Kenyan government has also issued bans on domestic and commercial packaging (plastic carrier bags) and plastic bottles, straws, and SUPs in protected areas. The specific objectives are to:

- Promote mindset change and public participation on use and management of single use plastics.
- Prohibit the use of and littering by SUPs in all protected areas.
- Promote development and uptake of innovative and sustainable alternatives to SUPs.
- Propose incentive schemes for private sector players.
- Strengthen management of post-consumer SUPs to eliminate their drifting into protected areas
- Increase enforcement of the ban.

The government of Rwanda has also set targets related to SWM to improve access to sanitation services from 86% to 100%. As part of the National Sanitation Policy Implementation Strategy in 2016, the government also aims to properly dispose 80% of domestic waste by 2030. The Standard Regulation No: 002/EWASTAN/SW/RURA/2015 of 24th April, 2015, seeks to provide a regulatory framework for the design, installation, and operations that recycle, compost, or convert solid wastes. Concerning plastics and marine litter, in 2004, ministerial instructions on the use and manufacturing of plastic bags with a thickness of 60 microns and below were adopted. Due to the lack of alternatives to polythene bags and single use plastics, this policy did not reduce the proliferation of environmental pollution by plastic bags. Nevertheless, the instructions managed to halt the use of colored carry bags which were found on local markets. To increase the efforts, in 2008 the Law No. 57/2008 of 10/09/2008 was enacted prohibiting the manufacturing, import, use, and sale of polythene bags in Rwanda. In 2019, it was amended through the Law No. 17/2019 of 10/08/2019.

At a regional level, the East African Community Polythene Materials Control Bill establishes a regional approach for the control and regulation of use, sale, manufacture and importation of and use of polythene materials and products within the East African Community (EAC).

A detailed description of the legislation relevant to SWM for the case study and non-case study countries can be found in the local expert reports (Annex 10.2) and Annex 10.3, respectively.

4.2. Key Players

Table 4.1 below provides a selective summary of the important institutions participating in national MSWMS.

Table 4.1: Key institutional entities and relevant responsibilities participating in national MSWMS. Source: Local experts.

Countries	Key players
Burundi	Institute for Waste Management (supervised by the Bujumbura city mayor) ➢ Removal of MSW. Municipal Councils ➢ Provide SWM services in urban areas, although waste management is a shared mandate between the Ministry of Public Health, the Ministry responsible for the environment and the Ministry of Interior and Municipal Development.
DR Congo	Ministry of Environment and Sustainable Development (Ministère de l'Environnement et Développement Durable, MEDD) through the Department of Health (Direction de l'Assainissement, DAS) ➢ Responsible for waste management. Ministry of Health (Ministère de la Santé Publique et la Direction de l'Hygiène, MSP)

Countries	Key players
	➢ Involved in waste management from a public health perspective.
Kenya	Ministry of Local Environment ➢ Sets national SWM agenda for local authorities. NEMA ➢ Coordination of environmental management activities undertaken by various agencies. ➢ Development of the National Solid Waste Management Strategy to facilitate sustainable SWM.
Rwanda	Ministry of Commerce and Trade ➢ Lead and promote waste management and circular economy initiatives. Rwanda Utilities Regulatory Authority (RURA) ➢ Develop regulations and guidelines on solid waste collection, transportation, and recycling. Rwanda Environmental Management Authority (REMA) ➢ License waste management operators. Water and Sanitation Corporation (WASAC) ➢ Develop waste management infrastructure. Rwanda Development Board ➢ Promote research and development for circular economy initiatives.
South Sudan	Ministry of Environment Juba City Council (JCC)
Sudan	Ministry of Environment, Forestry, and Physical Department ➢ Derived from the EPA in 2003 to coordinate all sustainability-related projects.
Tanzania	Central Government: ➢ Guidance to the municipal council. ➢ Provision of resources (e.g. finance, equipment, etc.). City Council: ➢ Coordination of solid waste management. ➢ Management of solid waste final disposal. ➢ Awareness creation of solid waste management. Municipal Councils ➢ Primary responsibility for waste management. ➢ Refuse collection and night soil removal from households. ➢ Law enforcement.

4.3. Implementation, Enforcement, and Penalties

The gap between policy and adequate action remains large due to political interference, corruption, lack of willingness, or poor governance. Enforcement is either lacking or weak with capacities of enforcement organizations being quite low. Considering the complex nature of MSWMS, institutional coordination between waste regulators and stakeholders is important for

effective implementation of sustainable waste management systems. Even progressive regulatory frameworks like that prevalent in Kenya do not provide institutional mechanisms to establish linkages between waste authorities and other stakeholders in the value chain. In almost cases, the role of the informal waste sector is ignored. Considering the importance of sub-national public-sector institutions in providing SWM services, it is crucial to include them in any relevant regulations. Generally, the following factors appear to be the cause of low compliance levels:

- Rapid urbanization resulting in high population densities in urban centers.
- Improper coordination between stakeholders and other policy gaps.
- Inadequate technical and financial resources such as budget, equipment, technical staff, and collection bins.
- Poor access to waste-related data resulting in inadequate monitoring by enforcement organizations.
- Contradictory or inadequate legislations characterized by absence of operational, coordination mechanisms, and clear penalties.

Even with the implementation of new regulations, institutions continue to follow previous laws; for example, the NEA No. 5 of 2019 has not been integrated into daily operations by regulators at the municipal level in Uganda. The implementation authority, NEMA in Uganda, has indicated that awareness campaigns will be conducted to target local political leadership and citizens to ensure that the NEA No. 5 of 2019 replace previous laws. Similarly, compliance with the Solid Waste Management Regulations in Kenya also remains low.

Table 4.2 provides an overview of national plastic bans in effect in Africa. While plastic bag bans have been observed to reduce the waste volumes disposed in dumpsites, the bans do not address the important issue of legacy waste. Several regulations were implemented in Kenya to curtail the negative environmental impacts of certain plastic types. However, there were policy gaps with regards to providing alternatives for important applications such as food packaging, disposal of plastic types not covered under regulations, and treatment of plastics used in industrial applications. Similarly, interventions related to the implementation of circular economy initiatives under the National Solid Waste Management Strategy remain generic with the exclusion of measurable targets and indicators.

Table 4.2: National plastic bag bans in Africa. Source: Adapted from (Greenpeace Africa, 2020).

Countries	Plastic ban status
Burundi	➢ Use and possession of plastic bags banned in 2019.
DR Congo	➢ Manufacture and sale of plastic bags and bottles is banned.
Ethiopia	➢ Thin plastic bags banned in 2008.
Kenya	➢ Manufacturing, use, import, and sale of SUP bags is banned and penalized. ➢ Use of SUPs in protected areas will be banned.
Rwanda	➢ National ban on non-biodegradable plastic bags.

Countries	Plastic ban status
	➢ Manufacturing, use, import, and sale of plastic carrier bags is prohibited. ➢ Prohibition on tourists entering country with plastic carrier bags.
South Sudan	➢ No regulations passed.
Sudan	➢ No regulations passed.
Tanzania	➢ Plastic sachets for packing beverages cannot be manufactured or imported. ➢ Prohibition on tourists entering country with plastic carrier bags.
Uganda	➢ Plastic bags banned in 2007.

While widespread implementation of EPR policies have not taken place, countries like Kenya and Uganda have led the way here. The implementation of EPR regulations in Kenya has faced some challenges with respect to the exclusion of sub-national regulatory institutions and lack of public awareness and infrastructure.

Penalties and disincentives remain an important part of regulatory frameworks. The EPA in Sudan carries penalties for violation of section 20 (environmental pollution in all forms) ranging from imprisonment for up to 3 years, fines up to 1,000 SDG (Sudanese pound), and revocation of the license. Comparatively, the Kenyan government may impose a term of imprisonment between 1 – 4 years and a fine of up to four million Kenyan Shillings (40,000 USD) for a violation of the plastic bag ban. The government of Rwanda utilizes revenues collected from similar fines to fund plastic waste management projects. In some cases, due to the lack of financial and institutional capacities such as in Ethiopia, municipalities struggle in enforcing penalties for illegal activities.

5. Main Contributors

It is difficult to estimate the exact amount due to variations in methodologies, but research suggests that 0.15 – 0.75 million tonnes/year of macroplastics could leak into the Mediterranean Sea (Boucher & Billard, 2020; Jambeck et al., 2015). Egypt, Italy, and Turkey are the leading contributors to the leakage due to high quantities of mismanaged waste, with an estimated contribution of over 50% (Boucher & Billard, 2020). While concerns remain over data accuracy, it is estimated that 0.15 – 0.39 million tonnes/year of marine debris leak into the Mediterranean Sea from Egypt (Akan et al., 2021; Geyer et al., 2017). (Boucher & Billard, 2020) estimates that Egypt's plastic leakage contribution could be significantly lower at approximately 75,000 tonnes/year, reinforcing the lack of data reliability and availability. The total amount of mismanaged plastic waste in coastal African countries was estimated at 4.4 million tonnes in 2010 (Sadan & de Kock, 2021). It is estimated that approximately 66,000 tonnes of plastic leaked into the marine environment from Kenya and Tanzania in 2018 (Sadan & de Kock, 2021). Research seems to suggest that artificial polymer materials, including plastic, comprises the largest share of marine litter in Egypt (Ayoub, 2018). Additionally, the discharge of untreated industrial wastewater into drains, canals, the Nile River, and subsequently, the Nile River is also a concerning problem (Mostafa & Peters, 2012). Generally, the primary sources of plastic leakage are:

- Plastic packaging sector: This sector is characterized with the highest absolute leakage and highest volumes of mismanaged waste.
- Textiles: The advent of fast fashion has contributed both macro- and microplastic pollution originating from synthetic textiles. In terms of absolute leakage, the textiles industry ranks second to the plastic packaging sector in Kenya and Tanzania.
- Plastic carrier bags: In spite of 37 African countries regulating plastic carrier bags in one form or another, with the exception of Rwanda, enforcement of regulations has been a challenge establishing this as a significant marine and riverine litter problem.
- Plastic from the fishing sector: While the absolute leakage from the fishing sector contributes to less than 1% of the total plastic leakage in each country, estimates suggest that 12 – 36% of plastic used in fishing activities ends up in oceans.
- SUPs such as plastic medical gear, plastic bottles, sachets, and disposable nappies have also been observed to contributors to plastic pollution.

Site visits in Uganda revealed that the most commonly collected and recycled plastic types are thicker plastic carrier bags and bottles. Non-recyclable plastic waste was left uncollected by the informal sector as shown in Figure 5.1. Kampala, in particular, has a vibrant plastic manufacturing and recycling sector (Annex 10.4.4, Table 10.35). Similarly, the primary plastic pollution contributors in Sudan, South Sudan, and Burundi are uncollected MSW and plastic processing industries.

Figure 5.1: Non-recyclable plastic waste abandoned at Kitezi landfill, Uganda. Source: Local expert (Uganda).

In contrast, the main riverine litter contributors in Bahir Dar around Lake Tana in Ethiopia belong to the tourism and services industry. Lake Tana is the source of the Blue Nile in Ethiopia. A study conducted by the Urban Development Housing and Construction Bureau in Bahir Dar in November, 2020 identified 21 sources of marine debris in Lake Tana (Annex 10.4.1, Table 10.32). 14 of the 21 identified contributors belonged to the leisure industry and the tourism sector. The activities of the identified contributors have exacerbated soil erosion, pollution, effluent discharge into Lake Tana, and vulnerability to floods.

The main contributors to riverine litter in Rwanda are the food and beverage manufacturing and processing companies primarily located in Kigali and secondary cities such Rubavu, Rusizi, Huye City, and Nyabihu District (Annex 10.4.3, Table 10.34). Use of SUPs in these industries is widespread despite the ban enacted in Rwanda. However, companies such as SKOL Brewery have taken positive steps by launching the first Rwandan mineral water in a returnable glass bottle. The transboundary trade of plastic products has resulted in disposal of plastic waste in landfills or water bodies. Apart from plastic pollution, wastewater discharge in rivers and lakes is also a significant source of stress on aquatic ecosystems. The Nyabugogo River is heavily polluted by wastes from the city of Kigali due to uncollected MSW and industrial wastewater discharge.

Similar to Rwanda, industrial effluent discharge into the LVDB were observed to be significant sources of pollution. These industries included sugar million, breweries, tanning, paper, fish processing, etc. (Annex 10.4.2, Table 10.33). However, manufacturers are adopting pollution reduction measures including use of SWM and cleaner production technologies. Apart from industrial wastewater discharge, activities of the fishing sector on the beaches around Lake Victoria are also riverine litter contributors. Dumping is the main method of waste disposal,

perhaps because it involves no or minimal cost to the user, even though long-term effects are not often taken into consideration.

6. Waste Generation Hotspots

This section covers the work done to map marine debris hotspots along the Nile River along with the main contributors. This included an attempt to quantify and map the waste process flows from source to disposal (and possible leakages) for specific locations across the Nile in the form of WFDs.

6.1. Identified Marine and Riverine Litter Hotspots

Hotspots were mainly found in urbanized areas that are under-serviced or lack waste collection and disposal services in residential and commercial areas. Table 6.1 summarizes the key marine and riverine litter hotspots identified. The degree of urbanization, proximity to water bodies relevant to the Nile, dumpsite locations have also been taken into account when identifying hotspots. Annex 10.5 illustrates the hotspots for each country and for the entirety of the Nile Basin as well.

Table 6.1: Marine and riverine litter hotspots in the Nile Basin countries. Source: Local experts.

