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ADDRESSING LAND BASED ACTIVITIES IN THE WESTERN INDIAN OCEAN

DRAFT REGIONAL 'STATE-OF-THE-ART' REPORT ON MUNICIPAL WASTEWATER MANAGEMENT IN THE WIO – Lab REGION

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FINAL DRAFT

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LIST OF ACRONYMS AND ABBREVIATIONS

MWW	Municipal Wastewater
WIO	Western Indian Ocean
EMCA	Environmental Management and Coordination Act
PUC	Public Utilities Corporation
WMA	Wastewater Management Authority
NGO	None Governmental Organization
WHO	World Health Organization
GPA	Global Programme of Action
SBR	Sequencing Batch Reactor
WSP	Waste Stabilization Pond
TF	Trickling Filter
RBC	Rotating Biological Contactors
GVSP	Greater Victoria Sewerage Project
MLVSS	Mixed Liquor Volatile Suspended Solids
NYS	National Youth Service
EPA	Environmental Protection Agency
OAS	Organization of American States
MDG	Millennium Development Goals
UWASA	Urban Water and Sanitation Authorities
IWRM	Integrated Water Resources Management
WSS	Water Supply and Sanitation
NEMA	National Environment Management Authority
GVSP	Greater Victoria Sewerage Project
BVSP	Beau Vallon Sewerage Project
LBA	Land-based Activities
WSSD	World Summit for Sustainable Development
GNP	Gross National Product
MPA	Marie Protected Areas
EACC	East African Coastal Current
WIOMSA	Western Indian Ocean Marine Science Association
NEAP	National Environmental Action Plan
EMPS	Environmental Management Plans of Seychelles
EIA	Environmental Impact Assessment
MEA	Multilateral Environmental Agreements
O&M	operation & maintenance
CBO	Community Based Organizations

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Executive summary

The marine and coastal environment of the countries of the Western Indian is rich in biodiversity and associated natural resources that in some hotspot areas are already been stressed by discharge of wastewater from urban areas. The need for action to reduce stress on ecosystems by strengthening the regional legal basis for preventing land based sources of pollution, partly through development of capacity for sustainable development cannot be under emphasized. The Regional status report presents the findings of the review of municipal wastewater management approaches in the WIO Region. The report also examines the GPA Municipal wastewater management guideline and establishes their applicability in the WIO Region.

The existing wastewater management policies and strategies in the WIO Region countries have been potential of resulting into significant changes in the way wastewater is managed and thus enhance public health and the integrity of the environment. The major problem, however, is the enforcement of policies, regulations and legislations. Wastewater management in the region is also hampered by weak institutional capacity, inadequate coordination and collaboration, unclear demarcation of responsibilities among various actors and low public awareness among the targeted communities. There is also a problem on the implementation and dissemination of policy and regulatory frameworks at all levels, particularly at the lower level close to beneficiaries (local communities, private sector, etc). Training and capacity building in local authorities with respect to attribution of ownership would considerably contribute to effective implementation of water and sanitation policies and associated legislation/regulations. Capacity building in the region is required for proper management of municipal wastewater.

The urban areas located along the coast are the major sources of contamination of the ocean due to disposal of raw industrial and domestic wastewater. Some of the sewerage systems installed in the region have no connection to wastewater treatment plants. Lack of technical manpower for operation and maintenance of sewerage systems in WIO Region has resulted in many installed sewerage systems and treatment plants not to function according to design. Sewage treatment technologies vary considerably among the WIO countries. South Africa, Seychelles and Mauritius use non conventional and conventional wastewater treatment technologies for domestic and industrial wastewater treatment. The application of conventional wastewater treatment technology in South Africa, Seychelles and Mauritius has been successful mainly due to good economy and reliable energy supply.

The most commonly used sanitary facility in the region is traditional pit latrine (78%), followed by septic tank (13%). The population served by sewerage system is only 3%. Six percent (6%) of the population in the region have no facilities, less than 1% of the population in the region use ventilated improved pit latrines and different sanitary facilities such as Ecosan toilets and others. This data indicates population in most of the coastal areas in the WIO Region do not have adequate and appropriate sanitary facilities. The pollution loading due to usage of septic tanks in the region was estimated to be

21,739 tonnes per year BOD_5, 5041 tonnes year Suspended solids, 10397 tonnes per year nitrogen and 1260 tonnes year phosphorous.

Overall, control of pollution from sewage and industrial wastewater is a major challenge for most countries in the WIO region. The total volume of industrial wastewater discharged into the ocean (some partially treated and untreated) was found to be 1,515,762m^3 per day (discharged from Tanzania, Madagascar, Mauritius and South Africa). The expansions of the wastewater treatment facilities and infrastructure have not kept pace with population growth and the proportion of the population without wastewater treatment facilities is increasing.

The Existing constraints in MWW management practices and methods in the region are numerous. These constraints range from inadequate financial capacity, human resources, lack of capacity within the institutional arrangements; poor organisation structures, lack of clear allocation of responsibilities and political interference of supposedly autonomous institutions by other arms of governments. Capacity for the selection of appropriate technology in the region is also one of the constraints due to the fact that experts in the field of MWW management are limited.

The review of the GPA MWWM Guidelines indicate that the guideline and principles are relevant to most of the countries in the WIO Region and if adopted could lead to a major improvement in the way wastewater is managed. Opportunities for domestication of the GPA Guidelines for Wastewater management exist in all countries in the region. The level of domestication might, however, differ from one country to another due to availability of resources, urban setup and technological selections. Devolution of responsibilities for the MWWM sector requires an enabling environment both at national and local levels in the region.

Sustainable utilization of the coastal environment and its resources in the Western Indian Ocean (WIO) region is paramount importance considering the ecological, social economic and cultural importance of the coastal and marine ecosystems to the to the local communities and countries economies. There will be more challenges as a result of increasing population including the increasing dependency on coastal and marine ecosystem.

Chapter 1 INTRODUCTION

1.1 Background information

The project "Addressing land-based activities in the Western Indian Ocean (WIO-Lab)" is designed as a demonstration project for the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (LBA). The WIO region is comprised of five coastal States (Somalia, Kenya, Tanzania, Mozambique, and South Africa) and four island States (Mauritius, Comoros, Seychelles and Madagascar). The project is financed by the Norwegian government and the Global Environment Facility (GEF). This project is a direct follow-on to the African Process and the World Summit for Sustainable Development (WSSD), and addresses IW strategic priorities elucidated in the Draft IW support for WSSD decisions. The project focus on addressing major land-based activities in the region represents a strong partnership between the WIO Lab countries, the Norwegian government, UNEP, and the GEF. The project is designed to serve as a GPA demonstration project to achieve three objectives;

The three objectives of the project are to (i) reduce stress to the marine and coastal ecosystem by improving water and sediment quality; (ii) strengthen the regional legal basis for preventing land-based sources of pollution; and (iii) develop regional capacity and strengthen institutions for sustainable, less polluting development. The activities of the WIO-Lab Project are all geared towards achieving these objectives, with the final goal to improve management of land-based activities for the better protection of the marine and coastal environment of the WIO region. The WIO-Lab Project Management Unit is located at the UNEP/Nairobi Convention Secretariat in Nairobi, Kenya.

The WIO-Lab Project is a deliberate and conscious effort of the people of the WIO region, taken in response to a call from the First Meeting of the Contracting Parties to the Nairobi Convention in March 1997. The project is furthermore a direct follow-on to the 2002 World Summit for Sustainable Development (WSSD) and the related Johannesburg Plan of Implementation, which called for "advanced implementation of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA/LBA)". Being committed for the improvement of the environment in the coast the project supported financially the demonstration projects in the WIO Lab countries. Following an extensive project identification, development and selection process, eight demonstration projects are currently underway, at different stages of development. The WIO-Lab demonstration projects are as follows;

(i) A Subsurface flow constructed wetland system for wastewater management at Shimo La Tewa Prison, Mombasa – Kenya (ii) Development of eco-tourism in the Marine Park of Toliara – Madagascar (iii) Application of vetiver grass for erosion and leachate control at a landfill site in Dar es Salaam – Tanzania (iv) Solid Waste Management in Port Louis Harbour –Mauritius (v) Integrated Algal Ponding System technology for the polishing and beneficiation of effluent from municipal sewage treatment facilities - South Africa (vi) Enhancing the ecological function of mangroves –Mozambique (vii) Wastewater management on Pemba Island – Tanzania (viii) Integrated management and protection of the coastal zone at Itsamia, Mohéli - Comoros

1.2 Background of the region

The Western Indian Ocean (WIO) region extends from latitude 12^o N to approximately 34^{o}S and longitude 30^o to 80^{o}E (see Figure 1.1). The region encompasses a large array of marine and coastal settings, ranging from small island states and large countries with extensive coastlines and tropical and subtropical climates. The continental coastal states are Somalia, Kenya, Tanzania, Mozambique and South Africa and the island states are Mauritius, Comoros, Seychelles, Madagascar and Réunion (France).

The WIO countries share common biological resources and climatic features but also many historical, cultural and economic ties. Despite these commonalities, the countries in the region are at different stages of both political and economic development, reflected among others by the individual economic indicators for countries in the region ranging from those with a *per capita* gross national product (GNP) of over US$ 7,000 per annum (Seychelles and Reunion), to those with less than US$1,000 GNP (Comoros, Tanzania, and Madagascar).

Some 40 million people inhabit the coastal areas of the region and so overall population density of the region is not remarkably high. However, while large areas are almost unpopulated, such as much of the Somalia coastline, certain areas are indeed very densely populated. Urbanization pressures are most marked in the mainland states, where main urban centres such as Mombasa (Kenya), Dar es Salaam (Tanzania), Maputo (Mozambique) and Durban (South Africa) have arisen, supporting populations of 2 to 4 million.

These same coastal settlements are centres of economic activities in the WIO region, sheltering internationally important ports and harbours that handle most of the region's incoming and outward-bound ship-borne cargo. During the last three decades, the tourism industry played a significant role in the economic development of most of the countries of the WIO region. Tourism expansion has been actively pursued by national governments because of its positive effects on national income, high levels of employment and diversification of the economic structure. Much of the tourism activities take place in coastal areas, often associated with Marie Protected Areas (MPAs)

Figure 1. 1. Map of the western Indian Ocean (WIO) region

1.2.1 Climate, hydrology and oceanography

The climate of most of the WIO region is tropical humid and dominated by seasonal movements of the Inter-tropical Convergence Zone and the monsoons. The northern part of the Western Indian Ocean region is dominated by the monsoons, which have a dominant influence on wind direction and strength, ocean currents, temperature, and rainfall, among others. Ocean currents are important features that strongly influence the distribution of marine organisms and the availability of nutrients. The major currents in the region are strongly influenced by the monsoon. There are two monsoon seasons, namely the Northeast monsoon, which prevails November to February and is characterized by higher air temperatures and weaker winds and the Southwest monsoon which lasts from April to September and is marked by lower temperatures as well as stronger winds. The South Equatorial Current and the East African Coastal Current are strongest during the Southwest monsoon; the East Madagascar and the Mozambique current systems are strongest during the North-east Monsoon. The Somali Current shows reversals in direction reflecting the alternating monsoons. The southern part of the WIO region, including southern Mozambique, Madagascar, Comoros, Reunion, and Mauritius, lies within a belt affected by tropical cyclones. Cyclones occur during December and March. Most of the Western Ocean tides are semidiurnal or mixed, mainly semidiurnal.

Oceanic current patterns and monsoon seasons have a major influence on the biogeography and biodiversity of the region. The permanently west flowing South Equatorial Current, is partly diverted south along the eastern Madagascar coast where it turns into the Madagascar Current. The main South Equatorial Current, on approaching the mainland, splits to form the northward flowing East African Coastal Current (EACC), and the southward flowing Mozambique Current. The latter joins the Madagascar Current to form the Agulhas Current.

1.2.2 Population Growth and Coastal Urbanization

The coastal region of the mainland states between Somalia and Mozambique is home to 25 million people. This represents 20 percent of the combined population of the mainland states living on 12 percent of the land. Population trends indicate a doubling of population in about 25 years in the major coastal cities of Mombasa, Dar es Salaam and Maputo, which are presently experiencing growth of 5.0%, 6.7% and 7.2% per annum respectively (Mohammed and Francis, 2002). Population pressure is particularly high in urban centres e.g. Mombasa where the population has doubled in the last 15 years. Mombasa town with a population density of 2,348 persons per square kilometer is one of the most densely populated towns in Kenya (UNEP, 1999).

Table 1.1:Population and population density statistics for WIO Lab countries

Country	Total Pop. (M)	Coastal Pop. (M)	% pop. In Coastal Zone	Pop Growth rate %	GDP per capita US$
Comoros	0.54	0.54	100	3.55	700
Kenya	26.80	2.30	8.10	3.30	1,300
Madagascar	12.10	4.80	36.60	2.83	820
South Africa					
Mauritius	1.10	1.10	100	1.23	9.600
Mozambique	16.60	6.50	39.30	2.65	700
Seychelles	0.07	0.07	100	0.76	6,000
Tanzania	28.39	4.61	16.20	1.15	800
TOTAL	85.39	19.04			

1.3 The Objectives of the project

The UNEP Coordination Office for the GPA, in collaboration with the Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region (Nairobi Convention) and the Western Indian Ocean Marine Science Association (WIOMSA) have worked with joint efforts on Municipal Wastewater (MWW) Management in the Eastern Africa Region for years. Based upon these efforts, the WIO-Lab Project aims at enhancing effective and efficient management of MWW in the WIO Region partly through internalization/domestication of the Guidelines on MWW Management as developed by the GPA. In order to achieve this aim, the Project established a Regional MWW Management Task Force to spearhead the implementation of activities in the WIO Region. One of the goals of the MWW Task Force is to facilitate development of a Regional Annex to the global MWW Guidelines, targeted specifically for application in the WIO Region. The objectives of this regional analysis on MWW management were as follows;

- To review the UNEP/GPA Guidelines, key principles, and checklist on MWW Management and establish the extent to which they can be adopted in the WIO Region bearing in mind the existing socio-economic conditions and governance.

- To Review the existing policy, regulatory and institutional arrangements in the participating countries in regard to the management of MWW (largely based upon an ongoing review undertaken by the Legal and Technical Review Task Force of the Nairobi Convention) and definition of reforms necessary for effective management of MWW in the countries,
- To review the status of wastewater management in the region based on the report prepared by national experts on the following specific areas;
  - (i) Inventory of wastewater treatment infrastructure in the coastal catchment area of the participating countries, including the status of operation of such infrastructure, according to a standard framework for inventory
  - (ii) Assessment of MWW management practices and methods in the participating countries
  - (iii) Review of existing technologies in MWW Management and preparation of recommendations for appropriate technologies that could be adopted in the participating country bearing in mind the existing socio-economic conditions.
  - (iv) Extraction of lessons learnt and 'best practices' from projects on MWW Management in the participating countries and
  - (v) Review of existing national mechanisms that can be used to internalize the Regional Guidelines on Municipal Waste Management in the participating countries and establishment of factors that could compromise the domestication of these guidelines and principles in the country
- To review and assess available secondary information and documentation with regard to MWW infrastructure, practices and policies in the participating countries in order to establish the current status of MWW Management in the WIO region.
- To review and assess experiences and lessons learnt from MWW Management approaches and projects in the WIO region, as well as lessons learnt from around the world, which could be appropriate to the WIO situation.
- To provide recommendations with regard to existing national and regional mechanisms that can be used to further internalize the Global and Regional Guidelines on Municipal Waste Management in the participating countries, and establishment of factors that could compromise the domestication of these guidelines and principles in the country

1.4 Methodology

The national reports prepared by National Experts from, Tanzania, Kenya, Mauritius and Seychelles formed a basis for evaluation of status of municipal wastewater management in the WIO Lab countries. The guideline was developed for national level review of the GPA Guidelines, as well as for inventory of the status of MWW Management in the WIO region, including the guidelines for review of; (i) the UNEP/GPA Guidelines, key principles and checklist on MWW Management, (ii) existing policy, regulatory and institutional arrangements (iii) Inventory of wastewater treatment infrastructure (iv) Assessment of MWW management practices and methods (v) existing technologies in MWW Management and preparation of recommendations for appropriate technologies and (vi) on existing national mechanisms that can be used to internalize the Regional Guidelines on Municipal Waste Management of the participating countries.

The data provided by the National Experts on wastewater flow rate, concentration of the pollutants in the effluent and wastewater were used to calculate the pollution loading to the ocean. The pollution loading due to domestic wastewater from various sanitary facilities used in the region was calculated based on WHO approach. The pollution loading from industries was calculated from the industrial flow rates and the concentration of the pollutants. Literature review and nation reports were used during reviewing on the existing technology in the region. Literature on the status of pollution of marine environment was consulted and among them are;

(a) Thematic reports on the following themes: Analysis of legal and institutional frameworks related to PADH in the region;
(b) Regional Overview report in coastal erosion Land-based activities and sources of pollution affecting the marine environment in the WIO-Lab Region
(c) National pollution reports prepared in 2001 by Kenya, Mauritius, , Seychelles South Africa and Tanzania, for the WIO Lab countries

The absence of consistent and systematic data of key parameters for most of the priority aspects as well as for all the countries concerned prevented a detailed analysis of the problems facing the countries. Consequently, the report is more detailed in some aspects and countries than others.

CHAPTRE 2: REVIEW OF ENABLING POLICY, REGULATORY AND INSTITUTIONAL ENVIRONMENT FOR MWW MANAGEMENT

2.1 Background

This chapter presents a review of the enabling policy, regulatory and institutional arrangements for Municipal wastewater management in the region including stakeholder involvement and the financial mechanisms. The analytical dimension is about conceiving and clearly articulating effective policy alternatives that are based on sound analysis. The acceptability of a policy proposal rests on the endorsement and sanctioning of the proposed course of action by the decision-makers in particular and the stakeholders in general (Opio-Odongo and Woodsworth, 2004). Where there is policy then there should be rules and guidelines which gives overall direction to planning and development of the organization.

The methodology used to undertake the review has been through the reviews from the National Reports and other relevant documents already existing touching the same area on policy, regulatory framework and institutional arrangements for municipal wastewater management. Each of the countries in the region has responded with a set of laws, institutions, policy and regulatory instruments, some constitutional, while others are framework and others are sectoral. Most of the countries have fairly new framework legislation, in many cases made after the mid 1990s. The countries have numerous of sectoral legislation, some dealing directly and others indirectly with coastal and marine environmental protection and particularly with the LBS issues. However, in terms of variety and detail of legislations and institutions the various countries differ remarkably. Some of the legislations are detailed and focused; some are sketchy and rather thin on detail. Also equally noteworthy is the fact that in the countries with a blend of national and provincial or regional legislations, policies, regulatory and institutional frameworks, such as South Africa, the level of detail and variety is greater.