Location (i.e city)	Population (inhabitants)	Type of waste	Causes
Burundi			
Bujumbura	1,075,000	MSW	Largest city in Burundi and located in the Nile Basin characterized by heavy industrial and domestic activities.
Ethiopia			
Bahir Dar	218,429	MSW and various types of chemical and liquid waste.	Unsuitable waste management systems, widespread household littering, septic tanks for hotels are built near the lake, soil characteristics, production of Chat plant, unlawful construction of houses, deforestation and soil erosion, rain-caused flooding, loss of lakeshore habitats and the liquid waste sewage lines from Bahir Dar are set to end at Lake Tana.
Kenya			
Kisumu	721,082	Food waste, reeds, hyacinth, papyrus	Waste is generated from different sectors in Kisumu,

Location (i.e city)	Population (inhabitants)	Type of waste	Causes
		waste, fecal waste, plastics, and glass wastes.	namely residential areas, markets (formal and informal), commercial enterprises, institutions, manufacturing industries and healthcare facilities. Quantities of solid waste generation increasing due to improved income levels, increasing population, changing lifestyles and consumption patterns.
Eldoret	475,716	Beverage containers, papers, glass, cartons, ceramics, tyres, organic food refuse, charcoal dust and batteries.	Improvement in family social status increase the per capita waste generation, especially with regard to biodegradable organic waste which accounts for three quarters of total waste in a household/town.
Kisii	183,000	MSW	Kisii is a medium sized town with residential commercial and, also well-known trade in agricultural commodities such as bananas and vegetables.
Kakamega	91,768	Mixed wastes comprising of food waste and packaging materials such as carton and plastic.	Commercial activities with a few health and educational institutions.
Kericho	104,282	Household and industrial wastes.	Mainly caused by population explosion in the towns. A county environmental officer quoted acknowledging that waste management is a great challenge in the county due to the absence of appropriate technologies and modern facilities for collecting, recycling and treating waste. Impacts of informal sector activities

Location (i.e city)	Population (inhabitants)	Type of waste	Causes
			including improper solid waste dumping poor hygiene.
Rwanda			
Kigali City	1,370,550	MSW	Nyabugogo river, a tributary in the Nile Basin, is the main carrier of the pollution from Kigali city which is mainly made of soil erosion coming from rural areas and households and industrial wastes from urban areas. The industrial effluents and by-products are discharged in the water bodies by a number of industries namely textile and iron industries manufacturing iron sheets, paint and sugar among others.
Muhanga	386,161	MSW	Muhanga is becoming a hub for mining, trade, industry, tourism, and logistics growth potentials. Muhanga is located is the middle of the country and has huge traffic and home to many schools. No sanitary landfill, all collected waste is accumulated into an uncontrolled dumpsite and some waste generators (e.g., hospitals) dispose of waste on-site. Uncontrolled wastes from Muhanga could potentially end in the Nyabarongo River (tributary in the Nile Basin).
Huye	397,362	MSW	Huye is home to many universities and has tourism and entertainment potential due to its large population of

Location (i.e city)	Population (inhabitants)	Type of waste	Causes
			students and research activities happening in the city. The district of Huye borders Burundi through the Akanyaru River.
Bugesera/Nyamata	437,916	MSW	Nyamata is a city that will grow exponentially in the coming years. The government of Rwanda is building a large international airport to be completed by 2023 and will make the area into a hub for transport, trade, logistics and tourism. The waste from Nyamata could end up in Akagera river (forming part of the upper headwaters of the Nile) if not well managed.
Nyagatare	563,685	MSW	A hub for milk production with large herd of cattle, Nyagatare is potential for large daily and livestock industry exporting processed meat and milk to neighbouring countries of Uganda and Tanzania. Nyagatare is also rich in granite mining and tile manufacturing. There is a good, controlled dumping site in the city and there are also manual sorting activities going on and recovered materials (plastics and glass) are used to produce pavers.
Rwamagana	379,288	MSW	Rwamagana, similar to Kigali, has special economic zones and industrial activity. As a satellite city, more construction and related infrastructure developments will be expected. Commercial agriculture and

Location (i.e city)	Population (inhabitants)	Type of waste	Causes
			processing will be equally important as the district has soils suitable for agriculture. There are no controlled landfill in Rwamagana as wastes ate collected and open dumped in open dumping site.
South Sudan			
Juba, South Sudan	525,953	MSW	Poor waste management systems with rampant illegal dumping and minimal waste recovery.
Sudan			
Sinja	250,000	MSW	Poor waste management system and implementation
Sinnar	130,122	MSW	Poor waste management system and Implementation
Wad Madani	332,714	MSW	Poor waste management system and implementation
Greater Khartoum (including Khartoum, Omdurman, and Khartoum North)	10,000,000	MSW	Poor waste management system and implementation and disposal of plastic litter into major storm drains affecting the Nile River and its two tributaries (Blue and White Nile)
Atbara	107,930	MSW	Poor waste management system and implementation
Duem	87,068	MSW	Poor waste management system and implementation
Dongola	13,473	MSW	Poor waste management system and implementation
Kosti	346,068	MSW	Poor waste management system and implementation
Port Sudan	489,725	MSW	Main harbor of the Red State in Sudan. Plastic litter originating from Port Sudan could have a significant impact on the marine ecosystem of the Red Sea which joins the

Location (i.e city)	Population (inhabitants)	Type of waste	Causes
			Mediterranean Sea with the Indian Ocean.
Tanzania			
Mwanza	658,070	MSW	Located at Lake Victoria with an annual plastic generation rate of approximately 21,718 tonnes. Rapid urbanization has resulted in increasing waste leakage into aquatic environments.
Uganda			
Makindye Division,	445,278	MSW	Adjacent to Lake Victoria with 3 streams traversing through it (Kansanga, Kyetinda, and Nabisasiro) entering Lake Victoria. Densely populated with many heavy settlements. It has 49 dump sites – the largest no in city with some of these within the lake buffer zone.
Nakawa Division	359,187	MSW	Three rivers drain through industrial parts of the division (Nankolokola, Kinawataka, Vuberebenge) and pouring into Lake Victoria through the Kinawataka wetland. Lacustrine location with many dense settlements with 36 dumpsites. Flooding during rain events is a common occurrence in these zones and washing off plastic waste through Nakivubo Swamp to Lake Victoria can occur.
Central Division	85,165	MSW	Central business district with population doubling during daytime. The main drainage channel of the city traverses the entire business district entering Lake Victoria via

Location (i.e city)	Population (inhabitants)	Type of waste	Causes
			Nakivubo wetland. The channel is misused by dumping of uncollected waste. There are 45 dump sites.
Bweyogerere	317,127	MSW	The population density is very high with two slums- Kireka, Kasokoso that do not receive waste collection services. Many industries are located in this lower parts of the municipality. Flooding is very frequent making it a very common method of waste plastics being moved through Kinawataka and adjacent streams towards Lake Victoria.
Jinja	115,396	MSW	The entire city fringes with Lake Victoria and River Nile thus, the plastic leakage risk is quite substantial. From the WFD, the quantities of waste collected at the transfer station is very small compared to the per capita generation. The uncollected waste amount is substantial and can sieve through because of the location. The waste collection infrastructures are much poorer than those in Kampala.
Fort Portal	52,911	MSW	The city drains through the Mpanga River that traverses it and eventually enters Lake George through to Lake Edward that outs to Lake Albert through Semliki River. The hilly terrain makes it more probable that the uncollected plastics drains into the river.

Location (i.e city)	Population (inhabitants)	Type of waste	Causes
Mbarara	120,900	MSW	River Rwizi transcends the city as its main water drain. This a bustling activity city and the impact of the uncollected waste can negatively enable plastics to leak to the environment is a faster manner.

6.2. WFD – Ethiopia

While Bahir Dar has been identified as a riverine litter hotspot, lack of data availability precluded efforts to apply the WFD for Bahir Dar.

6.3. WFD – Kenya

According to the Kenya National Guidance for Plastic Pollution Hotspotting and Shaping Action report, Kenya generates 503,000 tonnes of plastic waste annually of which only 7% is recycled. Of the 465,000 tonnes of mismanaged waste, 37,000 tonnes leak to water systems as demonstrated in Figure 6.1. Typically, plastic waste comprises approximately 12% of generated MSW.

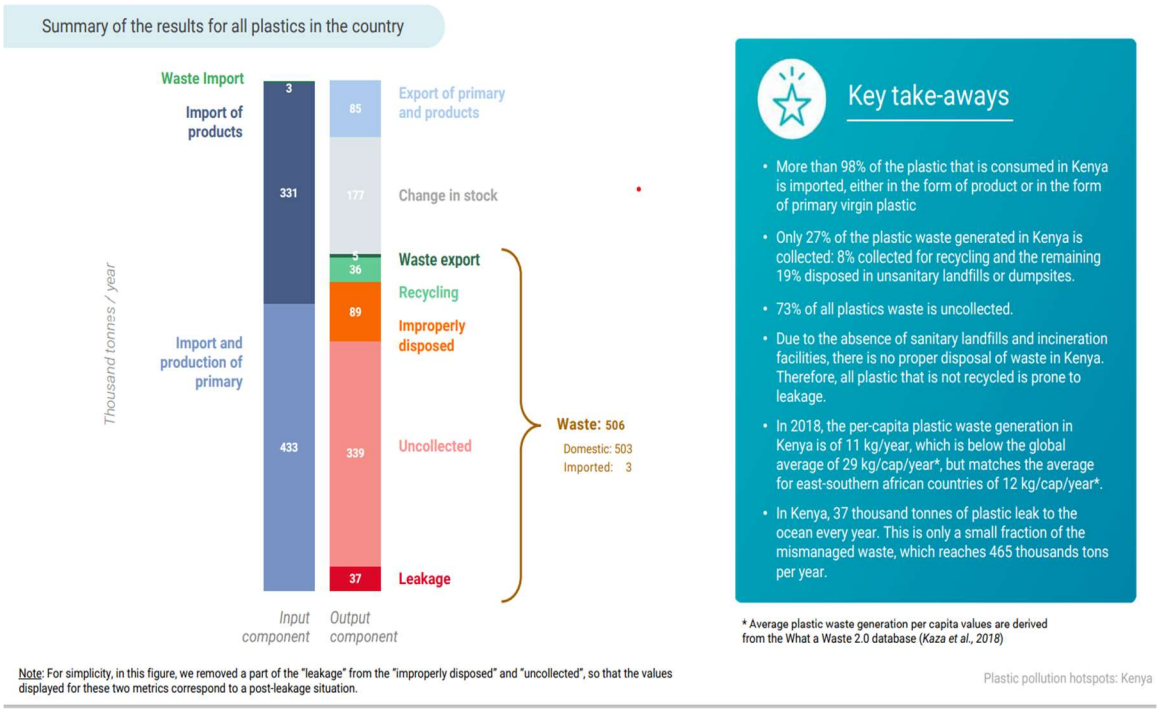


Figure 6.1: Kenya plastic material flow 2018. Source: Local expert (Kenya).

Hotspots have been observed mainly in areas that lack adequate SWM provisions. As shown below in Table 6.2, the significant contributor to plastic waste leakage is uncollected waste. Since collection rates are low, the result is that most plastic waste remains unmanaged and ends up retained with 25 – 30% leaking into water systems. Kisumu exhibits much higher rates of plastic waste collection due to the presence of disposal infrastructure in the city as compared with other identified hotspots.

Table 6.2: Key conclusions from the WFD for Kenya. Source: Local expert (Kenya).

Location	% of plastic waste that is uncollected	% of plastic waste mismanaged	% of plastic waste leaking after collection	% of uncollected plastic waste retained on land	% of uncollected plastic waste entering water systems	% of uncollected plastic waste openly burned	Plastic amounts entering water systems (tonnes/year)
Eldoret	61	65	0	39	26	34	1,863
Kakamega	78	80	0	39	25	36	421
Kericho	79	81	0	39	25	36	482
Kisii	80	81	0	39	25	36	851

Kisumu	44	49	0	37	30	32	1,667

6.4. WFD – Rwanda

Due to data reliability issues, WFDs could not be generated for Rwandan hotspots.

6.5. WFD – Sudan

Although collection rates are comparatively high in Khartoum, the absolute plastic waste leaked into water systems is significant at approximately 15,112 tonnes/year as shown in Table 6.3. The primary cause behind this is plastic leakage into storm drains and then into water systems. Almost half of the plastic leaked into water systems is transported via storm drains.

Table 6.3: Key conclusions from the WFD for Sudan. Source: Local expert (Sudan).

Location	% of plastic waste that is uncollected	% of plastic waste mismanaged	% of plastic waste leaking after collection	% of uncollected plastic waste retained on land	% of uncollected plastic waste entering water systems	% of uncollected plastic waste openly burned	Plastic amounts entering water systems (tonnes/year)
Khartoum	38	86	1	31	62	7	15,112

6.6. WFD – Uganda

Based on the potential impact caused by hotspots and data availability, the hotspots shown in Table 6.4 were selected for WFD application. Considering the proximity to Lake Victoria and the high density of temporary waste storage sites, the Central, Makindye, and Nakawa divisions are the most significant hotspots. After Kampala, the following cities are ranked in descending order of potential impact – Jinja, Fort Portal, and Mbarara. In the case of Jinja, Fort Portal, and Mbarara, data reliability issues and low collected waste volumes means that the WFD could not applied accurately. Keeping in mind data inaccuracies, there is a potential of plastic marine debris generation from Fort Portal, Jinja, and Mbarara, with an estimated 458, 133, and 266 tonnes/year of unmanaged plastics leaking into the environment, respectively. Most plastic waste is retained on land with quantities of 300, 632, and 386 tonnes/year applicable for Fort Portal, Jinja, and Mbarara, respectively.

The Kampala WFD indicates a high risk of plastics reaching Lake Victoria due to heavy rains and subsequent flooding serving as transport mechanisms. This result is similar to that for Khartoum.

Table 6.4: Key conclusions from the WFD for Uganda. Source: Local expert (Uganda).

Location	% of plastic waste that is uncollected	% of plastic waste mismanaged	% of plastic waste leaking after collection	% of uncollected plastic waste retained on land	% of uncollected plastic waste entering water systems	% of uncollected plastic waste openly burned	Plastic amounts entering water systems (tonnes/year)
Kampala	47	62	0.05	52	30	17	9,011

Preliminary results from ongoing studies at Makerere University and NEMA indicate the presence of microplastics in the Lake Victoria Inner Murchison Bay (where both Nakawa and Makindye divisions drain). Figure 6.2 below shows an example of waterways clogged with plastic waste.

Figure 6.2: Kampala drainage channel choked by plastics. Source: Local expert (Uganda).

6.7. WFD – Conclusions

Since the WFD is a rapid assessment tool, additional research is required to validate the results of the application for this project. In several cases, primary data was lacking and assumptions were made in order to apply the WFD which could have increased the degree of inaccuracy in the results. As an example, several assumptions were made regarding the quantity of each waste fraction and involvement of the formal sector compared with the informal sector with respect to collection and sorting. For this reason, the WFD results are not representative, but simply provide an idea on the scale of the issue.

7. Holistic Overview of Plastic Transport within Nile Basin

7.1. Nile Basin Hydrology

The Nile River flows through eleven countries in East Africa from south to north. It originates in rivers that flow into Lake Victoria (located in present-day Uganda, Tanzania, and Kenya) and flows into the Mediterranean Sea more than 6,600 kilometres. As a result, the Nile River is one of the longest rivers in the world, flowing through diverse landscapes. Figure 7.1 shows the level of dependence of the relevant countries on the Nile and its geographical importance. Many of the Nile Basin countries are heavily dependent on the Nile River; for example, in the case of Egypt, it represents 97% of the country's water consumption. Figure 7.1 also depicts the relative importance of the dams as more than 10 dams of varying capacities exist on the Nile River.

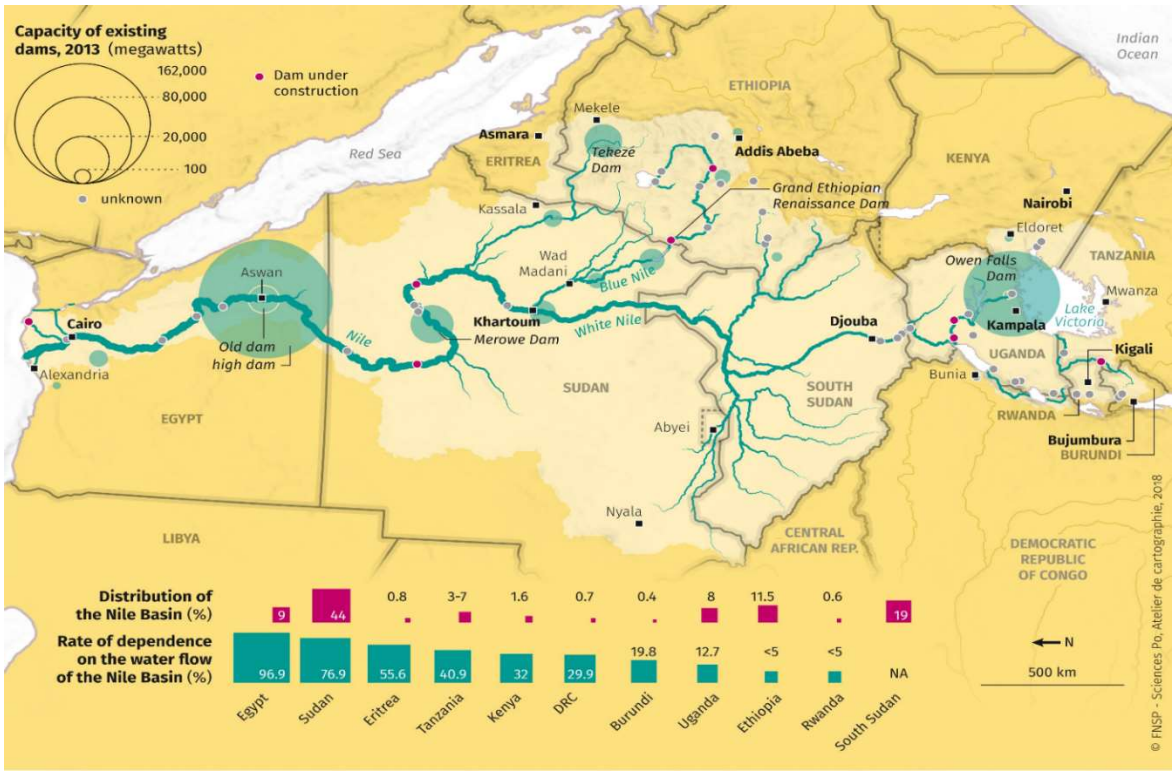


Figure 7.1: Impact of the Nile River on all the countries in its catchment area. Source: (Nile Basin Initiative, n.d.-b).