2.2 Assessment of existing policy framework

Policy framework is a set of principles and long-term goals that form the basis of making rules and guidelines, and to give overall direction to planning and development of the organization. It clarifies, demarcates, or interprets a law or policy. Effective formulation of policy is achieved when the policy proposal is deemed valid, efficient and generally acceptable for handling the problem(s) at hand. Most of the WIO Lab countries have prepared the policy framework in late 1990’s. Protection of the natural environment in the region has been one of the focuses of government policies over the last two decades. The laws and regulations which have been enacted are supported by authorities within the ministries concerned. The policies are supported by action plans prepared by the respective Government. The policies also indicate the agency or authority entrusted with their enforcement. The policy frameworks on water and wastewater management in the region are mainly based on the globally celebrated principles of decentralization, participation and sustainability. While enabling policy framework is already established in the region, the implementation process is however being slowed by the limited financial resources available from national and international funding. The policies relevant to municipal wastewater management are well defined in Water policy (Tanzania), Water, Hygiene and Sanitation Sectoral Policy statement (Madagascar), National Environmental Action Plan ((NEAP) – Mauritius), Water Resources Management and Development Policy (Kenya), National policy of the Environment (Comoro) and Environmental Management Plans of Seychelles (EMPS, Seychelles).

After formulation of the policy and policy frameworks the central governments in the region have been creating enabling environment as initiator and facilitator for water and sanitation sector through delegation of authority and responsibility at the lowest i.e. at community level. To enable the implementation of the policy and create the enabling environment for effective water resources management, the countries in the region have put in place several pieces of legislation, regulations and enforcement mechanisms.

The major emphasis of policy framework is on active participation of communities, private sector and Local Governments as the role of Central Government in services provision diminishes. Changes in management for improving wastewater services such as decentralization, privatization, and public-private partnership are typical institutional arrangements being advocated to bring changes in wastewater management and enhance performance in the region. Sectors related to municipal wastewater management are well listed within the national policy relevant to municipal wastewater management. There are also sector policies developed to guide the sectors during the implementation of policy. Analysis shows that policies developed in respective WIO Lab countries reflect common themes that respond to the 1992 United Nations Conference on Environment and Development's ("The Rio Summit") "Agenda 21," by supporting "integrated resource management" and "balance between sustainable development and environmental protection."

Policy made in many countries requires amendments and reviews to reflect integrated approaches to wastewater management. Many institutions involved with coastal management activities experience difficulty separating coastal management activities from general environmental management activities. Institutions with specific coastal management responsibilities consider coastal management to be a specialized form of environmental management. Example, in the past 10 years, South Africa's greatest effort in combating the impact of land-based activities on the marine environment has been in the development of sound environmental policies and legislation. For instance, in 1998, the National Water Act, which placed a strong emphasis on resource management, was promulgated. The White Paper for Sustainable Coastal Development for South Africa (April 2000) also sets out a policy that aims to achieve sustainable coastal development through integrated coastal management. The policy is currently being defined in the National Environmental Management. Coastal Zone Management Bill to provide better control of coastal development without compromising economic development and job creation (UNEP, 2006).

Although Africa has never been short of policy documents, the implementation record of existing policies has not been impressive. The ineffectiveness of policies related to human vulnerability to environmental change was particularly noted. Absence of adequate implementation plans, weak implementation capacity, conflicts between agencies with related environmental mandates, and failure to seize on the synergies that exist among various sector policies and between such policies and the Multilateral Environmental Agreements (MEAs) are some of the implementation difficulties that deserve careful consideration during the AEO assessment process(Opio-Odongo and Woodsworth, 2004). Ekbom, (2002) commented that in Kenya at present, there is good understanding of the nature of the key environmental problems. What is lacking is the capacity to monitor and enforce existing legislation, and to implement the current environmental policies.

2.3 Assessment of existing legal and regulatory framework

The legal framework must provide institutions with the statutory, regulatory and enforcement tools they require. Once a framework is in place, practical regulatory functions can be defined, and the mechanisms for their implementation designed. The operational legal framework embraces the legal structures needed to establish, maintain and oversee specific government objectives. However, the formulation of new laws and policies can contribute to improving governance only if the management systems for enforcing them can creatively couple the modern resource management regimes with the traditional one thereby avoiding the dangers of the "one-size–fits-all" syndrome (Opio-Odongo and Woodsworth, 2004).

The syntheses of the National Reports indicate that most countries of the region do have framework legislations and other instruments on environment, including coastal and marine environment exist in the region. These laws are quite recent enactments, such as in Kenya, Madagascar, Mauritius, Seychelles, and South Africa. Therefore, in many respects, these laws incorporate recent international environmental law principles and requirements, such as the polluter pays and precautionary principles, sustainable development, the establishment of environmental crimes, dispute resolution and avoidance, key institutions and EIA rules and processes (Okunga, 2007).

However, many of the legislations reviewed appear to play a regulatory role in the respective sectors to facilitate an orderly and rational access to and utilisation of the coastal and marine resources without hurting the integrity of the environment. A common characteristic of national legislation in this region is that they are scattered and fragmented across sectoral disciplines. This accounts for apparent overlaps, duplications and contradictions in some national legislation. This fragmentation of pollution control across different pieces of legislation and within different departments is considered a key weakness. Central government and other public institutions having mandates in the coastal and marine areas often pursue contradictory or parallel mandates as the National Reports have shown.

The other interesting feature for most national legislation is that they create huge pools of authority or power in central government line ministries (sometimes with sweeping ministerial powers) and/or in public entities (usually Parastatals organizations) which are almost exclusively controlled by the executive. This means that decision making, implementation and enforcement remains a government prerogative and function.

Although most of the existing legislation and institutions are sector specific (such as tourism, fisheries, mining, water or forestry) there is an increasing trend towards multi-sectoral legislation, policy and institutional arrangements to facilitate a more cohesive vertical and horizontal co-ordination and integration. Each of the countries has established key national institutions responsible for policy formulation and co-ordination of environmental activities including the coastal zones. They include ministries responsible for environment (with responsible state ministers); environmental protection agencies with statutory powers; and inter- ministerial committees.

Based on the National Reports, there are no material differences in legal, policy and institutional arrangements between the mainland states (South Africa, Mozambique, Tanzania and Kenya), on the one hand and the island states (Comoros, Mauritius, Madagascar and Seychelles) on the other. However, it is obvious that island states are more vulnerable and exposed to the vagaries of environmental degradation, and particularly LBS issues. Strong legal, policy and institutional arrangements are needed to protect all these countries from environmental degradation and especially along the coastal and marine areas. The legal framework for managing coastal resources consists of different legislative acts, each with a different background and origin. However, the major problem in the WIO Region is how to enforce the laws and weak penalties attached to regulatory framework. The laws, apart from being inadequate, they are not properly enforced. Furthermore, they lack close correlation with environmental planning and management and the element of integration, i.e., cross-sectoral issues. At the same time, human activities in the coastal and marine environment do not recognize sectoral boundaries.

The regulatory frameworks in all countries failed to define clearly the type of technologies to be used for wastewater management. Even the equivalent loading produced per person per day is not provided hence this may give indication of haphazard design of the systems in the region. Example in Mauritius guideline for coastal water quality is given in several categories and to each category the standard of water quality is given (Annex A, Table 2.1A and Table 2.1B). Hence for any development one has to observe that effluent disposed in the ecosystem must meet the required standard.

2.4 Assessment of existing institutional mechanisms

The institutional frameworks in WIO region exist as overseers of the entire spectrum of the national environment, even in fairly decentralized systems such as the Comoros and South Africa. In each country several institutions and Government departments are involved in aspects of managing the coast and its resources in the course of carrying out their functions. As a result of the absence strong institutional frameworks and a single co-ordinating body to provide direction and guidance, there is administrative confusion and inefficiency, duplication of efforts, gaps in management and an uncoordinated approach to coastal management. It is thus difficult to always adequately deal with LBS/A issues, which are frequently multi-sectoral and multi-disciplinary in nature, (Okunga, 2007). The main functions of the Governments in the region should be policy formulation and the setting of national standards, with implementation occurring at lower level.

The Water and Sanitation sector, including MWW management involves multiple ministerial departments, river basin boards, basin committees, municipalities, national and international NGOs, and funding organisms. There is also considerable variation in the institutional arrangements for promoting environmental protection and management in the region. In some countries the institutional arrangement for water and wastewater management has been explicitly defined with mandates and roles of the various actors well stated. This calls for the region to consider development of clear division of responsibilities to the institutions involved in municipal wastewater management so as to avoid overlapping of responsibilities. Example in Mauritius the Wastewater Management Authority Act of 2000 (WMA Act) was proclaimed on the 30th August 2001, thereby giving a clear institutional set up to the WMA. The WMA has been transformed into a corporate autonomous body with defined legal status. The WMA Act details the objects, duties and powers of the WMA as the sole agency responsible for the wastewater sector in Mauritius. This is a good example where other countries could adopt to wave out overlapping of responsibilities. Mong (2007) stated that failure on the implementation of policy in Madagascar by institutions involved was due to poor dissemination of information and insufficient coordination of actions among ministries and institutions. Sensitization strategy should be sought in order to get private sector interested in wastewater management.