The Nile Basin can be delineated into ten sub-basins, as seen in Table 7.1.

Table 7.1: Sub-basins of the Nile River. Source: (Nile Basin Initiative, n.d.-b).

No.	Sub-Basin	Area (km^2)
1	Lake Victoria	241,983
2	Lake Albert	96,807
3	Victoria Nile	85,521
4	Bahr El Jebel	185,364
5	Bahr El Ghazal	604,746
6	Baro-Akobo-Sobat	204,228
7	White Nile	258,803
8	Blue Nile	304,656
9	Tekeze-Atbara	232,374
10	Main Nile	958,872

The five broad physiographic regions of the sub-basins include:

- Highlands such as plateaus and mountains.
- Open water surfaces such as lakes (both natural and man-made).
- Wetlands and swamps.
- Flatlands.
- Deserts.

Each physiographic region is characterized by a unique set of geographical characteristics such as surface, slope, soils, topography, and vegetation. The first two physiographic regions occur in the upper sub-basin, while the latter three regions occur mostly in the mid and lower sub-basins. Due to the wide variation in landscapes, the flow of the Nile is variable, as shown in Figure 7.2.

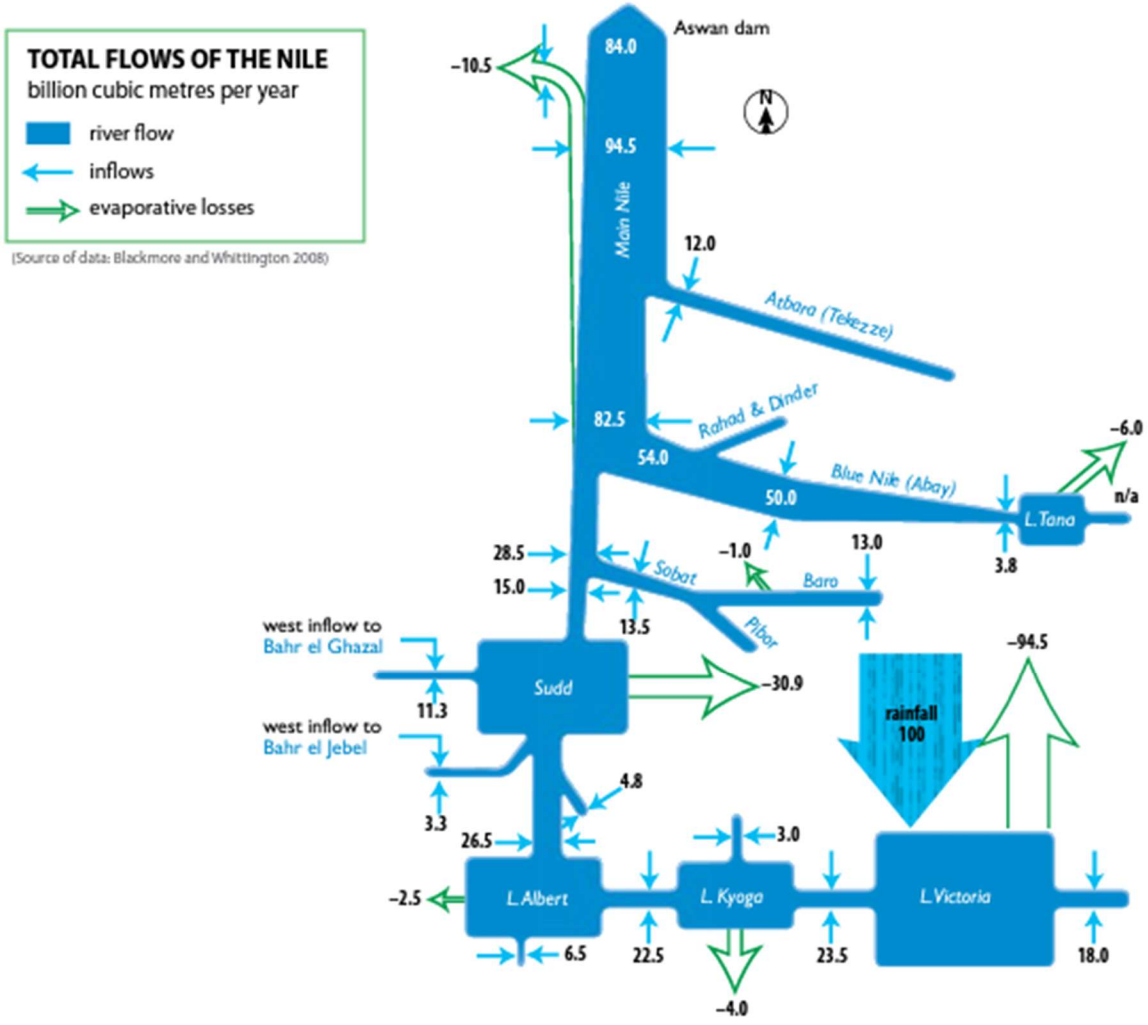


Figure 7.2: The total flows of the Nile in billion cubic meters per year considering river flows, inflows, and evaporative losses. Source: (Onencan & Van de Walle, 2018).

7.2. Macro and Micro Plastic Transport

Due to the Nile River's length and the complex ecosystems, estimating the quantities of macro and microplastic waste transport is a challenge. Research on macro and microplastic waste largely focuses on larger countries such as South Africa and Nigeria, with very little information available on most of the Nile Basin countries. Even within existing research, there is a wide variance in figures reported for plastic leakage into the Mediterranean Sea due to different methodologies and challenges in applying sampling methods to estimate plastic accumulation along the shoreline, at the water surface, in the water column, at the bottom of water bodies, and in marine organisms (Boucher & Billard, 2020).

The mechanisms behind macroplastic waste transport are currently poorly understood. The effects of dams, barrages, and aquatic flora on riverine waste transport need to be further investigated. The spatial distribution of plastic items with varying physical and chemical properties in the water column is also unclear. Factors such as plastic particle density, biofilm formation, and aggregation of suspended particles could affect this spatial distribution. The presence of dams, reservoirs, and barrages may further amplify these effects due to decreased water flow velocity. Plastic waste accumulation has been observed around dams in several parts of the world, such as Serbia and DR Congo (The East African, 2022). Some research suggests that rivers may act as reservoirs for plastic waste, with very small amounts of marine litter being emitted into oceans (van Emmerik et al., 2022). For long rivers such as the Nile, with abundant anthropogenic infrastructure (Figure 7.1), plastic waste can accumulate on riverbanks, floodplains, plants, riverbed sediments, infrastructure, and lakes. The retention times and distribution of accumulated plastic remain under-researched.

According to (Boucher & Billard, 2020), the majority of plastic waste entering aquatic ecosystems consists of macroplastics, as shown below in Figure 7.3. Figure 7.3 also indicates that Egypt is the largest contributor of plastic waste to the Mediterranean Sea within the Nile Basin countries. However, this result could be a function of a lack of research on other countries within the Nile Basin. While Egypt is a major contributor of marine litter to the Mediterranean Sea, most research tends to focus on Egypt and other European countries bordering the Mediterranean Sea. There is little research on the effects of transboundary plastic waste transport upstream of the Nile River. However, there is a clear positive correlation between plastic leakage quantities and mismanagement waste.

In contrast to Egypt's large share of macroplastic waste among the Mediterranean countries, its share of microplastic is comparatively low. Microplastic leakage occurs mainly due to the contributions of tire dust (53%), followed by textiles (33%), cosmetics (12%), and finally, plastic pellet production (2%). This indicates that high-income countries tend to leak more microplastics into the environment than the Nile Basin countries. As shown in Figure 7.3, the microplastic leakage from high-income countries such as Italy are higher than that of Egypt even though Egypt contributes more waste to the Mediterranean Sea.

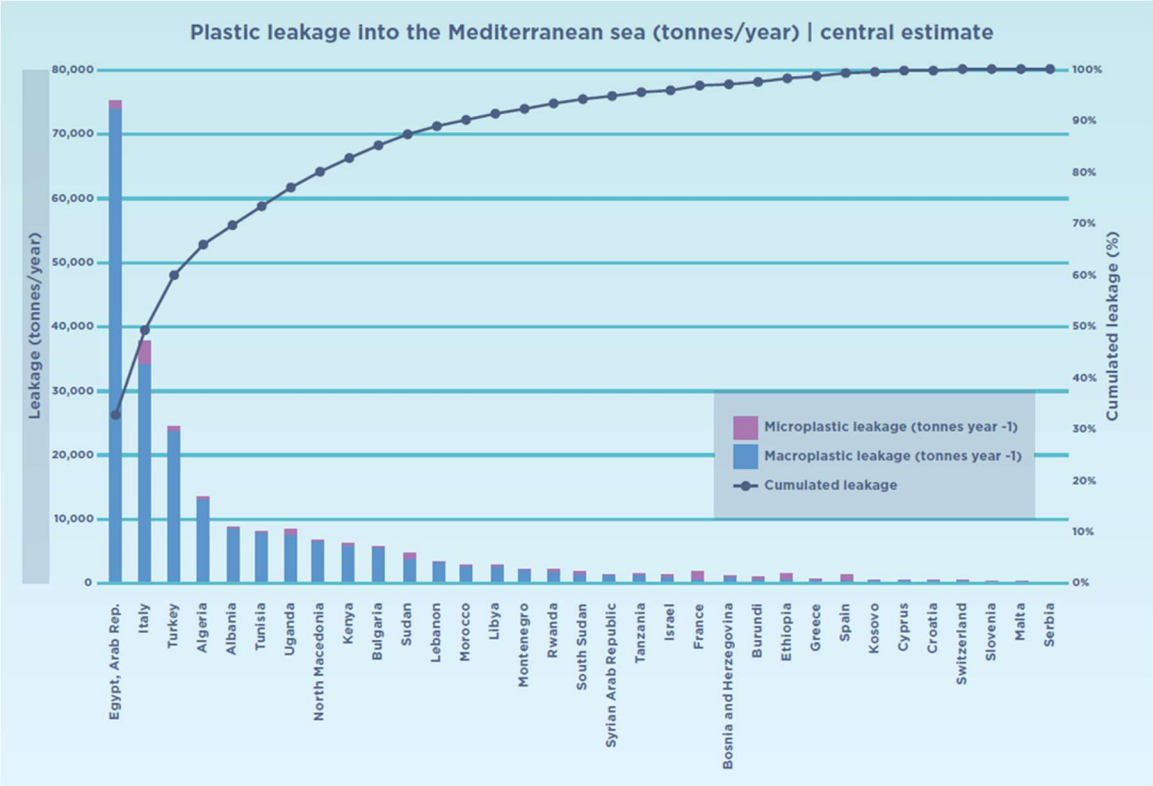


Figure 7.3: Overview of the plastic leakage in the Mediterranean basin for macroplastics and microplastics. Source: (Boucher & Billard, 2020).

8. Recommendations and Conclusions

8.1. Recommendations

Improved data collection

One of the biggest challenges impeding the successful application of interventions to tackle the marine and riverine litter problem is the lack of reliable and accurate data. Currently, there is little to no data that can allow researchers to accurately map the mechanism and source of marine debris generation into the Nile River. WFD application revealed key data gaps related to the informal waste sector and other elements of the waste management value chain, such as the quantity of waste segregated by the informal sector for recovery or the quantity of waste leaked from the formal or informal sector. Additionally, the primary findings of the WFD show that a significant amount of mismanaged waste ends up in water systems, is retained on land, or is transported by storm drains to water systems. Further research is required to validate these findings.

Recommendations for future research include:

- Quantification of plastic waste entering Lake Victoria, the Nile River, and Lake Albert with a focus on transport mechanisms.
- Comprehensive waste composition analysis, particularly to identify different plastic types, to facilitate efficienct recycling.
- An investigative survey with samples and hydrological modelling should be conducted to understand better the role of dams, barrages, and other anthropogenic infrastructure play on the Nile in transporting plastic waste.
- More data must be collected, primarily through a clear water flow mapping and sampling of aquatic fauna/water samples to understand the severity of the situation of microplastics on the Nile ecology.
- Research must be conducted on the pathways via which marine litter flows from the point of generation to its final destination, either in the Mediterranean Sea or at accumulation points along the Nile River.

Strengthening linkages in the SWM value chain

The informal sector should also be integrated to prevent open burning and waste leakage into the environment since the informal sector already utilizes a large portion of the MSW in urban areas. Based on the WFD, it appeared that there is a relation between informal sector activities and mitigation of open burning in addition to waste leakage. The contributions of the informal sector are currently overlooked and regulatory frameworks fail to account for this important part of the SWM value chain. This is especially important since public-sector institutions struggle to provide

adequate SWM services. Collaboration with NGOs, the private sector, the general populace, and the informal sector must be improved in order to provide adequate SWM services. The private sector can be incentivized to collect waste in places where service coverage is poor. Building effective and inclusive institutions can promote capacity building.

Integrated SWM strategies

Due to economic growth and rapid urbanization, growing urban centers will continue to be waste generation hotspots. Appropriate waste management strategies and regulations will have to be developed in order to cope with the increasing burden on already weak infrastructures. There is also a need to promote capacity building of enforcement agencies to ensure effective implementation of enacted waste management laws, regulations, and strategies. The development of a comprehensive, centralized, and integrated waste management system can ensure that adequate data collection and analysis occurs for improvements and information sharing. In countries where SWM-related laws and regulations are missing or inadequate, such frameworks should be implemented keeping in mind the plastic pollution problem and circular economy principles.

A thorough investigation of national and sub-national MSWMS is required to better understand the resources available, the prevalent systemic gaps, and common public practices. Such an investigation can help arrest waste leakage at each stage of the SWM value chain and promote environmentally-sound waste disposal techniques. Comprehensive national action plans can also then be developed to address the systemic gaps. For example, Ethiopia's Environment, Forestry, and Climate Change Commission lacks a national action plan that seeks to reduce SUP consumption. A new action plan can specifically be developed to target this gap. Furthermore, existing laws or regulations should be revised to cover the management of all plastics in their entire life cycle from manufacturing to disposal.

Awareness campaigns

Apart from research, awareness campaigns and environmental literacy programs are required to ensure successful implementation of regulations. Regular communication regarding plastic waste management and sustainable practices should be ensured through the appropriate channels to reach out to the public. Waste management courses should be introduced in educational institutions to improve the quantity of technical experts available.

Waste disposal practices

As evidenced in Kisumu, Kenya (Table 6.2), establishing disposal facilities in hotspots can help reduce the amount of plastic waste leakage into the environment. In the same vein, Ethiopia established the continent's first waste-to-energy facility in 2018 in Addis Ababa. Since Bahir Dar and Asosa have been identified as potential hotspots, setting up appropriate waste disposal facilities to complement improved waste collection will be a significant step in mitigating plastic

pollution. Modern infrastructure such as sanitary landfills must be constructed to mitigate waste leakage into the environment.

Circular economy perspectives must be taken into account to ensure that waste-to-resource initiatives are undertaken. With an increase in population and per capita income, consumption patterns will change with regards to an uptick in the amount of plastic consumed and disposed. This trend should be accounted for to provide more opportunities in the waste sector mostly for private companies and to ensure that municipalities and regulators are able to carry out their responsibilities efficiently.

8.2. Conclusions

Mismanagement of waste is one of the major developmental challenges that the Nile Basin countries have been facing for a prolonged period of its modern history. With the introduction of more chemically complex materials such as plastic, the problem has only become more severe and intricate. This was not sufficiently met with an adequate improvement or enhancement of the SWM system. Unsustainable population growth places an additional burden on the SWM infrastructure. One of the problems with the continued increase of waste mismanagement was plastic pollution and marine litter. Plastic pollution was primarily caused due to weak MSWMS, particularly low collection rates.

This study outlined the status quo of the MSWMS in all the Nile Basin countries and mapped significant marine and riverine litter hotspots through site visits and literature review. From a holistic perspective, the key points to be considered moving forward are:

- Setting up and ensuring the sustainable expansion of a vibrant recycling industry taking into account the informal sector. Apart from recycling, alternative materials and disposal methods should also be looked into.
- Ensuring capacity building of enforcement agencies to implement successfully the enacted SWM regulations.
- Encouraging and incentivizing public-, private-, and civil-sector initiatives that attempt to involve citizens via awareness-raising campaigns.
- The study provides clear evidence for the lack of data and where exactly data is needed to enhance better our understanding of SWM and, specifically, plastic pollution of the Nile.
- Plastic waste transport mechanisms must be better understood.

This scoping report coupled with the WFD further develops the understanding of the generation of MSW, the sources of waste, the modes of collection/transportation, and efficiency and means

of disposal. In addition to that, it provides evidence for the inadequate management of plastic pollution at the local level. The mapping exercise showcased that, in some cases, up to 62% of mismanaged plastic ends up (in the case of Khartoum) in water systems. Recommendations have been provided, primarily for further studies, to better map out the marine debris problem before providing an adequate solution to the marine debris challenges faced across the Nile.

9. References

Akan, O. D., Udofia, G. E., Okeke, E. S., Mgbechidinma, C. L., Okoye, C. O., Zoclanclounon, Y. A. B., Atakpa, E. O., & Adebanjo, O. O. (2021). Plastic waste: Status, degradation and microbial management options for Africa. In *Journal of Environmental Management* (Vol. 292). Academic Press. https://doi.org/10.1016/j.jenvman.2021.112758

Alimi, O. S., Fadare, O. O., & Okoffo, E. D. (2021). Microplastics in African ecosystems: Current knowledge, abundance, associated contaminants, techniques, and research needs. In *Science of the Total Environment* (Vol. 755). Elsevier B.V. https://doi.org/10.1016/j.scitotenv.2020.142422

Antea Group. (n.d.). *Study on the organization of solid waste collection and preliminary landfill assessment | Antea Group*. Retrieved April 1, 2022, from https://int.anteagroup.com/projects/solid-waste-collection-in-kinshasa#87043

Austria Forum. (2014). *Ethiopia*. Austria Forum. https://austria-forum.org/af/Geography/Africa/Ethiopia/Maps/Ethiopia

Ayoub, S. (2018). *Marine litter Management In Egypt*.

Boucher, J., & Billard, G. (2020). *The Mediterranean: Mare plasticum*.

CIA. (n.d.). *Sudan - World Factbook*. Retrieved February 15, 2022, from https://www.cia.gov/the-world-factbook/countries/sudan/

Egypt Ethiopia Kenya South Sudan Uganda, S., & Victoria Tekeze Atbara Bahr el Jebel Baro Akobbo Sobat Victoria Nile Lake Albert, L. (n.d.). *Democratic Republic of the Congo Eritrea United Republic of Tanzania Burundi Rwanda Main Nile Bahr el Ghazal Blue Nile White Nile*.

Eunomia. (2016). *Plastics in the Marine Environment*. *June*, 13. www.eunomia.co.uk

Geyer, R., Jambeck, J. R., & Law, K. L. (2017). Production, use, and fate of all plastics ever made. *Science Advances*, *3*(7), 3–8. https://doi.org/10.1126/sciadv.1700782

Gilardi, K. V. K., Antonelis, K., Galgani, F., Grilly, E., He, P., Linden, O., Piermarini, R., Richardson, K., Santillo, D., Thomas, S. N., Dries, P. Van den, & Wang, L. (2020). Sea-Based Sources of Marine Litter – a Review of Current Knowledge and Assessment of Data Gaps. In *GESAMP - FAO* (Vol. 2021, Issue February).

Godfrey, L., Ahmed, M. T., Gebremedhin, K. G., Katima, J. H. Y., Oelofse, S., Osibanjo, O., Richter, U. H., & Yonli, A. H. (2019). Solid Waste Management in Africa: Governance Failure or Development Opportunity? *Regional Development in Africa*. https://doi.org/10.5772/INTECHOPEN.86974

Government of Uganda. (n.d.). *The Economy | Uganda National Web Portal*. Retrieved April 1, 2022, from https://www.gou.go.ug/about-uganda/sector/economy

Greenpeace Africa. (2020). *34 Plastic Bans in Africa | A Reality Check*. Greenpeace. https://www.greenpeace.org/africa/en/blogs/11156/34-plastic-bans-in-africa/

IUCN-EA-QUANTIS. (2020). *National Guidance for plastic pollution and shaping action, Country Report Tanzania*.

Jambeck, J. R., Geyer, R., Wilcox, C., Siegler, T. R., Perryman, M., Andrady, A., Narayan, R., & Law, K. L. (2015). Marine pollution. Plastic waste inputs from land into the ocean. *Science (New York, N.Y.)*, *347*(6223), 768–771. https://doi.org/10.1126/science.1260352

Japan International Cooperation Agency. (2017). *PROJECT FOR STRENGTHENING SOLID WASTE MANAGEMENT IN KHARTOUM STATE - Project Completion Report*.

Japan International Cooperation Agency (JICA). (2018). *Data Collection Survey on Solid Waste Management in Juba Republic of South Sudan Final Report*.

Joshua Palfreman. (2015, May 13). *A Study about waste pickers in Dar es Salaam, Tanzania*. Https://Globalrec.Org/2015/05/13/a-Study-about-Waste-Pickers-in-Dar-Es-Salaam-Tanzania/.

Kaudia, A., & Erika, R. (2018). Tackling the Waste Crisis in Kenya. *The Magazine for Environmental Managers*, *January*.

Kinshasa_EN. (n.d.).

Lyons, B. P., Cowie, W. J., Maes, T., & Le Quesne, W. J. F. (2020). Marine plastic litter in the ROPME Sea Area: Current knowledge and recommendations. *Ecotoxicology and Environmental Safety*, *187*. https://doi.org/10.1016/j.ecoenv.2019.109839

Manirakiza, N., Théophile, N., Jung, C. G., Ndikumana, T., & Jung, C. G. (2020). Municipal Solid Waste Sorting in Burundi, Inventory and Perspectives: Case of Bujumbura City Comparative study of briquette produced from micipal waste and residual biomass with different processes View project Municipal Solid Waste Sorting in Burundi, Inventory and Perspectives: Case of Bujumbura City. In *International Journal of Innovative Science and Research Technology* (Vol. 5, Issue 3). https://www.researchgate.net/publication/340540651

McAllister, J. (2015). Factors Influencing Solid-Waste Management in the Developing World. *All Graduate Plan B and Other Reports*. https://doi.org/https://doi.org/10.26076/2c24-5944

Mier, I. A. M., & Zhuo, L. (2020). Current Status of Municipal Solid Waste Management in Juba City, South Sudan. *International Journal of Scientific and Research Publications (IJSRP)*, *10*(8), 671–684. https://doi.org/10.29322/ijsrp.10.08.2020.p10485

Mostafa, M., & Peters, R. W. (2012). *Characterization and Assessment of Industrial Wastewaters in Egypt*.

Mpinda, M. T., Zakari, S., Abass, O. K., Nsokimieno, E. M. M., Sebagenzi, G. D., Basheke, L. L., Kesonga, M., Nkomerwa, H. de P. I., Khonde, R., & wa Kasangij, P. K. (2017).

Characterization of Household Wastes in D.R. Congo, a Case Study of Lubumbashi. *American Journal of Environmental Sciences*, *13*(3), 277–288. https://doi.org/10.3844/ajessp.2017.277.288

Nile Basin Initiative. (n.d.-a). *Member States | Nile Basin Intitative (NBI)*. Retrieved January 8, 2022, from https://nilebasin.org/index.php/nbi/member-states

Nile Basin Initiative. (n.d.-b). *Nile Basin Water Resources Atlas*. Retrieved January 8, 2022, from http://atlas.nilebasin.org/start/

NILE BASIN INITIATIVE. (n.d.). *SOUTH SUDAN WETLANDS GOVERNANCE AND MANAGEMENT PROFILE*. Retrieved February 14, 2022, from http://nilebasin.org/wetlands/wp-content/uploads/2019/03/South-Sudan-Wetlands-Governance-and-Management-Profile.pdf)

Ntakamulenga, R. (n.d.). *THE STATUS OF SOLID WASTE MANAGEMENT IN IN TANZANIA*.

Nyampundu, K., Mwegoha, W. J. S., & Millanzi, W. C. (2020). Sustainable solid waste management Measures in Tanzania: An exploratory descriptive case study among vendors at Majengo market in Dodoma City. *BMC Public Health*, *20*(1). https://doi.org/10.1186/s12889-020-08670-0

Onencan, A. M., & Van de Walle, B. V. (2018). Equitable and Reasonable Utilization: Reconstructing the Nile Basin Water Allocation Dialogue. *Water 2018, Vol. 10, Page 707*, *10*(6), 707. https://doi.org/10.3390/W10060707

Osman, A. (2020). *Sudan First State of Environment and Outlook Report 2020 Environment for Peace and Sustainable Development Republic of Sudan*. https://www.unep.org/resources/report/sudan-first-state-environment-outlook-report-2020

PPIAF Assistance in the Democratic Republic of Congo. (2011).

REMA. (2021). State of Environment and Outlook Report. *Rwanda Environment Management Authority*, *August*, 88.

Sadan, Z., & de Kock, L. (2021). *Plastic Pollution in Africa: Identifying policy gaps and opportunities*.

Scarlat, N., Motola, V., Dallemand, J. F., Monforti-Ferrario, F., & Mofor, L. (2015). Evaluation of energy potential of Municipal Solid Waste from African urban areas. *Renewable and Sustainable Energy Reviews*, *50*, 1269–1286. https://doi.org/10.1016/J.RSER.2015.05.067

Sibanda, L. K., Obange, N., & Awuor, F. O. (2017). Challenges of Solid Waste Management in Kisumu, Kenya. *Urban Forum*, *28*(4), 387–402. https://doi.org/10.1007/s12132-017-9316-1

Tanzania National Bureau of Statistics. (2021). *Highlights on Third Quarter_GDP_2021*. https://www.nbs.go.tz/index.php/en/census-surveys/national-accounts-statistics/na-publications/698-highlights-on-the-third-quarter-gdp-july-september-2021

Tassie, K., Endalew, B., & Mulugeta, A. (2019). Composition, Generation and Management Method of Municipal Solid Waste in Addis Ababa City, Central Ethiopia: A Review. *Asian Journal of Environment & Ecology*, *2*, 1–19. https://doi.org/10.9734/AJEE/2019/V9I230088

Teshome, F. B. (2020). Municipal solid waste management in Ethiopia; the gaps and ways for improvement. *Journal of Material Cycles and Waste Management 2020 23:1*, *23*(1), 18–31. https://doi.org/10.1007/S10163-020-01118-Y

The East African. (2022). *Plastic pollution cuts electricity in DR Congo - The East African*. The East African. https://www.theeastafrican.co.ke/tea/rest-of-africa/plastic-pollution-cuts-power-in-dr-congo-3756640

The World Factbook - The World Factbook. (n.d.). Retrieved September 14, 2022, from https://www.cia.gov/the-world-factbook/

UNEP. (2009). Marine Litter : A Global Challenge. In *UNEP*.

UNITED REPUBLIC OF TANZANIA THE NATIONAL SOLID WASTE MANAGEMENT STRATEGY. (2018).

van Emmerik, T., Mellink, Y., Hauk, R., Waldschläger, K., & Schreyers, L. (2022). Rivers as Plastic Reservoirs. *Frontiers in Water*, *3*, 212. https://doi.org/10.3389/FRWA.2021.786936/BIBTEX

Vice President's Office of United Republic of Tanzania. (2020). *Investment Guide on Waste Management in Tanzania*. https://www.vpo.go.tz/uploads/publications/en-1592551770-Tanzania Investment Guide on Waste Management 2020_3.pdf

Victoria Basin Water Board, L. (2021). *ANNUAL BASIN HYDROLOGICAL REPORT 2020/2021 LAKE VICTORIA BASIN WATER BOARD*.

Vlachogianni, T. (n.d.). *Overview of best practice marine litter monitoring methodologies and management measures*.

Wilson, D., Rodic, L., Modak, P., Soos, R., Rogero, A. C., Velis, C., Iyer, M., & Simonett, O. (2015). Global Waste Management Outlook. In *Global Waste Management Outlook*. https://doi.org/10.18356/765baec0-en

World Bank. (n.d.). *Population, total - Uganda | Data*. Retrieved April 1, 2022, from https://data.worldbank.org/indicator/SP.POP.TOTL?locations=UG

World Development Indicators. (n.d.). *Worldbank - Databank - Tanzania*. Https://Databank.Worldbank.Org/Reports.Aspx?Source=2&country=TZA.

Yusuf, A. A., Peter, O., Hassan, A. S., Tunji, L. A., Oyagbola, I. A., Mustafa, M. M., & Yusuf, D. A. (2019). Municipality solid waste management system for Mukono District, Uganda. *Procedia Manufacturing*, *35*, 613–622. https://doi.org/10.1016/J.PROMFG.2019.06.003

10. Annexes

10.1. Annex A – Waste Management flow

10.1.1. Burundi

General information

Table 10.1: General information about Burundi regarding populations, country area and area in the Nile Basin and waste generation rate. Source: (Nile Basin Initiative, n.d.-a; World Bank, n.d.).

Aspect	Details
Population (million)	12 (2020)
Population growth (annual %)	3.1 (2020)
Country area (1000 km^2)	28.7
Area in the Nile Basin (1000 km^2)	13.9
% of Country Area in Nile Basin	49.4
% population living in the Nile Basin	58.8%
Main industries	Agriculture 28.5% Industry 10.7% Services 45.2%
Waste generation rate	N/A

Waste management flow – Burundi

Table 10.2: Waste management flow in Burundi. Source: (CIA, n.d.).

Waste flow	Details
Waste generation	1,872,016 tonnes/year (2002)
Recycling at source	N/A
Collection approach	➢ Households keep their waste till it is collected. The collection occurs once a week. ➢ Door to door by private associations.
Transport approach	Trucks with risk of waste scattering in the street.
Waste storage (e.g. transfer stations)	N/A
Intermediate recycling	N/A
Uncontrolled disposal	Solid waste is discharged in disorder on a not landscaped site
Controlled disposal	N/A
Treatment	N/A

Waste management flow – Bujumbura

Table 10.3: Waste management flow in Bujumbura. Source: (Manirakiza et al., 2020).