2.5 Assessment for mechanisms for stakeholder involvement in MWW management

Generally, stakeholders can be defined as those who are affected by the outcome of a decision or who can affect this outcome, either negatively or positively. Literally, a stakeholder is an individual who has a stake in a certain issue or decision. In practice, (socially) organized groups or individuals that perceive themselves as being affected by a decision, that share common values and preferences, or that have an interest regarding the decision at stake, are also considered as stakeholders (Mostert, 2003; van de Kerkhof, 2004). Often a distinction is made between two kinds of stakeholders, the primary and secondary stakeholders. The primary stakeholders are the stakeholders who are directly affected, either positively or negatively by the project. As such, the primary stakeholders include the intended users of the improved facilities; in other words the intended beneficiaries of the project. Secondary stakeholders are government and donors but also include local NGO's, private sector entrepreneurs, local government, water and sanitation utilities, river management boards, consumer groups, clergy, etc. The secondary stakeholders are stakeholders, which play some intermediary role and may have an important effect on the project outcome.

Stakeholder participation is an instrument that provides stakeholders the opportunity to participate in decision-making and potentially influence projects or policies. Stakeholder participation is more than involvement only. It implies a certain level of joint responsibility and/or empowerment of the stakeholders in the decision-making. Consequently, stakeholder participation can best be defined as 'the act of empowering stakeholders in decision-making on issues they have a stake in'. Stakeholder participation is considered as required in order to achieve sustainable management from economic, environmental as well as from a social point of view. Hence, stakeholder participation is expected to improve the quality, efficiency, effectiveness and sustainability of projects and to increase the capacities, self-reliance and empowerment of stakeholders. Benefits and strengths of stakeholder involvement include (OAS, 2001): (i) it leads to more informed-decision making, (ii) a consensus is reached at early stages of the project, (iii) transparency is increased as different stakeholders monitor the development of the project, and (iv) stakeholder involvement can build trust between the government and civil society.

WIO Lab countries are at different stages in promoting the integration of environment with development. The countries also vary in the extent to which they have opened spaces to civil society and the private sector to participate in policy-making. These differences must be taken into account in whatever strategy is adopted to provide support to national-level counterparts and sub-regional inter-governmental organizations for purposes of strengthening the implementation of the policy. The following are some of the possible actions in that regard: a) strengthening data and information systems to allow for a better assessment of the situation to be addressed by the policy response; b) strengthening capacity for policy analysis, policy dialogue and advocacy, especially in countries and sub-regions with good data and information systems; c) strengthening the technical skills needed to use the available information to get the policy issue. The thrust of the Acts is geared towards facilitation of Private Sector Participation in the water supply and sewerage in WIO Lab countries.

In the past water and sanitation projects were implemented without the active participation of the stakeholders in planning, construction and management. Water and sanitation development and service delivery has been dominated by the public sector and very little attention has been given to participation of the private sector. This was due to lack of policy which integrated involvement of stakeholders. As a result, the projects were not properly operated and maintained and thus became unsustainable. Ownership of facilities was not legally vested in stakeholders, which has led to a lack of commitment of ownership, operation and maintenance. The Government was the sole implementer and operator of water and sanitation project in urban areas. Failure to involve all stakeholders in planning and operation of water supply and sanitation systems has led to a lack of appreciation of problems faced by water and sanitation service deliverer in operating and maintaining the system.

The level of awareness and participation by stakeholders on waste management in region is very low. Most of countries in the region have just started to involve the stakeholders in the planning and implementation of sanitation projects. Hence, to move along with the objectives stated in the policies, the governments need to create awareness to all stakeholders and disseminate the policy and regulations governing the wastewater management. Besides that the policies in the region calls for involvement of stakeholders there are gaps which are needed to be considered for effective participation. These are;

establishing appropriate mechanisms for involving stakeholders in the planning and provision of services; increase stakeholder awareness of their new participatory roles and responsibilities; and encourage dialogue between stakeholders including Non-government Organizations and Community Based Organisations (CBOs).

Example in Mauritius the Sector Policy Letter states that one of the key features through which the objectives of the Policy are to be achieved is stakeholder participation and consultation. In that spirit, the WMA undertook public media campaigns under the IBRD Loan for the Montagne Jacquot Project (Ridhay 2007). These have been carried out over a number of years and comprised television clips, radio announcements, posters, brochures and pamphlets, to encourage safe hygienic habits, and to encourage and promote the connection of premises to the sewerage system, where available. It is now the policy of the WMA to include a Public Relations component in every major sewerage implementation project to reinforce public awareness and also to mitigate problems that might be encountered during project implementation (Ridhay 2007). Assistance is therefore required in the first place to ensure a smooth shift from centrally managed utilities, to autonomous water utilities working under proven corporate principles.

The levels of stakeholder participation in wastewater management differ from one country to another due to delayed preparation and signing of policy. Mwaguni (2007) and Melania (2007) reported that the level of awareness and participation on waste management is very low and that the private sector plays a very minimal role in waste water management. Example in Mauritius the operation and maintenance of several small wastewater treatment plants and pumping stations has been outsourced to private contractors through service contracts. This indicates that private contractors in Mauritius have been sensitized on the wastewater management. Hence there are opportunities do learn on how to let the stakeholder to participate within the region from Mauritius. This effort is based on the principle that: *In order for environmental activity to be successful in the long term, it must take root in the hearts and minds of the world's people. When people understand the reasons for making responsible environmental choices, there is a greater chance they will take the reasons to heart and incorporate the actions into their daily lives, (UNEP/NGLS, 1995)).* Note that creating awareness will help private sector in the region which suffers from lack of financial back up, competence (especially for sanitation sub sector),and ill information regarding water and sanitation project.

There is a need to assess the importance of and the influence of the stakeholder in the region based on the followings; (i) The power and status of the stakeholder (political, economic, and social) (ii) The degree of organization of the stakeholder (iii) The control the stakeholder has over strategic resources (iv) The informal influence of the stakeholder (personal connections, etc.) and (v) The importance of these stakeholders to the success of the project.

2.6 Assessment of existing financing mechanisms

The traditional approach on financing for MWW management was based on government grants and subsidies. There was limited contribution from the consumers. The sources of funds for municipal wastewater management in the regions are mainly from the government, tariffs, loans and grants from international funding agencies. The wastewater charges applied to customers is based on the volume of water consumed and usually is paid as a certain percentage to wastewater management. Example in Mauritius the wastewater charges are set at 5% of water used. Similarly in Kenya water consumers pay a levy of 50% on their water bills, a levy that goes towards maintenance of the sewerage infrastructure (Mwaguni, 2007). In Tanzania the charge for the sewerage service varies according to the customer category and is applied to 50-80% of the billed water consumption (Melania 2007). The collection depends on the methods used to estimate or measure the amount of water consumed. In some countries where water meters are not used the collection of tariffs are very low and hence may affect the performance of the wastewater project. In countries where sewerage systems are installed billing constitutes an income for wastewater treatment plant operation and maintenance. However the tariffs used do not cover for expansion of the systems.

Another source of financial for wastewater management is from the sale of treated effluents. This has been practiced in Mauritius where 45,000m^3/day is sold to irrigation authority at a rate of MUR 0.8 per cubic meter (Radhay, 2007). However, with the current thinking of considering water as an economic good, and its consumption based on volume consumed, then the revenue base for the sector is widening. Also taking into account the polluter pays principle, the countries are in the right path in generating added revenue for wastewater management. Polluter pays principle is already adopted for managing industrial pollution.

However Melania (2007) argues that the constraint of inadequate recurrent financial resources from both consumer revenues and the Government, together with an absence of financial guidelines for re-allocation of recurrent financing to the water supply and sanitation sector and inadequate transparency in the use of funds, has resulted into poor performance in service delivery at all sector levels. Sustainable operation and maintenance of water supply and sanitation schemes should be based on financial mechanisms that ensure adequate levels and appropriate channeling of financial resources. The source of funds for recurrent costs in urban areas should be from consumers, based on cost recovery tariff principles**.**

Provision of water and sewerage services has been seen as a social service, resulting in low willingness to pay, making revenue collection very difficult. In determining tariffs, affordability is given more weight than cost recovery, although no meaningful studies have been carried out on affordability. Tariff levels and structures should be controlled and regulated based on the levels of service to be provided, the cost-efficient provision of these services, and the cost-recovery targets to be achieved.
A designing and enforcing cost-recovery mechanism in the wastewater sector is a complex process. It requires arrangements (technical, institutional, legal, and financial) for a good monitoring system, including regulations and legislation on receiving water quality levels and emission standards. An efficient revenue collection system should be in place (including the capacity to determine the right tariffs, to implement appropriate billing systems, and to enforce fines). Moreover, polluters need to be willing to change their behavior. There are many advantages on cost recovery on MWW management,

namely (i) Increasing cost-recovery would increase available funds for investment (ii) With increasing cost-recovery comes an increase in consumer orientation (iii) The traditional subsidy-based approach generally promoted only one service level. Increasing cost-recovery will lead to a variety of service levels (iv) Payments increase the sense of value and commitment among users (v) with user paying for services, they will also demand that the utility deliver good services. The mechanisms for cost recovery advocated in the national reports include; (a) Consumption-based charges – user charges based on the volume of wastewater discharged and/or characteristics of wastewater (often directly related to consumption of potable water); (b) Effluent charges – Based on a fixed amount per household, or in the case of industry on a proxy (such as production, number of employees, etc.); and (c) Discharge permits – Charges/levies can be incorporated in discharge permits.

2.7 Conclusions and recommendations

2.7.1 Conclusions

The WIO-Lab countries have adequate policy and regulatory frameworks for wastewater management. The institutional arrangements put in place are adequate so are the mechanisms for fund raising. The existing polices and strategies have potential (strength and opportunity) to bring positive changes and enhance public health and the environment. They include indicators that can be monitored. The biggest problem however is the enforcement of the policies. There is also a problem on implementing and dissemination of policy and regulatory framework to all level, particularly at level close to beneficiaries (local community, private sector). Training and building capacity of local authorities with respect to the attribution of ownership would considerably contribute to effective implementing of water and sanitation policy.

The institutional frameworks are existing in the region and the main problem is how to make the institutions fit to the objectives of the policy. Lack of financial resources for performing their responsibilities may indicate the total absence of frameworks. The frameworks were set prior to assessment on the human resources capacity of the institutions; hence more effort should be on training for technical personnel. Private sector participation is low and so is their financial contribution.

The private sector involvement is advocated in the policies and widely recognised as an important factor that could accelerate the implementation of water and sanitation management. Failure to involve all stakeholders in planning and operation of water supply and sanitation systems has led to a lack of appreciation of problems faced by water and sanitation service deliverer in operating and maintaining the system.

Lack of or inadequate financial and material, as well as technical and professional human, resources to carry forward the intent of the various legal, policies, regulatory and institutional frameworks has been identified. The shortage or absence of these capacities is apparent in all the countries, but much more so in the small island states.

Although it is expected that much investment will come from grants in the immediate future, wherever possible Authorities should be expected to fund investments from their own resources. Indeed, the imposition of tariffs that reflect the real cost of the services will require increases in the tariffs over the coming years. There is a general attitude in developing countries that potable water and sanitation should be obvious services to be provided at a minimum cost by a government. Introduction of tariff in the wastewater sector has even faced serious opposition due to a lack of understanding from the general public regarding the need for proper collection, treatment and disposal of wastewater and its effect on the environment and public health.

2.7.2 Recommendations

- It is recommended that basic sanitation principles be introduced at primary school level to change the whole cultural attitude of the coming generation. The attitude and perception of the public can be upgraded by media campaigns and television programs where dedicated sector staff can provide useful information on sanitation to the general public. This, coupled with the need for better water resources management, can sensitize the public on water conservation and better use of sanitation facilities, increased willingness to pay for sanitation services as an informed and educated population will feel more concerned by knowing that their behavior will affect the future generation is terms of water availability and environmental degradation. Annual presentations to inform the public about the achievements of the sector in terms of expansion of the sewerage infrastructure, environmental protection through monitoring and control of effluent discharges, re-use of treated wastewater will also increase the public's interest and participation in the wastewater sector. An educated and informed population will ensure full participation and co-operation of stakeholders at all levels, be it the general public or the industrial sector.

- The policies formulated within the region have many similarities. Both policies address the need to protect aquatic environment. Each country has standards for wastewater effluents. Hence the policies may be unified to have similar standards and procedures for monitoring.

- The deadlock to the success is due to lack of funds for wastewater sewerage system and treatment plants to meet the standards set for effluent disposal. The sources of funds may be from Tariffs, Grant Finance, Loans from Government and Multilateral agencies, Commercial bank loans, Revolving funds and Other income (reuse of waste water). Hence it is recommended that all Municipal Councils need to operate more commercially with increasing responsibility for meeting all their own costs, including capital investment. Willingness to pay studies should be undertaken in the WIO Lab region in order to estimate the income from tariffs collections.
- The best policy addressing an environment should reach a consumer in well elaborative language and presentation. Hence countries in the region should embark on dissemination of the policy to the public even before other actions are called upon.

The policy must be written in the language which may be understood by all stakeholders.

- Involvement of the private sector in the financing and provision of water supply and sanitation services should be encouraged where this would result in a more efficient and cost-effective level of service to consumers.
- The policies lack specifications and appreciation of rural community. Note that the planned areas in urban only constitutes to 20% of the towns. Policy should stipulate clearly what type of technology should be located in what type of settlements with consideration of adverse conditions like water table. On site sanitation technologies and monitoring should be properly addressed in the policy and indicating responsibilities of various actors.
- There are number of organizations involved in the monitoring of the environment. Very often the responsibilities of these organizations are not clearly defined leading to duplication or overlap of work and projects. Gaps must be identified and rectified to allow good monitoring and avoid overlapping of responsibilities which may lead to wastage of resources and time with little or poor quality outcomes.
- A few of the countries have specific constitutional environmental provisions while others do not. Among the countries with constitutional provisions are Seychelles and South Africa. Kenya's recent effort to have a new constitution could have yielded very detailed constitutional provisions on the protection of the environment. However, the constitutional provisions, even where they exist, are not explicit on the coastal and marine environment as such, and this specificity is left to either the framework legislations or sectoral laws. Thus it may be noted that in most cases there are no direct constitutional rules to address LBS issues as such. The implication is that they are and are treated as part of the general environment. The challenge for most of these countries is to at least incorporate environmental issues in their state constitutions and thereby create better scope for protection even of the coastal and marine environment and resources.

- Countries of the region should align their framework legislations, institutions and policy instruments to give more deliberate attention to coastal and marine environment generally, and LBS issues particularly. Alternatively, the countries should consider specific consolidated laws, institutions and policies to address these issues in a more concerted, focused and sustainable manner. The new laws and other instruments should be as closely aligned to the proposed LBS Protocol to the Nairobi Convention as possible.

Chapter 3: INVENTORY OF MWW TREATMENT INFRASTRUCTURES

3.1 Background

This chapter presents the Regional Overview on the infrastructures used for Municipal Wastewater treatment and is based on National Reports presented by National experts from Comoro, Kenya, Madagascar, Mauritius, Mozambique, Seychelles and South Africa. During the review the following factors were considered; the type of technology used for collection, treatment and disposal of the municipal wastewater. The demographic data along the coast and types of settlements in the catchment are being restricted to less than 100 km from the coastline also was reviewed. Furthermore, an overview of the most important industrial enterprises is also presented. The types of industries, data on products produced, quality and the quantity of wastewater generated and the methods of industrial wastewater collection, treatment and effluent disposal is also discussed. Also the methods of stormwater collections and disposal and sludge management in the region have been synthesized. The standards used for wastewater management in the WIO Region and the practices of effluent reuse (aquaculture and irrigation) are also discussed in this chapter. Further more the general problems on operation and maintenance of sewerage systems and wastewater treatment plants is discussed with respect of the type of infrastructures used.

3.1.1 Types of settlements and demographic data

The type of settlement in the region has high influence on the type of sanitary technologies used for wastewater management. The types of settlements in the region are as follows; (i) informal settlements; (ii) low-cost, high-density settlement; (iii) middle-cost, high-density settlements; (iv) high-cost, low-density settlements; and, (v) the Beach Hotels. Informal settlements constitute large percentage of the settlement in some countries in the region. The population residing along the coast has been evaluated based on the data from the National Report and is restricted to the population leaving to less than 100 km from the coastline. The total population along the coast is as indicated in Table 1.1. above.

3.2 Domestic wastewater

Domestic wastewater management involves collection, treatment and disposal of effluent or sludge. The collection of municipal wastewater in the region falls into two categories namely, onsite (on plot sanitation) and offsite. Hence the review of National Reports on the types of municipal wastewater collection infrastructures used in the region has focused on these two categories of MWW collection systems. On-plot sanitation refers to types of sanitation that are contained within the plot boundaries occupied by a dwelling. Commonly, on-plot sanitation is equivalent to ‘household latrine but may also include facilities shared by several households living together on the same plot (Saywell and Shaw, 1999).

Domestic wastewater contains faeces, urine and sullage. Sullage is wastewater generated from processes such as washing dishes, laundry and bathing. Sewage is not a single contaminant but a complex mixture containing pathogens, nutrients, suspended solids (SS), oxygen demanding substances, and many other contaminants each with different environmental effects, and different responses to disposal and treatment. Domestic waste production per capita is fairly constant but the concentration of the contaminants varies with the amount of tap water consumed.

3.2.1. On site wastewater collection and treatment

The National Reports from Comoro, Seychelles, Mauritius, Mozambique, Tanzania, Kenya and South Africa indicate that the most common on site wastewater management falls into two main sanitary facilities; the use of septic tanks followed by soak way or under drain pipes and traditional pit latrines. Each type of the onsite wastewater collection and treatment system is discussed with relation to the population in each country. In practice, given the continuous growth of urban populations and the high incidence of low-income people in slums and peri-urban areas, there is no possibility of providing all urban inhabitants with sewerage systems. Well maintained and constructed on-plot systems offer a viable alternative. Small population along the coast of Kenya and Tanzania use Ventilated Improved Pit latrines (VIP latrine) and Ecosan.

3.2.1.1. Usage of traditional pit latrine

High population in WIO Lab countries make use of traditional pit latrine for disposal of domestic waste especially in low income areas. Based on the National Reports, the estimated population for Tanzania, Madagascar, Seychelles, Mauritius, Comoro, Mozambique and Kenya in year 2007 was 48,845,251 people. The total population using pit latrine in 2007 was 38,084,646 people. This indicates that about 78% of the population in the region use pit latrine as a sanitary infrastructure. Figure 3.1 shows the population using pit latrine in Madagascar, Kenya Mozambique and Tanzania for year 2007. It is anticipated that the population using pit latrine in the region will decrease when other types of sanitation will be adopted.

In Kenya a common feature in the Swahili houses that use pit latrines is that all of them have a shower room next to the toilet and all washings from the shower rooms are directed to the toilet pit. This method of draining the wastewater from personal washing to the pit latrines leaves the pits permanently wet and thereby acting as wet cells for groundwater contamination (Mwaguni, 2007). About 24% of urban population of Toliary in Madagascar are using sanitary latrine while 76% using non hygienic latrine.