Waste flow	Details
Waste generation	630 tons of waste are generated daily, from which 51 tons are plastic waste
Recycling at source	N/A
Collection approach	38.1% private company, 19% public company, 35.7% paid person
Transport approach	N/A
Waste storage (e.g. transfer stations)	N/A
Intermediate recycling	N/A
Uncontrolled disposal	Buterere landfill site (closed for 10 years but not remediated), Mubone landfill site
Controlled disposal	N/A
Treatment	N/A

10.1.2. DR Congo

General information

Table 10.4: General information about DR Congo regarding populations, country area and area in the Nile Basin and waste generation rate. Source: (CIA, n.d.; Nile Basin Initiative, n.d.-a; World Bank, n.d.).

Aspect	Details
Population (million)	89.6 (2020)
Population growth (annual %)	3.1 (2020)
Country area (1000 km^2)	2,516.4
Area in the Nile Basin (1000 km^2)	21.8
% of Country Area in Nile Basin	0.9
% population living in the Nile Basin	65.9
Main industries	Agriculture 19.7% Industry 43.6% Services 36.7%
Waste generation rate	N/A

Waste management flow – DR Congo

Although understanding households' economic and social behaviour is essential to improve solid household waste management, these studies in the Democratic Republic of Congo (DRC) are unavailable (Mpinda et al., 2017).

Table 10.5: Waste management flow in DR Congo. Source: (Scarlat et al., 2015).

Waste flow	Details
Waste generation (10^3 t/year)	4,640 (year 2012); 11,890 (year 2025 prognosis)
Recycling at source	N/A
Collection approach	N/A
Transport approach	N/A
Waste storage (e.g. transfer stations)	N/A
Intermediate recycling	N/A
Uncontrolled disposal	Uncontrolled dumping of waste in urban spaces and landfills
Controlled disposal	N/A
Treatment	N/A

Waste management flow – Kinshasa

Table 10.6: Waste management flow in Kinshasa. Source: (Antea Group, n.d.; *Kinshasa_EN*, n.d.).

Waste flow	Details
Waste generation	The waste generation rate is 0.7 kg/person/day. The municipal waste composition includes 65% organic material and 15% plastic.
Recycling at source	N/A
Collection approach	N/A
Transport approach	N/A
Waste storage (e.g. transfer stations)	N/A
Intermediate recycling	The solid waste sector is not structured or properly regulated, and the recycling potential is underdeveloped.
Uncontrolled disposal	Mombele, Matebe, Mososo, Funa, Kingabwa and Salongo landfills
Controlled disposal	Mpas landfill
Treatment	N/A

10.1.3. Ethiopia

General information

Table 10.7: General information about Ethiopia regarding population, area and area in the Nile Basin and waste generation rate. Source: (Nile Basin Initiative, n.d.-a; World Bank, n.d.).

Aspect	Details
Population (million)	11.9 (2020)
Population growth (annual %)	3.1 (2020)
Country area (1000 km^2)	28.7
Area in the Nile Basin (1000 km^2)	13.9

Aspect	Details
% of Country area in Nile Basin	49.4
% population living in the Nile Basin	58.8%
Main industries	Agriculture 28.5% Industry 10.7% Services 45.2%
Waste generation rate	N/A

Waste management flow – Ethiopia

Table 10.8: Waste management flow in Ethiopia. Source: Local expert.

Waste flow	Details
Waste generation	Source segregation is not widespread in Ethiopian cities. The rate of a municipal waste generation far exceeds its management capacity.
Recycling at source	Children and beggars on the streets go door to door, asking for food scraps, reusable textiles, and recyclable materials, which they either use themselves or sell to recycling brokers.
Collection approach	<u>Household waste:</u> ➢ Micro, small, and medium enterprises (MSMEs) are primarily in charge of door-to-door waste collection. ➢ The second most commonly practised method is the curbside collection system. City administrations place containers on street corners and street crossings. Residents deposit their waste using baskets, plastic bags, or sacks. ➢ Informal waste collectors go door to door in most Ethiopian cities (including Addis Ababa and Bahir Dar) and collect waste either on a client basis or by asking if people have solid waste to dispose of. The payment for collection services can be in cash or in kind. ➢ *Koralews*: itinerant buyers who go door to door collecting recyclable and reusable materials such as metals, plastics, glasses, corrugated iron sheets, tins, car batteries, and other materials. ➢ *Lewaches*: people who go door to door exchanging clothes and shoes for new plastic barrels, sauce panels, spoons, and other items, depending on the type and age of the cloth. <u>Apartments and condominiums:</u> ➢ Set out collection system is used. ➢ The collector uses horns to alert citizens they are approaching. Residents deposit their trash into pushcarts and take it to the transport truck. <u>Industry, hotels, hospitals and schools:</u> ➢ The block (container) collection system is the utilized approach.

Waste flow	Details
Transport approach	Door to door collection is done via manually driven carts or vehicles.
Waste storage (e.g. transfer stations)	Waste is gathered at transfer stations and transported to dumpsites in each city by municipal transportation infrastructure. The exception is Mekelle, where the private sector transports waste from transfer stations to municipal dumpsites.
Intermediate recycling	Dumpsite pickers collect recyclables and reusable materials at landfills and sell them to intermediaries or recycling companies.
Uncontrolled disposal	Uncontrolled dumping of waste in urban spaces and landfills.
Controlled disposal	N/A
Treatment	N/A

10.1.4. Kenya

General Information

Table 10.9: General information about Kenya regarding population, area and area in the Nile Basin and waste generation rate. Source: (Nile Basin Initiative, n.d.-a; World Bank, n.d.).

Aspect	Details
Population (million)	53.8 (2020)
Population growth (annual %)	2.25 (2020)
Country area (1000 km^2)	589
Area in the Nile Basin (1000 km^2)	51.4
% of Country Area in Nile Basin	8.7
% population living in the Nile Basin	40 (2012)
Main industries	Service (mainly tourism) 53.6% Agriculture 23.1% Industry 17.4%
Waste generation rate	0.46 kg/person/day

Waste Management flow – Kisumu

Table 10.10: Waste management flow in Kisumu. Source: (Sibanda et al., 2017).

Waste flow	Details
Waste generation	The waste generation is estimated to range between 200 – 450 tons of waste daily, with a population of 500,000 in 2013. The waste generation rate per capita ranges between 0.4 – 0.9 kg/day. Approximately 20% of the generated waste is collected and transported to the overflowing dumpsite Kachok, 80 % accumulates in skips, on vacant land and along the passageways.

Waste flow	Details
Recycling at source	Collection points contain a three-bin system, where waste is separated into organic (green bin), plastic (blue bin) and other (brown). Some other collection points also provide a yellow bin for glass and bottles and white bins for paper. However, the recycling at the source turned out to be not successful as mixed waste were found in all bins. Furthermore, private or public waste collectors hurdled the sorted wastes into one container.
Collection approach	➢ Public waste collection services are provided daily and are mostly concentrated within the business districts and market areas. ➢ Private waste collectors offer a weekly door-to-door collection service to major residential estates, schools, universities, hospitals and business complexes that are able and willing to pay for their services.
Transport approach	Public waste collection services use trucks/ lorries and tractors to collect and transport to the Kachok dumping site.
Waste storage (e.g. transfer stations)	There are few central waste transfer points or communal points.
Intermediate recycling	There is limited recycling and reuse. Waste containers from plastics, glass and metallic cans are generally reused for different domestic and commercial purposes (e.g., to store paraffin, water, oil and honey). Organic waste from households and slums are mainly fed to animals. Some of the plastic wastes are upcycled to crafts, bags, etc.
Uncontrolled disposal	➢ Most of the waste from Kisumu are disposed of at the dumpsite Kachok, but most commonly, landfilling, open burning and illegal dumping are the common waste disposal practices. ➢ Waste from households that are not able and/or willing to pay for waste collection services is disposed of in open spaces, alongside roads and drainage systems. ➢ Low-income residential and informal settlements receive little to no waste collection services due to poor accessibility.
Controlled disposal	N/A
Treatment	N/A

Waste management flow – plastic

Table 10.11: Waste management plastic in Kenya. Source: (IUCN-EA-QUANTIS, 2020).

Waste flow	Details
Waste generation	A total of 506 thousand tonnes of plastic waste was generated in 2018, whereby 3 thousand tonnes of plastic waste was imported. The per-capita plastic waste generation is 11 kg/person/year in the same year.
Recycling at source	27 % of the generated plastic waste was collected
Collection approach	Collection points

Waste flow	Details
Transport approach	Waste collection vehicles
Waste storage (e.g. transfer stations)	N/A
Intermediate recycling	N/A
Uncontrolled disposal	27 % of the generated plastic waste was collected, while 8% were recycled, the other 19 % were disposed of in unsanitary landfills or dumpsites. 73 % of the generated plastic waste remain uncollected. It is assumed that about 37 thousand tonnes of plastic leak into the ocean every year.
Controlled disposal	N/A
Treatment	N/A

10.1.5. Rwanda

General Information

Table 10.12: General information about Rwanda regarding populations, country area and area in the Nile Basin and waste generation rate. Source: (Nile Basin Initiative, n.d.-a; World Bank, n.d.).

Aspect	Details
Population	12,950,000 (2020)
Population growth (annual %)	1.8% (2021)
Country area (1000 km^2)	26.3
Area in the Nile Basin (1000 km^2)	20.6
% of Country Area in Nile Basin	84.0
% population living in the Nile Basin	82.6 (2010)
Main industries	Agriculture 31% (2017) Industry 19% (2017) Services 46% (2017)
Waste generation rate	0.57 kg/person/day

Waste Management flow - Rwanda

Table 10.13: Waste Management flow in Rwanda. Source: Local expert.

Waste flow	Details
Waste generation	Low waste generation rates ranging between 0.4 – 0.7 kg/person/day.
Recycling at source	Typically, source separation is non-existent.
Collection approach	Private companies are contracted with municipalities to collect wastes stored in bags from households on a weekly basis for a monthly payment. The commercial areas and markets use communal containers (sizes of

Waste flow	Details
	containers are 60, 120, 240, 660, 1100 liters) or walled collection bays (sizes of walled collection bays is 7x4x2.5 m3), from which waste is collected daily.
Transport approach	The transport is done through trucks, some are adequate and modern compactors trucks others are still normal trucks. However, from interactions with the operators, the government is requiring operators to use modern trucks in their operations. However, operators stated that the investment required is very high and would appreciate financial support from the government as it is being done to other sectors like agriculture, mining, and tourism.
Waste storage (e.g. transfer stations)	N/A
Intermediate recycling	N/A
Uncontrolled disposal	All waste ends up in uncontrolled dumped at sites where some manual sorting is undertaken for informal recycling. In addition to lack of disposal facilities, lack of wastes to resources initiative and low recycling rates, and irregularities of collection services continue to make the waste management sector a major contributor to public and environmental health in urban centers of Rwanda. More than half of waste generated is organic but most of it ends in landfills while it could be used for organic fertilizers.
Controlled disposal	N/A
Treatment	Recycling sector is mostly informal in nature with composting facilities treating a small fraction of generated organic waste.

10.1.6. South Sudan

General Information

Table 10.14: General information about South Sudan regarding populations, country area and area in the Nile Basin and waste generation rate. Source: (Nile Basin Initiative, n.d.-a; World Bank, n.d.).

Aspect	Details
Population (million)	11.5 (2022)
Population growth (annual %)	1.26 (2022)
Country area (1000 km^2)	610.95
Area in the Nile Basin (1000 km^2)	115.4
% of Country Area in Nile Basin	98
% population living in the Nile Basin	99
Main industries	Oil sector 70% Agriculture 15% Service sector 6.1%

Aspect	Details
Waste generation rate	N/A

Waste management flow - Juba City

Table 10.15: Waste management flow in Juba City. Source: (Egypt Ethiopia Kenya South Sudan Uganda & Victoria Tekeze Atbara Bahr el Jebel Baro Akobbo Sobat Victoria Nile Lake Albert, n.d.; Japan International Cooperation Agency (JICA), 2018; Mier & Zhuo, 2020; NILE BASIN INITIATIVE, n.d.).

Waste flow	Details
Waste generation	The waste generation rate is about 0.65 kg/person/day with a population of 1.5 million citizens, and the city produces roughly 950 tonnes of waste per day.
Recycling at source	No recycling as there is no market in South Sudan. However, according to Mier & Zhuo (2020), the landfill is not surrounded by fences, and waste pickers scavenge for hard plastic and metal scraps sold to Uganda and Kenya. Aluminium is upcycled into decorations and sold to Kenya and Uganda.
Collection approach	In 2012 the paving ratio of South Sudan was 2.2 %, where most paved streets are found in Juba. Most of the streets in Juba are unpaved and inaccessible due to narrow and muddy streets. According to Mier & Zhuo (2020), around 95% of Juba's homes are excluded from waste collection services.
Transport approach	2nd hand transportation vehicles with a capacity ranging between 8 – 25 m^3: ➢ 13 compactors. ➢ Trucks. ➢ Tractors. ➢ Operational vehicles.
Waste storage (e.g. transfer stations)	No waste storage is available and not desired by the Ministry of Environment due to smell.
Intermediate recycling	N/A
Uncontrolled disposal	Illegal dumping sites, where waste are either dumped or burnt by waste pickers ➢ Juba-Nimule Road.
Controlled disposal	JCC and JICA established the sanitary landfill of Rejaf Panam in 2012, which has an area of 25 hectares.
Treatment	N/A

10.1.7. Sudan

General Information

Table 10.16: General information about Sudan regarding populations, country area and area in the Nile Basin and waste generation rate. Source: (CIA, n.d.; Osman, 2020).

Aspect	Details
Population	43,850,000 (2020)
Population growth (annual %)	2.4 (2020)
Country area (1000 km^2)	1,861
Area in the Nile Basin (1000 km^2)	1,396
% of Country Area in Nile Basin	74.9
% population living in the Nile Basin	87% (2012)
Main industries	Agriculture 39.6% (2017) Industry 2.6% (2017) Services 57.8% (2017)
Waste generation rate	0.5 kg/person/day

Waste Management flow - Sudan

Table 10.17: Waste management flow in Sudan. Source: (Osman, 2020).

Waste flow	Details
Waste generation	7.67 million tonnes of solid waste were generated by 42 million Sudanese in 2017
Recycling at source	N/A
Collection approach	33% of the country's waste are collected
Transport approach	N/A
Waste storage (e.g. transfer stations)	N/A
Intermediate recycling	N/A
Uncontrolled disposal	67% of the solid waste is not collected annually, implying illegal disposal at residential and vacant areas. Some of the waste is recycled informally.
Controlled disposal	33 % of the generated waste are disposed of in open dump landfills, and at some waste disposal sites, waste is burnt.
Treatment	N/A

Waste Management flow – Khartoum State

Table 10.18: Waste management flow in Khartoum State. Source: (Japan International Cooperation Agency, 2017).

Waste flow	Details
Waste generation	In 2016 the daily amount of solid waste was 5752 tonnes/day from the entire Khartoum State with about 7.4 million residents, divided into seven localities. The highest waste generation rate was found in the Khartoum Locality with 1.53 kg/person/day, while the lowest was 0.52 kg/person/day in Umbadda Locality.
Recycling at source	N/A
Collection approach	The waste collection includes a door-to-door and collection point approach. The collection rate was around 63% for the entire state, with local differences in 2016.
Transport approach	705 registered trucks were in operation in 2016.
Waste storage (e.g. transfer stations)	N/A
Intermediate recycling	N/A
Uncontrolled disposal	37 % of the generated waste remained uncollected and were dumped illegally.
Controlled disposal	There are three landfills with a total area of 1000 ha distributed in the Khartoum State.
Treatment	N/A

Waste Management flow – Blue Nile (State)

Table 10.19: Waste management flow in Blue Nile State. Source: (Osman, 2020).