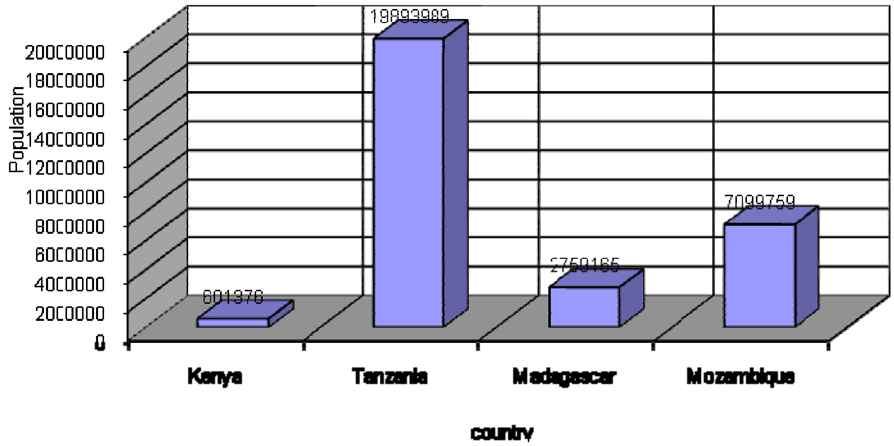

Figure 3.1 Population using traditional pit latrine in Kenya, Madagascar, Mozambique and Tanzania in 2007

The population using pit latrine in Mozambique and Comoro is based on 70% of the population in the respective country. Note that in Comoro and Madagascar there is no sewerage system and hence most of them use pit latrines or septic tank. The analysis indicates that in year 2007 about 80% of the population in the coast of Tanzania used traditional pit latrine and 0.06% used ventilated improved pit latrines. In Kenya about 71% of the population leaving along the coast use traditional pit latrines. The case is different for Seychelles and Mauritius where traditional pit latrine is used by small population. In Mauritius the actual number of residential premises making use of pit latrines is not known but is estimated to be less than 2% of the population. This is most probably due to the fact that more than 99% of residential premises in Mauritius are provided with pipes water supply and hence are connected to sewerage system or are using septic tanks. Pit latrines would normally be used in remote localities where it has not been possible to provide piped water due to technical reasons (Radhay, 2007).Figure 3.2 shows the population using pit latrine in Seychelles and Mauritius.

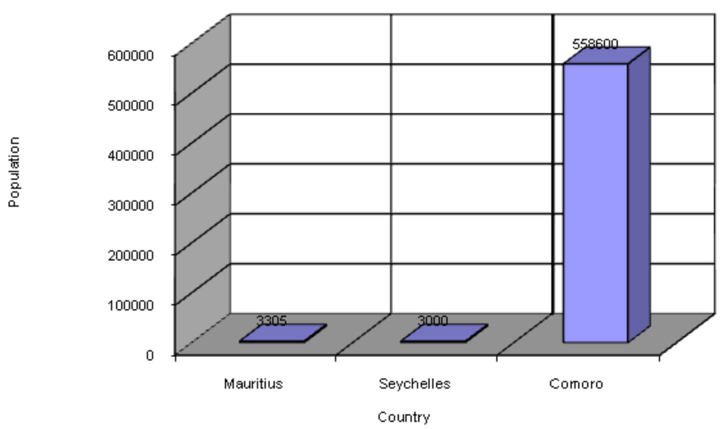

Figure 3.2 Population using traditional pit latrine in Mauritius, Comoro and Seychelles in year 2007

The national report from Seychelles indicate that only 3.5% of the household (751 house holds) use pit latrine and about 1.7% of the households (366 households) have no infrastructures for disposal of wastewater (Montano, 2007). The Comoro Islands since the colonial period did not profit from the installation of infrastructures for collection and treatment of municipal wastewater (Abdallah, *et.al*, 2007). High population in Comoro use pit latrine connected to the soak pit called tube which drains wastewater to the ocean.

The principle of all types of pit latrine is that wastes such as excrete, anal cleaning materials, sullage and refuse are deposited in a hole in the ground (WHO, 1992). In one form or another, pit latrines are widely used in most developing countries. At worst, pit latrines that are badly designed, constructed and maintained provide foci for the transmission of disease and may be no better than indiscriminate defecation (Melania, 2006). At best, they provide a standard of sanitation that is at least as good as other more sophisticated methods. Simplicity of operation and construction, low construction costs, the fact that they can be built by householders with a minimum of external assistance, and effectiveness in breaking the routes by which diseases are spread, are among the advantages that make pit latrines the most practical form of sanitation available to many people.

3.2.1.2 Usage of septic tank along the coast of WIO Lab countries

Septic tank is one of the onsite infrastructure used for municipal wastewater management. Septic tanks are commonly used for wastewater treatment for individual households in low-density residential areas, for institutions such as schools and hospitals, and for small housing estates. Usually septic tank effluent is further treated through soak way pit or infiltration system. The septic tank, in conjunction with its effluent disposal system, offers many of the advantages of conventional sewerage.

About 10% of the population in Tanzania and Madagascar uses septic tanks for wastewater disposal. The population using septic tank in Kenya is 17%. Figure 3.3 shows the population using septic tank in Kenya, Tanzania, Mozambique and Madagascar in year 2007. Figure 3.4 shows the population using septic tanks in Seychelles, Comoro and Mauritius. About 87% of the population in Seychelles and Mauritius use septic tanks for disposal of wastewater. Data on the population using septic tank for Comoro and Mozambique were not available hence it was estimated that 30% of the urban population use septic tank followed by soak way pits for disposal of sewage.

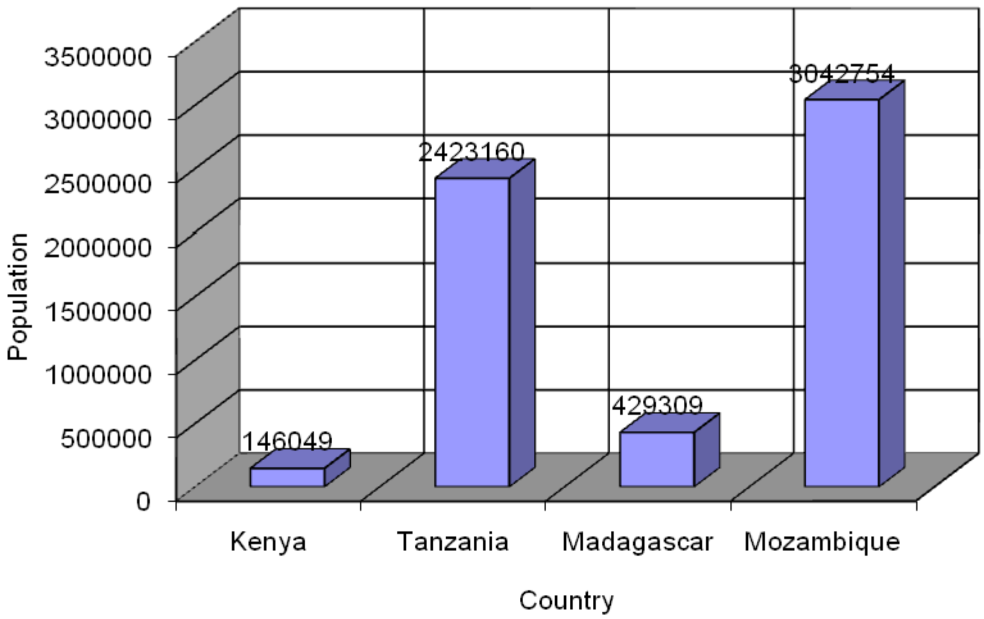

Figure 3.3 Population using septic tank in Kenya, Madagascar, Mozambique and Tanzania

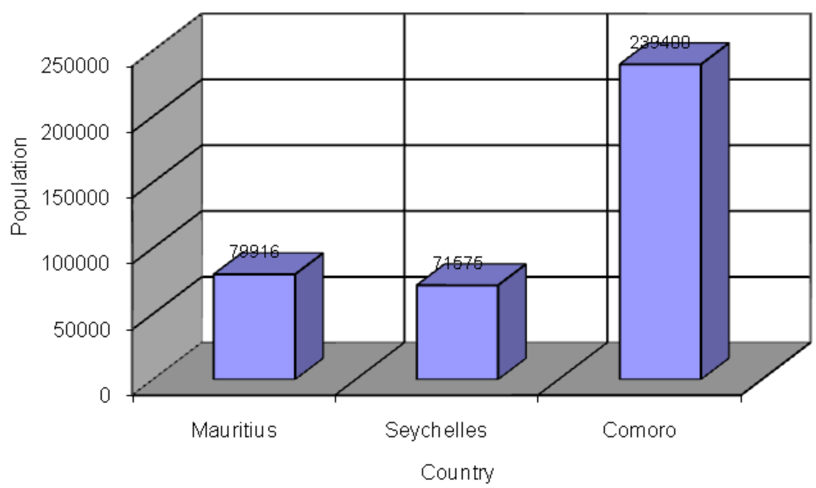

Figure 3.4 Population using septic tank in Mauritius, Comoro and Seychelles in 2007

Septic tanks may be designed to accommodate a population more than 5000 people. Such types of septic tank which accommodate large population are known as communal septic tanks. In Seychelles septic tanks are designed to serve a population of more than 200 people who are living in Housing Estates built by Housing Department in Mahe.