Waste flow	Details
Waste generation	➢ 561,200 tonnes/year with a waste generation rate of 0.5 kg/person/day in rural and urban areas. ➢ Agriculture: 117 tonnes/year ➢ Industry: 23 tonnes/year ➢ Medical: 17 tonnes/year
Recycling at source	Not in practice yet, but it is promoted via campaigns to increase the recycling at source rate to 40 % by 2030.
Collection approach	The state employed a total of 73 workers in 2017. The waste collection includes door-to-door collection points and others. The collection system coverage in urban areas is 40% and for rural areas 16%.
Transport approach	Collection frequency ➢ Urban areas: twice a week. ➢ Rural areas: twice a week. ➢ Markets: daily. Available collections vehicles are Trucks and tractors with trolleys.

Waste flow	Details
Waste storage (e.g. transfer stations)	N/A
Intermediate recycling	N/A
Uncontrolled disposal	N/A
Controlled disposal	N/A
Treatment	N/A

Waste Management flow – River Nile (State)

Table 10.20: Waste Management flow in River Nile (State). Source: (Osman, 2020).

Waste flow	Details
Waste generation	835.6 tonnes/ year, the waste generation rate is 0.75 kg/person/day Waste generation in different sectors Agriculture: 46 tonnes/ year Industrial: 8 tonnes/year Medical: 70 tonnes/year
Recycling at source	Not in practice yet, but it is promoted via campaigns to increase the recycling at source rate to 40 % by 2030.
Collection approach	The state employed 262 workers in 2017. The waste collection includes about 15 % door-to-door, 4% collection point (containers) and 81% other collection systems. The collection coverage for urban areas is about 35 %, while only 1 % covers rural areas.
Transport approach	The collection frequency for ➢ Urban areas: once a week ➢ Rural areas: once a week ➢ Markets: twice a day Available transportation vehicles: ➢ 9 trucks with two supervisor cars ➢ 29 tractor with trolley ➢ 4 compactor
Waste storage (e.g. transfer stations)	N/A
Intermediate recycling	N/A
Uncontrolled disposal	N/A
Controlled disposal	N/A
Treatment	N/A

10.1.8. Tanzania

General Information

Table 10.21: General information about Tanzania regarding population, area and area in the Nile Basin and waste generation rate. Source: (Vice President's Office of United Republic of Tanzania, 2020; Victoria Basin Water Board, 2021; World Bank, n.d.; World Development Indicators, n.d.).

Aspect	Details
Population (million)	59.7 (2020)
Population growth (annual %)	2.9 (2020)
Country area (1000 km^2)	947.3
Area in the Nile Basin (1000 km^2) *	115.4
% of Country Area in Nile Basin*	13
% population living in the Nile Basin	21
Main industries	Agriculture 25% Construction 15% Trade and Repair 8.7%
Waste generation rate	0.66 – 0.95 kg/person/day

*Lake Victoria as the source of the Nile river

Waste management flow – Tanzania

Table 10.22: Waste management flow in Tanzania. Source: (Ntakamulenga, n.d.; Tanzania National Bureau of Statistics, 2021; World Development Indicators, n.d.).

Waste flow	Details
Waste generation	12.1 – 17 million tonnes per year
Recycling at source	Urban context: ➢ Minimal waste segregation within the Central Business District Areas, industries, institutions and households. ➢ The informal sector recycles about 5 – 10 % of the generated MSW and mainly involves plastics, paper, scrap metal, aluminium cans and glass.
Collection approach[19]	➢ Less than 50% is collected and disposed of at landfills, while 3% is disposed of by open burning and 30% by burying. The remaining 17% is discharged into the environment illegally.
Transport approach	Waste is collected via trucks with rear and side loaders. Common problems with collection and transportation include: ➢ High operational costs due to poor choice of vehicles and distance from collection point to the disposal site. ➢ Inaccessibility of localities. ➢ Improper planning of collection routes and frequency. ➢ Limited supervision.
Waste storage (e.g. transfer stations)	N/A

Waste flow	Details
Intermediate recycling	N/A
Uncontrolled disposal	➢ More than 90% of MSW are disposed of in open and poorly operated dumpsites across the country.
Controlled disposal	➢ Eight municipalities since 2020, namely Arusha, Tanga, Mwanza, Ilemela, Mbeya, Dodoma, Kigoma and Mtwara, have improved landfills with lining and leachate collection system constructed by the Tanzania Cities Project (TSCP) and funded by Worldbank from 2010 to 2020.
Treatment	N/A

Waste management flow – Dar el Salaam

Information on waste management flow in Dar el Salaam, the fastest growing city in Tanzania, is based on the "National Solid Waste Management Strategy" published by UN Environment Programme in 2018.

Table 10.23: Waste management flow in Dar el Salaam. Source: (Joshua Palfreman, 2015; *UNITED REPUBLIC OF TANZANIA THE NATIONAL SOLID WASTE MANAGEMENT STRATEGY*, 2018).

Waste flow	Details
Waste generation	An estimated 4.2 million inhabitants generated 4,600 tonnes of solid waste per day in 2015, which equals 1 kg/day/household (average value for developing countries range from 0.4 – 0.6 kg/day/household).
Recycling at source	N/A
Collection approach	➢ Daily collection of waste at collection points directed by Municipal councils assisted with private companies and informal sectors ➢ Estimated 1,237 informal waste pickers were active in 2013.
Transport approach	➢ Dar el Salaam is divided into five local districts (Ilala, Temeke, Kigamboni, Ubungo and Kinondoni), and each district has a certain number of collecting trucks either owned by municipal councils or private companies.
Waste storage (e.g. transfer stations)	Containers without lids are at collection points.
Intermediate recycling	N/A
Uncontrolled disposal	➢ Less than 40% of the total wastes are appropriately collected and disposed of in designated dump (uncontrolled) sites at Pugu Kinyamwezi approx. 30 km away from the city centre. ➢ The remaining 60% are either burnt at the households or dumped by the roadside into drainage canals, sewers and shores or buried and thrown in an open field.

Waste flow	Details
	➢ Waste disposal is conducted in an open landfill without safety features such as a baseliner, leachate and gas collection system, soil cover, gates and fencing.
Controlled disposal	N/A
Treatment	N/A

Waste management flow – Plastic waste in Tanzania

In the last decade, Tanzania's economy grew significantly, which can be seen in the rapid growth of the cities and the increase of waste amount, especially plastic waste. To tackle plastic waste in Tanzania, the IUCN proposed in their study a shaping action to reduce plastic leakage and recycling (IUCN-EA-QUANTIS, 2020).

Table 10.24: Plastic waste management flow in Tanzania. Source: (Joshua Palfreman, 2015; *UNITED REPUBLIC OF TANZANIA THE NATIONAL SOLID WASTE MANAGEMENT STRATEGY*, 2018).

Waste flow	Details
Waste generation	315,000 tonnes of plastic waste were generated in 2018, which equals 5.6 kg/person/year.
Recycling at source	It is estimated that about 40% of plastic is collected, and only 4% will be recycled.
Collection approach	N/A
Transport approach	N/A
Waste storage (e.g. transfer stations)	N/A
Intermediate recycling	N/A
Uncontrolled disposal	There are no sanitary landfills and incineration facilities for proper plastic waste disposal. Around 95% of the plastic waste is mismanaged (improperly disposed and uncollected) and can leak to the oceans, rivers and lakes. In 2018, about 29,000 tonnes of plastic leaked into the ocean, rivers and lakes.
Controlled disposal	N/A
Treatment	N/A

Plastic waste in urban Mwanza (2020)

Mwanza Urban is located at Lake Victoria and therefore, important as plastic waste source of the Nile (IUCN-EA-QUANTIS, 2020).

Table 10.25: Plastic waste management flow in urban Mwanza. Source: (Joshua Palfreman, 2015; *UNITED REPUBLIC OF TANZANIA THE NATIONAL SOLID WASTE MANAGEMENT STRATEGY*, 2018).

Waste flow		Details
1	**Waste generation**	21,718 tonnes of plastic waste were generated by 658,070 inhabitants, which equals 33 kg/person/year
2	**Recycling at source**	N/A
3	**Collection approach**	6,950 tonnes were collected and improperly disposed
4	**Transport approach**	N/A
5	**Waste storage (e.g. transfer stations)**	N/A
6	**Intermediate recycling**	N/A
7	**Uncontrolled disposal**	14,768 tonnes remained uncollected 1,331 tonnes are leaked into Lake Victoria
8	**Controlled disposal**	N/A
9	**Treatment**	N/A

10.1.9. Uganda

General information

Table 10.26: General information about Uganda regarding populations, country area and area in the Nile Basin and waste generation rate. Source: (Government of Uganda, n.d.; Nile Basin Initiative, n.d.-a; World Bank, n.d.; Yusuf et al., 2019).

Aspect	Details
Population	45,741,000 (2020)
Population growth (annual %)	3.3 % (2020)
Country area (1000 km^2)	244.5
Area in the Nile Basin (1000 km^2)	240.1
% of country Area in Nile Basin	99.5 %
% of the population living in the Nile Basin	99.4%
Main industries	Services 50.3% Industry 25.5% Agriculture 24.2%
Waste generation rate	0.4 – 0.6 kg/person/day

Waste management flow – Uganda

Table 10.27: Waste management flow in Uganda. Source: Local expert.

Waste flow	Details
Waste generation	Urban context: ➢ According to the Uganda Bureau of Statistics (UBOS), Uganda's population growth rate is higher than the global average of 1.05% at 3.3%. This has resulted in a high degree of urbanization, triggering a waste management challenge due to the lack of waste management infrastructure in urban areas. Rural context: ➢ Waste generated from rural areas is not considered municipal waste since it is handled at the individual household level instead of collectively.
Recycling at source	Rural context: ➢ The most common method applied for organic waste is home composting, burning, and using mulching material when appropriate.
Collection approach	N/A
Transport approach	N/A
Waste storage (e.g. transfer stations)	N/A
Intermediate recycling	N/A
Uncontrolled disposal	N/A
Controlled disposal	➢ The dominantly used method of treatment and disposal of waste is landfilling, which is solely the responsibility of the city, Municipal, or Town Councils.
Treatment	N/A

Waste management flow – Kampala

Table 10.28: Waste management flow in Kampala. Source: Local expert.

Waste flow	Details
Waste generation	➢ Recent figures from KCCA indicate that Kampala city collects nearly 1200 MT per day. This figure is an increase from 950 MT in 2015. ➢ Approximately 50,176 MT of MSW generated each month (1,672 MT/day) with roughly 14,336 MT/month (478 MT/day) remaining

Waste flow	Details
	uncollected. Approximately 7.8% or 130 MT/day of the MSW generated is plastic waste.
Recycling at source	➢ Segregation of waste at the household level is not useful because collectors utilize only 1 truck of mixed waste.
Collection approach	➢ Kampala City licenses private operators to collect waste from defined locations to supplement the city's functionality and transport it to the Kitezi landfill. ➢ Private waste generators are charged a fee for the collection service. As a result, only affluent areas and institutions willing to pay are serviced by private operators. ➢ The Kampala City government serves other low-income areas without charging a fee. ➢ An increased amount of waste was reported as collected because KCCA imposed fines and licensing restriction policies on private operators who did not deliver collected waste to the Kitezi landfill. This was done to address the issue of illegal dumping by informal collectors. ➢ Roughly 38 MT/day of this plastic waste remains uncollected due to lack of access to generation sources and inadequate market.
Transport approach	N/A
Waste storage (e.g., transfer stations)	➢ There are currently over 1200 temporary holding storage sites (often designated as transfer stations where households place their waste awaiting municipal collection), with some sites near rivers/streams and Lake Victoria.
Intermediate recycling	➢ Public and private-sector waste collectors and transporters recover valuables and recyclables from household waste at the point of collection and/or at temporary storage sites. ➢ Approximately 25 – 40% of sorting of valuable waste by collectors and transporters occurs before reaching landfills. The sorted waste (recyclable plastics, metals, and paper) is sold to the agents of the recyclers before reaching the landfill. ➢ Segregated waste such as recyclable plastics, metals, and paper is sold to the agents of the recyclers before reaching the landfill. ➢ Of the 131 MT/day of plastic waste generated, approximately 66% or 86 MT/day of plastic waste is recovered before arrival at the Kitezi landfill. At Kitezi landfill, approximately 60% of the plastic waste is collected by waste pickers.
Uncontrolled disposal	N/A
Controlled disposal	➢ Kampala Landfill - Kitezi landfill. ➢ Over 1000 pickers are working daily at landfills to segregate waste.
Treatment	N/A

Waste management findings from other cities

Waste management systems in Fort Portal, Jinja, Mbarara, Kasese, Mbale, and Soroti were examined. Four of these cities are located near water bodies and, thus, potentially leaking plastics to the marine environment.

Table 10.29: Waste management flow in Fort Portal, Jinja, Mbarara, Kasese, Mbale and Soroti. Source Local expert.

Waste flow	Details
Waste generation	➢ Fort Portal – 28 MT/month (0.92 MT/day) of MSW generated of which 2.4 MT/month (0.08 MT/day) is plastic waste ➢ Kasese – 24 MT/month (0.79 MT/day) of MSW generated of which 0.80 MT/month (0.03 MT/day) is plastic waste ➢ Mbarara – 36 MT/month (1.2 MT/day) of MSW generated of which 1.6 MT/month (0.05 MT/day) is plastic waste ➢ Jinja – 21.2 MT/month (0.7 MT/day) of MSW generated of which 0.77 MT/month (0.03 MT/day) is plastic waste ➢ Soroti – 20.8 MT/month (0.7 MT/day) of MSW generated of which 0.63 MT/month (0.02 MT/day) is plastic waste
Recycling at source	N/A
Collection approach	Rural context: ➢ There are no private collectors of waste. ➢ More than 74% of the waste from these cities is not collected. Cities are predominantly rural areas.
Transport approach	N/A
Waste storage (e.g. transfer stations)	N/A
Intermediate recycling	➢ All the recyclable materials collected by the waste pickers are sold to the agents from Kampala, where the recycling plants are located.
Uncontrolled disposal	➢ Due to the rural nature of most parts of these cities, most waste is dumped into the environment.
Controlled disposal	N/A
Treatment	➢ In response to the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC), waste composting plants were set up by the Ugandan government at the landfills in these cities to minimize methane emissions.

10.2. Annex B – Local Expert Reports

Table 10.30: Names of the supplementary country reports.

Country	Supplementary Document Title
Ethiopia	S1_Local Consultant Report_Ethiopia
Kenya	S2_Local Consultant Report_Kenya
Rwanda	S3_Local Consultant Report_Rwanda
Sudan	S4_Local Consultant Report_Sudan
Uganda	S5_Local Consultant Report_Uganda

10.3. Annex C – Legislative Frameworks

Table 10.31: Key legislative frameworks enacted in non-case study countries.

Country	Legislative Frameworks
Burundi	No official legal system specialized for SWM. However, Law No. 1/10 of June 30, 2000 on the Environment Code of the Republic of Burundi fixes the fundamental rules intended to allow the management of the environment and the protection of this one against all forms of degradation.
DR Congo	Draft law on sanitation has been formulated but it is expected that laws specific to solid waste will be formulated in the future. The relevant regulations are as follows: ➢ Draft law on sanitation (Projet de loi sur l'assainissement), 2017. ➢ Constitution of the DR of Congo (Constitution de la RDC), 2006 (revised in 2015). ➢ Organic Law No. 08/016 of 2008 regarding composition, organisation and functioning of ETD (Decentralised Territorial Entities) and their relationships with state and province. ➢ Law No. 11/009 of 09 July 2011 regarding Fundamental Principles Relating to the Protection of the Environment (Loi n° 11/009 du 09 juillet 2011 portant principes fondamentaux relatifs à la protection de l'environnement). Formal guidelines for environmental impact assessment have not been formulated in the DRC
South Sudan	No official legal systems specialized for waste management, but two laws are related to SWM: ➢ National Environmental Protection Bill, 2013 – Prepared by Ministry of Environment and Forestry. – Has not been enacted. – A section for SWM. ➢ Local Government Act, 2009 – Description of general public works by the local governments. Local governments are responsible for waste management.
Tanzania	No official legal system specialized solely on waste management, however there are several laws and regulation supporting the Solid Waste Management. The following laws are listed based on their importance in descending order: ➢ Environmental Management Act No. 20 (2004) – Principal law on environment. – Part IX is dedicated to SWM. – Provides duties for local government in solid waste management, disposal of solid waste from market business areas, and institutions, storage of solid waste from industries, solid waste collection and waste transfer stations and final disposal of waste.

	➢ Regulations and guidelines supporting SWM: – Environmental Impact Assessment and Audit Regulations, 2005 and 2008 amendments – Environmental Management (Air Quality Standards) Regulations, 2007 – Environmental Management (Hazardous Waste Control and Management) Regulations, 2009 – Environmental Management (Soil Quality Standards) Regulations, 2007 – Environmental Management (Solid Waste) Regulations, 2009 – Land (Assessment of Value for Compensation) Regulations, 2001 – Land (Compensation Claims) Regulations, 2001

10.4. Annex D – Main Contributors of Marine Litter

10.4.1. Ethiopia

Table 10.32: List of institutions and organizations identified as marine litter contributors to Lake Tana, Bahir Dar. Source: Local expert (Ethiopia).

No.	Company/Institution	Industry	Product(s)	Location
1	Green Garden	Leisure	Recreational services	Bahir Dar
2	Abay Minch Lodge	Tourism	Recreational services	Bahir Dar
3	Ajip Gas Station	Fuel service	Fuel service	Bahir Dar
4	Tana Hotel	Tourism	Recreational services	Bahir Dar
5	Kuriftu Winery	Leisure	Recreational services	Bahir Dar
6	Garden of Moonlight	Leisure	Recreational services	Bahir Dar
7	Bahir Dar Water and Sewerage Service Office	Government office	Government services	Bahir Dar
8	Bahir Dar City Administration	Government office	Government services	Bahir Dar
9	Amhara National Regional State Head of Government office	Government office	Government services	Bahir Dar
10	Amhara Development Association	Non-for-profit organization for economic and social progress	Community development	Bahir Dar
11	Bernos Art Gallery and Cafe	Leisure	Recreational services	Bahir Dar
12	Tayitu Recreation Center	Leisure	Recreational services	Bahir Dar
13	Garden of Kokel	Leisure	Recreational services	Bahir Dar
14	Kuriftu Lodge	Leisure	Recreational services	Bahir Dar
15	Grand Resort & Spa Hotel	Tourism	Recreational services	Bahir Dar
16	Desset Lodge	Tourism	Recreational services	Bahir Dar

17	Blue Nile Resorts Hotels	Tourism	Recreational services	Bahir Dar
18	Michael Church	Religion	Religious services	Bahir Dar
19	Abel Fishery	Leisure	Recreational services	Bahir Dar
20	FelegeHiwot Referral Hospital	Healthcare	Medical services	Bahir Dar
21	Shimela Lodge	Tourism	Recreational services	Bahir Dar

10.4.2. Kenya

Table 10.33: List of institutions and organizations identified as marine litter contributors in Kenya. Source: Local expert (Kenya).

No.	Company/Institution	Industry	Product(s)	Location
1	Domestic waste from various categories of residential areas	Residential	Comprises of various forms of packaging and personal hygiene products	Various residential areas in urban centers in the LVDB including Kisumu, Kakamega, Homabay, Eldoret and Kisii.
2	Agricultural produce markets	Agriculture	Organic waste	Various residential areas in urban centers in the LVDB.
3	Shops, supermarkets and restaurants etc. in urban commercial zones	Business	Plastics, paper, and organic waste	Various residential areas in urban centers in the LVDB.
4	Learning institutions, hospitals, Hotels	Education, Health, hospitality	Plastics, paper, and organic waste	Various locations within the LVDB.
5	Bus and train stations	Transport	Plastic bottles and other containers	Various residential areas in urban centers in the LVDB
6	Beaches and fishing land sites	Tourism and fishing	Plastics packaging, and organic waste	Various locations along the shores of Lake Victoria.
7	Marine Based Sources	Water transport and economic activities - fishing, tourism	Plastics packaging, waste from fishing gear	In different locations within the lake.

8	Manufacturing industries	Food processing – food products, breweries	Effluent and solid particles	Food manufacturing industries mainly in Kisumu and Eldoret.

10.4.3. Rwanda

Table 10.34: List of institutions and organizations identified as marine litter contributors in Rwanda. Source: Local expert (Rwanda).

No.	Company/Institution	Industry	Product(s)	Location
1	Inyange Industries (operating since 1997) Later in 2001, the plant introduced Mineral Water processing and packaging.	Agriculture, manufacturing, agro-processing	High quality mineral drinking water, fruit juices, milk and dairy products.	Kigali City with distributors across the country.
2	Sulfo Rwanda Industries established in 1962 .	Manufacturing and marketing importation and trading	Soaps, packaged drinking water, cosmetics, plastics, and detergent.	Kigali City and two distributions in Rubavu and Rusizi.
3	Mukamira Dairy (Part of Inyange Industries) operating since 2017.	Milk processing plant	Its operations include processing and pasteurized milk, gouda cheese, yogurt, UHT-whole milk, UHT flavoured (Vanilla, strawberry, chocolate), Ikivuguto and UHT Drinking Yogurt (Vanilla, Strawberry& Chocolate).	Nyabihu District, Western province.
4	SINA Gerard Urwibutso Enterprise Akandi Water	Food processing and supply	Akandi natural mineral water, Agashya passion juice Akabanga chilli oil made in olive and Akarusho banana wine	Rulindo District: between Kigali City and Musanze City
5	Huye established its doors in 2000	Drinking water	Packaged drinking water	Huye City
6	Transboundary sources: Kenya,			

	Uganda, Tanzania, and DR Congo			
7	Jibu Rwanda	Drinking water	Packaged drinking water	Kigali City and distributors across the country
8	BRALIRWA SA	Beverage Manufacturing	Beverages	Rubavu
9	SKOL Breweries	Beverages manufacturing packaged mineral water	Beverages and Virunga (mineral) water	Kigali
10	Masaka Creamery	Food processing and manufacturing	Luxury cheese, yogurt, crème fraiche and a variety of soft cheeses.	Kigali
11	Industries	Leather factory		Kigali

10.4.4. Uganda

Table 10.35: Selective summary of major plastic manufacturing and recycling facilities in Uganda. Source: Local expert.

No.	Company/Institution	Industry	Product(s)	Location
1	Adia Jogi Enterprises	Plastic manufacturing and recycling	Plastics	Kampala
2	Plastic Industry Ltd.	Plastic manufacturing and recycling	Plastics	Kampala
3	Romplast	Plastic manufacturing	Plastics	Kampala
4	Mukwano Industries	Plastic manufacturing	Household plastics	Kampala
5	Blowplast Uganda Limited Barracks	Plastic manufacturing	Plastic packaging	Kampala
6	Pipeline Design and Foam Industries	Plastic manufacturing	Plastic carrier bags, construction sheets, and flat packaging plastic bags	Kampala
7	Safe Pack Industries	Plastic manufacturing	Plastic carrier bags	Kampala
8	Luley Plastics World Co. Ltd.	Plastic manufacturing	Plastic carrier bags	Kampala

9	Prince's Plastic Industries Ltd.	Plastic manufacturing	Plastic carrier bags	Kampala
10	Quality Polybags Ltd.	Plastic manufacturing	Plastic carrier bags	Kampala
11	Tic Plastics Ltd.	Plastic manufacturing	Plastic carrier bags	Kampala
12	Pargati Plastics Industry Ltd.	Plastic manufacturing	Plastic carrier bags	Kampala
13	Tian Yi Su Plastics Ltd.	Plastic manufacturing	Plastic carrier bags	Wakiso district
14	Nile plastic Industries Ltd.	Plastic manufacturing	Plastic carrier bags	Kampala
15	Jesco Plastic Industries Ltd. (Tesco)	Plastic manufacturing	Plastic carrier bags	Wakiso district

10.5. Annex E – Marine Litter Hotspots

10.5.1. Ethiopia

Figure 10.1: Map of Ethiopia with reference to the Nile. Source: (Austria Forum, 2014).

10.5.2. Kenya

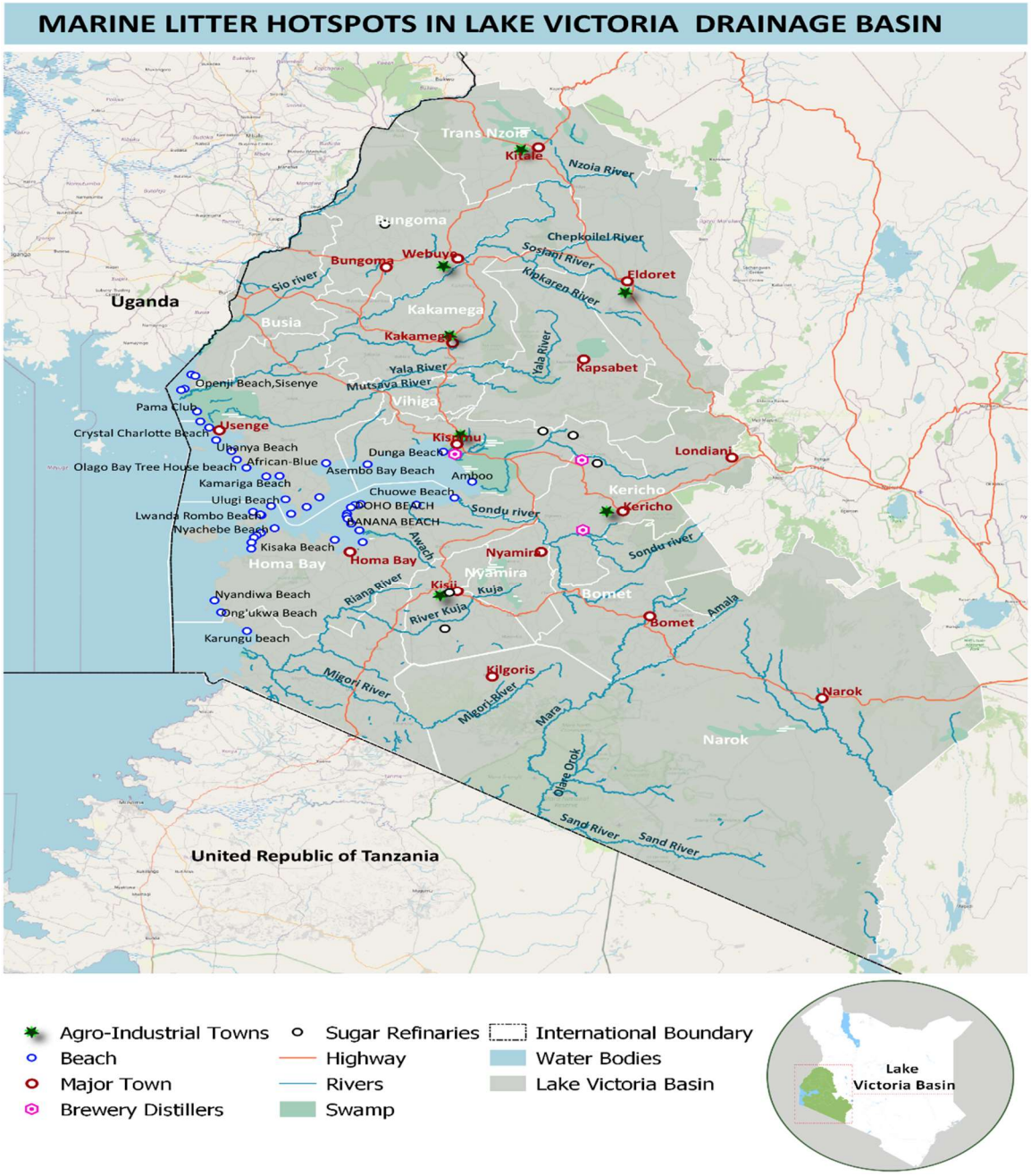


Figure 10.2: Potential marine litter sources in Kenya's LVDB. Source: Local expert (Kenya).

10.5.3. Rwanda

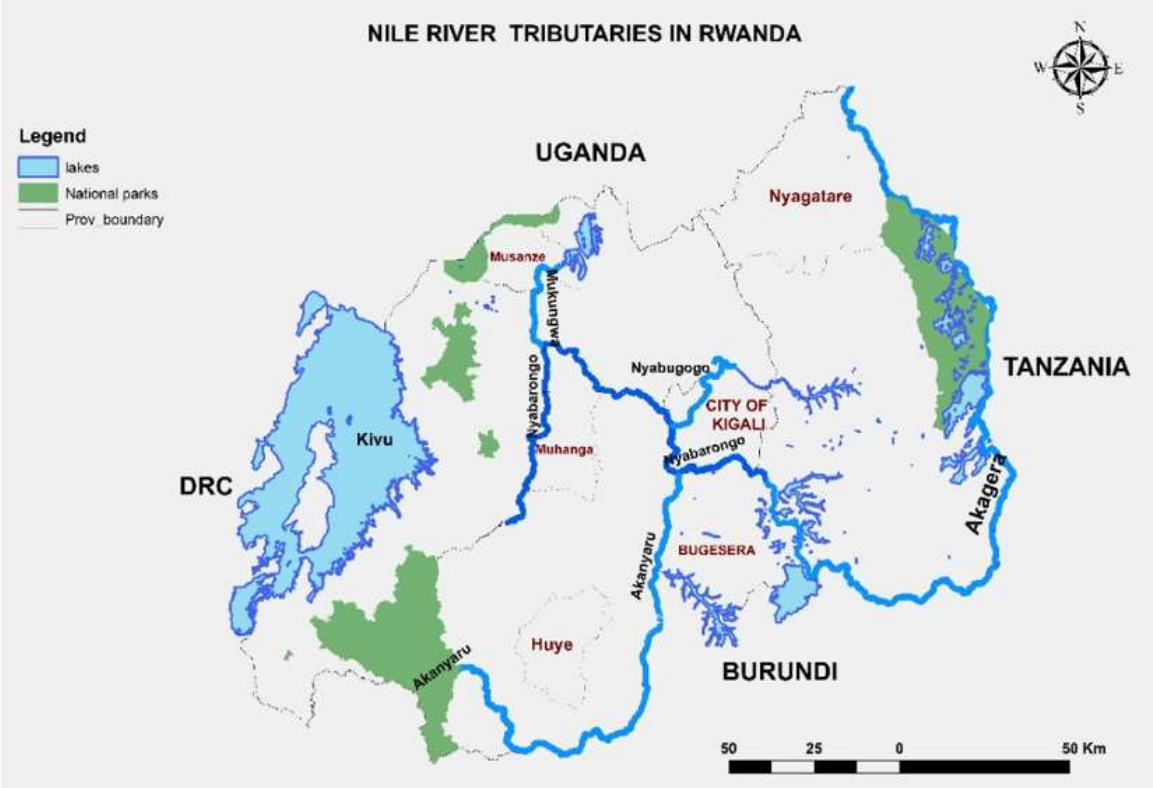


Figure 10.3: Hydrological map of Rwanda with a focus on the rivers constituting the Nile River in Rwanda. Source: Local expert (Rwanda).