Generally the usage of septic tanks is associated with high utilization of water. The estimated quantity of wastewater disposed through the septic tank in the region is as presented in Figure 3.5. The amount is estimated based on the assumption that each person per year uses 7.5m^3 for flushing to septic tank. The total volume of wastewater discharged through septic tank from all countries in the region is 48,245,967 m^3/year. Wastewater from septic tank may overflow to the open channels or rivers if the soil permeability is poor. Hence wastewater from the septic tank is also a potential source of pollution to the ocean water. Figure 3.5 indicates that much wastewater is discharged through septic tank from Mozambique and Tanzania.

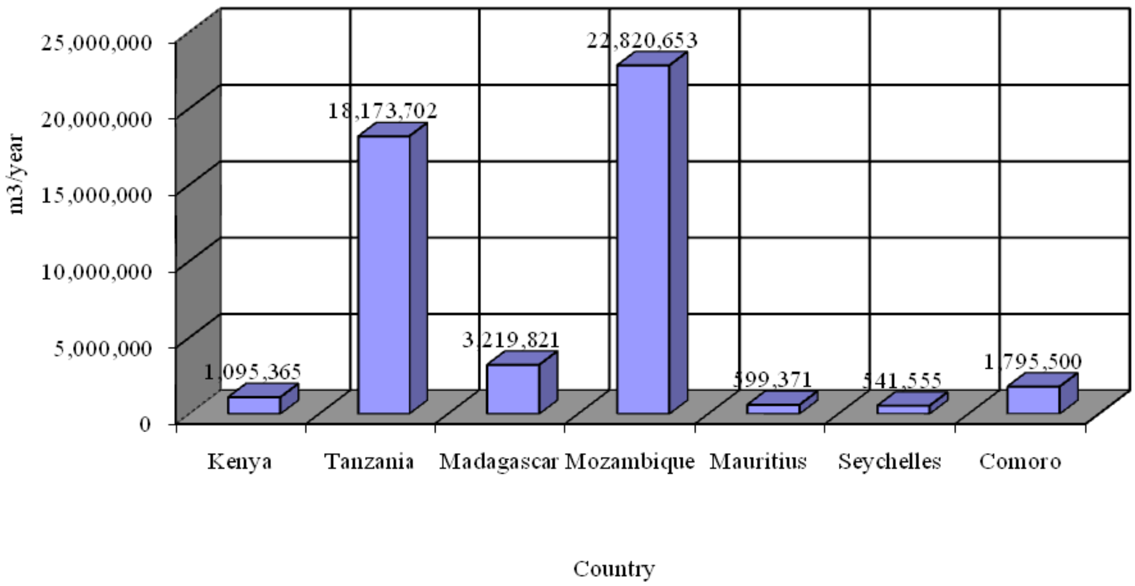

Figure 3.5 Estimated quantity of wastewater being discharged through septic tanks

Some communities within the WIO Lab countries have no sanitary facilities hence they use beach as a defecating area (Mong 2007). The population without sanitation facilities in Kenya, Tanzania and Madagascar is significant (Figure 3.6). The population without sanitary facilities is still high hence more efforts should be directed to provide facilities for population without. Where there are no latrines people resort to defecation in the open. Open defecation encourages flies, which spread faeces-related diseases. In view of the health hazards created and the degradation of the environment, open defecation should not be tolerated in villages and other built-up areas.

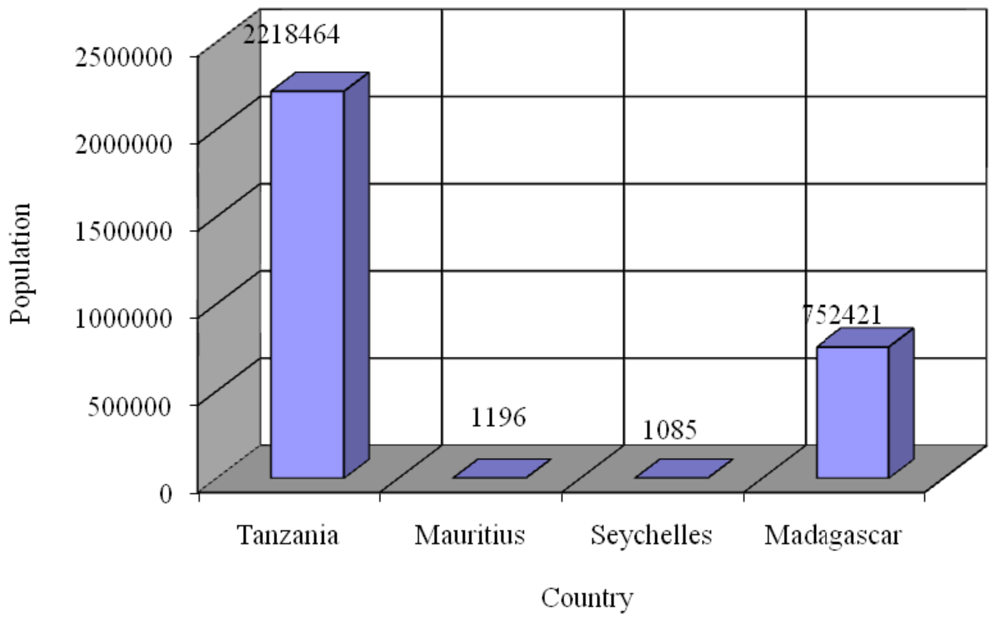

Figure 3.6 Populations without sanitary services in the region

The overall distribution of sanitary infrastructures used as onsite in the region is as shown in figure 3.7. Figure 3.7 shows that the most commonly used sanitary facility in the region is traditional pit latrine (78%), followed by septic tank (13%) and sewerage percent coverage is only 2%. Note that the regional analysis also indicates that 6% of the population in the region have no facilities. A very small percentage of the population and is mainly reported from Tanzania and Kenya use ventilated improved pit latrines and Ecosan toilets for disposal of wastewater.

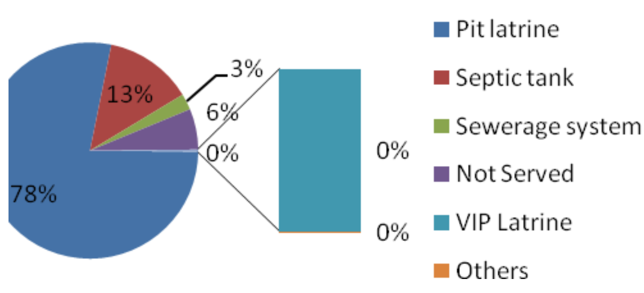

Figure 3.7 Percentage distribution of sanitary technology in the region

At regional level the coverage for sewerage infrastructures is very small when compared to coverage of about 7.5% for a population in Mauritius. The population without sanitary facilities shown in Figure 3.7 above does not include the population from Mozambique and Comoro due to lack of data on the distribution of sanitary facilities. The overall distribution of sanitary facilities in the respective countries in the region is as shown in Table 3.1 below.

Table 3.1 Distribution of sanitary infrastructures in the WIO Lab countries

Country	Pit latrine	Septic tank	Sewerage system	Others (VIP Latrine etc)	Without
Comoro*	70	30	-	-	-
Kenya	72	17	11	-	-
Mauritius	3.7	87.5	7.5	-	1.3
Madagascar	70.0	10.9	-	-	19.1
Mozambique*	70	24.6	5.4	-	
Seychelles	3.9	86.9	7.5		1.7
Tanzania	80.9	9.8	2.2	0.1	7.0

* *Data on the distribution of the population based on the infrastructures used was not available*

The analysis shown in Table 3.2 is mainly based on the data presented in the National Reports. The population using septic tank in Mauritius and Seychelles is high compared to other countries in the region. This may allow in future connecting septic tanks to small bore sewerage system and discharge wastewater to a single treatment plant. Based on the Nation Reports the population using unsanitary facilities in the region might decrease in future if more population will be connected to sewerage system.

3.2.2. Conventional wastewater collection infrastructures

Offsite wastewater collection infrastructures include the use of sewerage system and sometimes shallow sewerage system. The system collects wastewater and discharges to the treatment plant located far away from the community. Based on the National Reports only few urban areas in WIO Region have been served by sewerage system. In the region, cities and towns along the coast are typically only partially sewered. The proportion of the population served range from a small percentage to 18% in a very few cases. The regional synthesis on the usage of sewerage system for wastewater collection indicates that, in South Africa the towns and cities are installed with sewerage system for wastewater collection. Large percentage of the population in Seychelles and Mauritius is sewered and hence they are at advanced stages. In Tanzania and Kenya the percentage of population sewered is very low and hence large population still relies on the use of onsite sanitation (Mwaguni, 2007; Melania, 2007). With exception to Seychelles, Mauritius and South Africa, the sewerage systems in Tanzania, Kenya and Mozambique is either discharge wastewater to the poorly working treatment plant or discharged untreated sewage to the ocean.