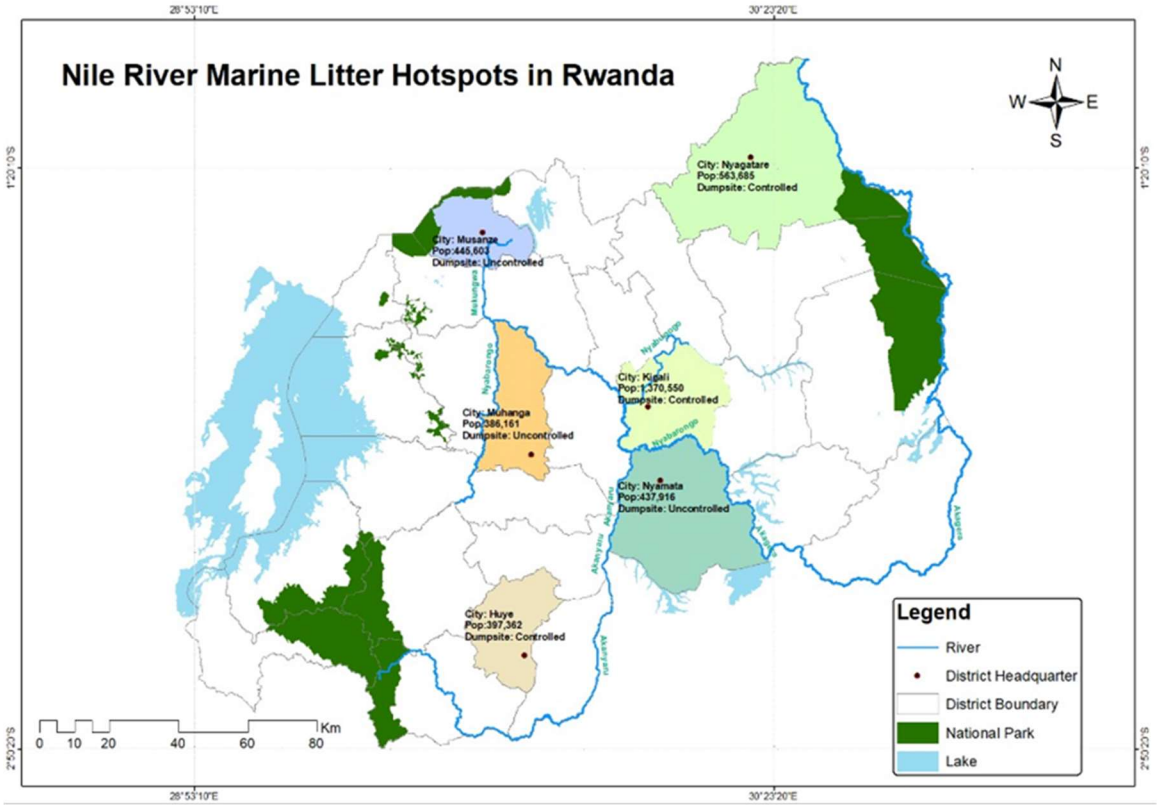
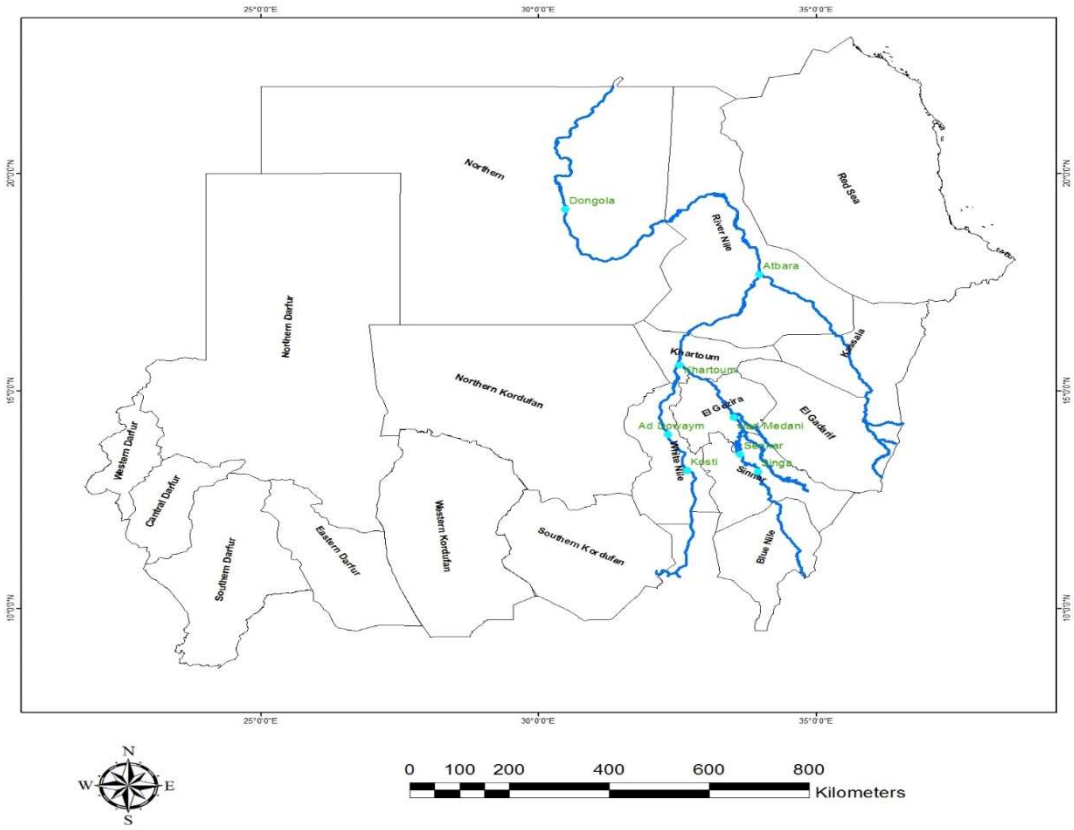


Figure 10.4: Potential marine litter sources in Rwanda. Source: Local expert (Rwanda).

10.5.4. Sudan



NAME	N	E
Sennar	33.62131297330	13.54807148260
Singa	33.94083202350	13.15193124650
wad Medani	33.51839518600	14.40041321600
Dongola	30.47426462300	19.18422446400
Kosti	32.66859817500	13.18064403530
Atbara	33.96679687500	17.67603492740
Khartoum	32.53098779910	15.60439124310
Ad Dowaym	32.32482754580	14.00560986480

Figure 10.5: Potential marine litter sources in Sudan. Source: Local expert (Sudan).

10.5.5. Uganda

Figure 10.6: Map of cities determined to be hotspots in relation to the Nile Basin. Source: Local expert (Uganda).

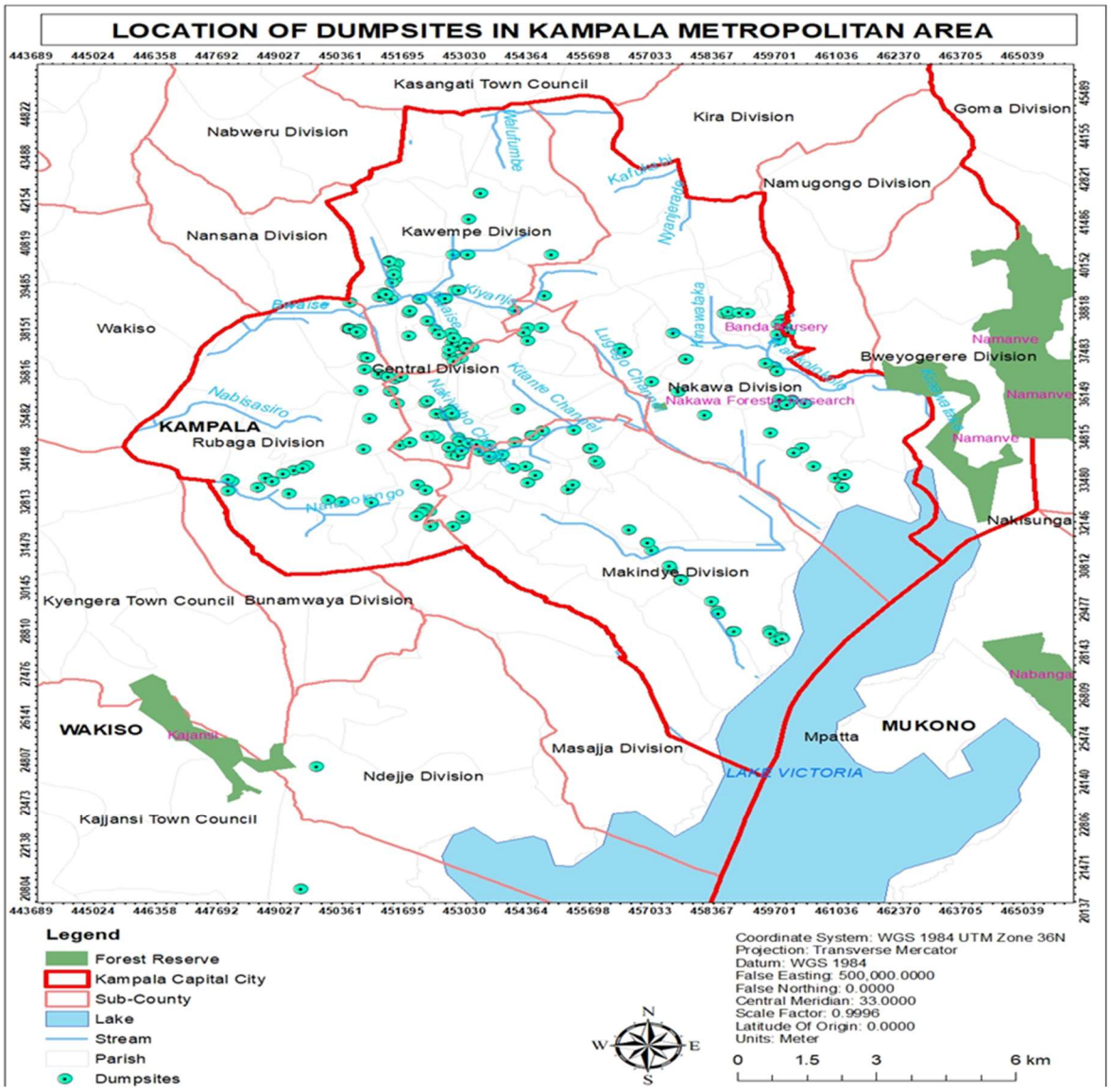


Figure 10.7: Location of waste collection dumpsites in Kampala and parts of Kira Municipal Council. Source: Local expert (Uganda).

10.5.6. Nile Basin

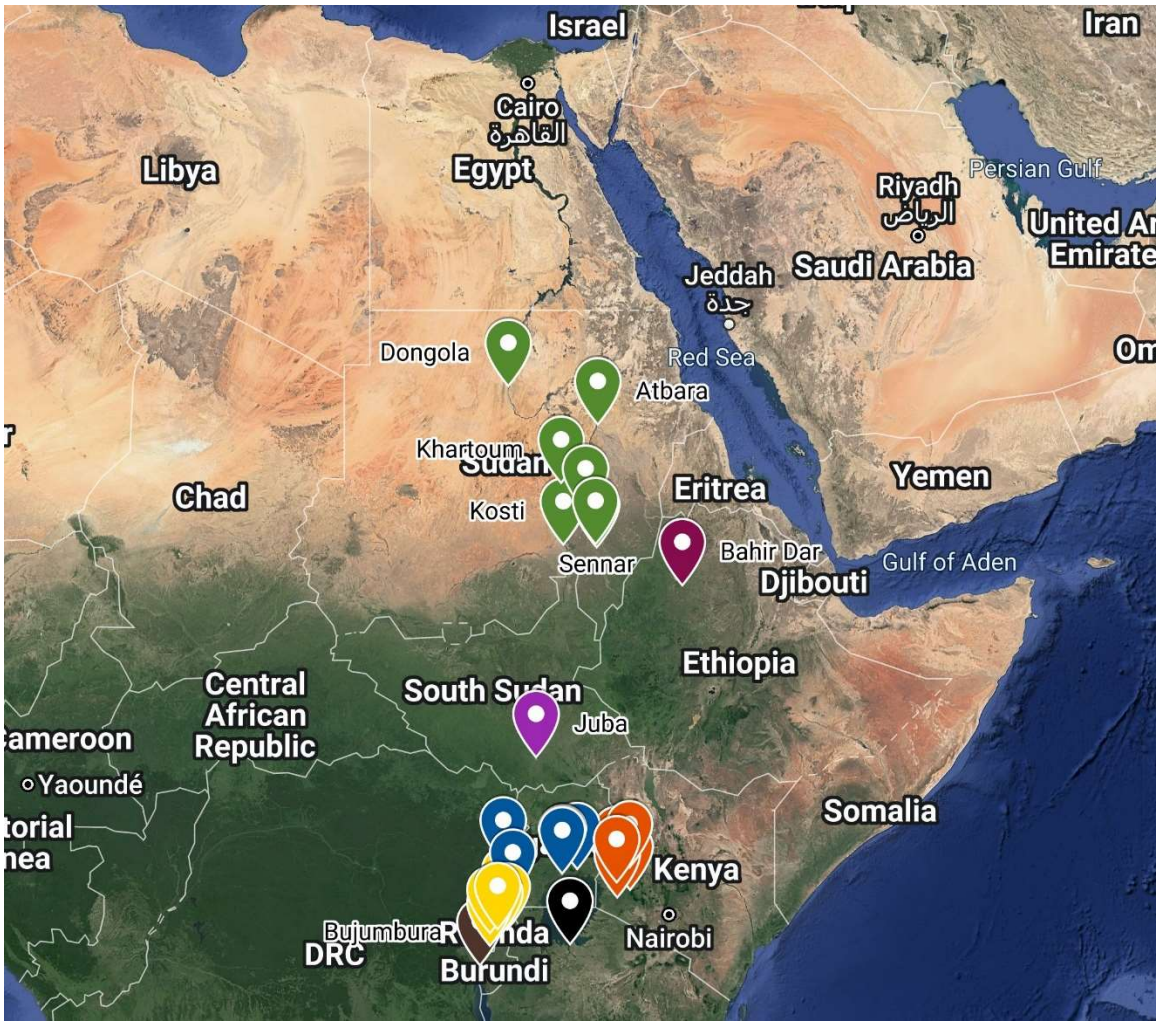


Figure 10.8: Mapping of all hotspots identified in the Nile Basin countries. Source: BFS.

10.6. Annex F – Country Case Study Reports

10.6.1. Ethipoa

10.6.2. Kenia

10.6.3. Rwanda

10.6.4. Sudan

10.6.5. Uganda

ONE RIVER
ONE PEOPLE
ONE VISION

Nile Basin Initiative Secretariat
P.O. Box 192
Entebbe – Uganda
Tel: +256 414 321 424
+256 414 321 329
+256 417 705 000
Fax: +256 414 320 971
Email: nbisec@nilebasin.org
Website: http://www.nilebasin.org

/Nile Basin Initiative
@nbiweb

Eastern Nile Technical Regional Office
Dessie Road
P.O. Box 27173-1000
Addis Ababa – Ethiopia
Tel: +251 116 461 130/32
Fax: +251 116 459 407
Email: entro@nilebasin.org
Website: http://ensap.nilebasin.org

ENTRO

Nile Equatorial Lakes Subsidiary Action Program Coordination Unit
Kigali City Tower
KCT, KN 2 St, Kigali
P.O. Box 6759, Kigali Rwanda
Tel: +250 788 307 334
Fax: +250 252 580 100
Email: nelsapcu@nilebasin.org
Website: http://nelsap.nilebasin.org

NELSAP-CU