Figure 3.8 shows the population served by sewerage system in the region. It is clear that the population sewered in the countries shown in Figure 3.8 is still very small compared to the population using other sanitary facilities. In Mozambique, Maputo is the only city with a central sewage system for collection and treatment of domestic sewage. However, it is estimated that only 50% of Maputo’s sewage are treated (Buuren and Heide, 1995)

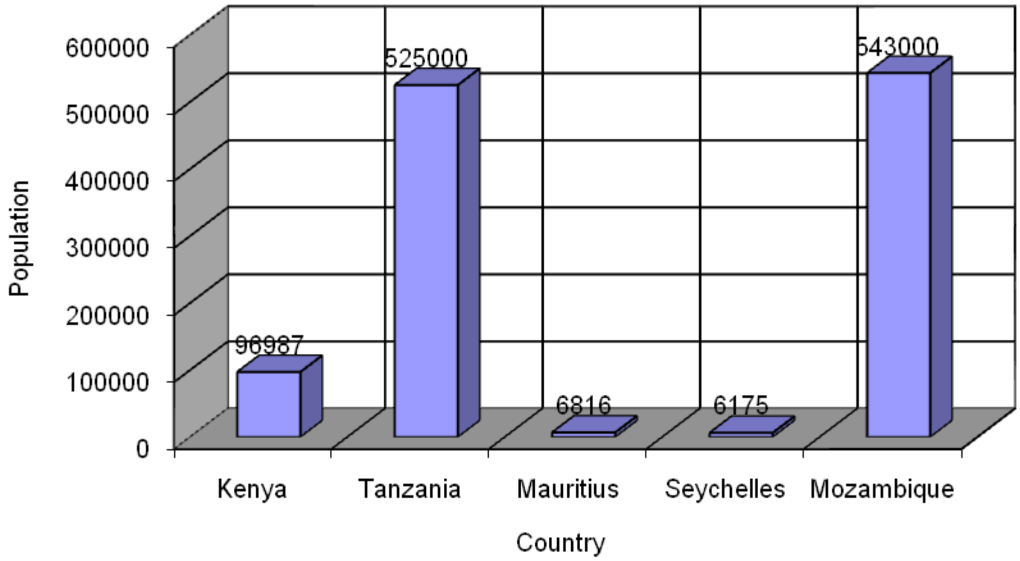

Figure 3. 8 The population served with sewerage system in the region in 2007

The estimated volume of wastewater generated from the population using sewerage system in the region is 64,788,772 m^3/year. The value is estimated based on the assumption that each person per year discharges 55m^3 as wastewater through the sewer. If the whole population in the region would have been connected to the sewerage system then the total amount of wastewater that will be generated would be 2,686,488,794 m^3/year from a population of 48,845,251 people for a year 2007. Figure 3.9 shows the estimated amount of wastewater from each country based on the population of year 2007.

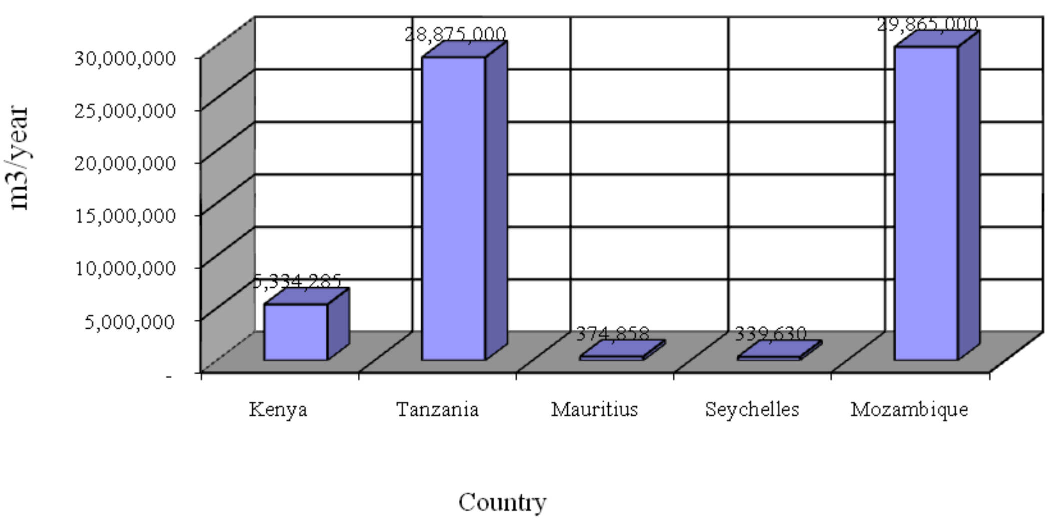

Figure 3. 9 Estimated volume of domestic wastewater generated from the population connected to sewerage system in the region for a year 2007.

3.2.3 Domestic wastewater treatment infrastructures

The infrastructures used for wastewater treatment in the region includes conventional (Activated sludge systems etc) and non-conventional (Waste stabilization ponds) systems. In Tanzania nine sets of waste stabilization ponds were installed and have a total area of 23.2 hectares and overall volume of 304,376 m^3 for wastewater treatment collected from part of Dar es Salaam city (Mgana, 2003). In Mombassa Kenya, Aerial/biological oxidation sewage treatment plants were installed for domestic wastewater treatment. However the treatment plant is not working due to management and operational problems. Hence raw sewage from Mombasa town is discharged direct into the ocean. Figure 3.10 shows one of a channel carrying raw sewage bypassed from the treatment plant and now draining to the ocean. Some of the hotels in Mombasa have installed their wastewater treatment plants to avoid disposal of raw wastewater to the ocean.

Figure 3.10 Wastewater from the Kipevu treatment plant in Mombasa draining directly into the Indian Ocean.

There are about 19 wastewater treatment plants in Mauritius for domestic and industrial wastewater. The type of treatment is usually biological treatment with either activated sludge process or RBC followed by disinfection with chlorine and re-use through irrigation. The total number of the treatment plants includes septic tanks, conventional plants and leaching fields. There are about 45 large hotels located along the coastal zone of Mauritius that possess their own wastewater treatment plant and treat their wastewater for irrigation of their golf courses and lawns. The volume of domestic wastewater treated in private treatment facilities, such as hotels, is about 5,000 m^3 per day. Table 3.2 shows the location of treatment plants, the number of household served, and the quantity of wastewater treated in Mauritius. Most of the treatment plants are still working below the design capacity of the system and hence allowing for future connections. The effluent from the treatment plants is discharged either through lagoon or direct to the ocean. Figure 3.11 shows ST Martins' processes flow diagram of wastewater treatment plant in Mauritius.

Table 3: 2 : Treatment units installed in Mauritius

Name of treatment plant	Household connected	Quantity treated (m^3/day)	Design capacity (m^3/day)	Treatment units
St. Martin WWTP	*27, 000*	*40, 000*	*87, 000*	*Screening, Grit Removal, activated sludge plant with biological nutrient removal, sludge treatment by thickener fed with polyelectrolyte, anaerobic sludge digestion in tank, sludge dewatering by centrifuges together with polyelectrolyte dosage, The secondary effluent is passed through rapid sand filters and UV disinfection channels*
Grand Baie	*1, 500*	*1,200*	*3, 500*	*Screening, Aerated grit chamber with skimming and grease removal, activated sludge with biological nutrient removal, effluent is discharged into Borehole injection*
Baie du Tombeau	*1,500*	*24, 000*	*35, 000*	*Screening, Flat bottom detritus tank, coarse, manually rakes screens and finally the effluent is discharged into the ocean*
Montagne Jacquot		*35, 000*	*48, 000*	*Screening, 4 primary sedimentation tanks, The effluent from the primary sedimentation undergoes disinfection with chlorine in chlorine contact tanks, The final effluent is discharged into the ocean through a long sea outfall. The primary sludge is pumped into sludge holding tanks and is thickened by means of two picket fence thickeners. A sludge conveyor directs the dewatered sludge to skips/trucks and the cake is disposed of in landfill at Mare Chicose.*

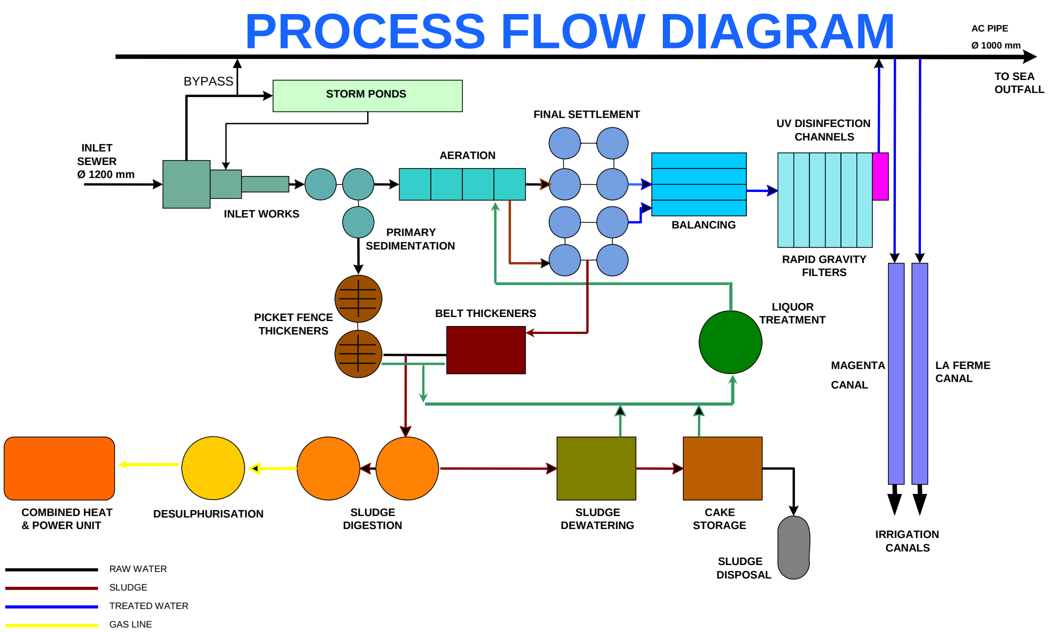

Figure 3.11 ST Martin process flow diagram of wastewater treatment plant in Mauritius.

The treatment plant at ST Martin includes primary treatment units (screening, primary sedimentation), biological units (aeration and secondary sedimentation tank) and sludge management units (digesters) and is installed with chlorination unit for disinfection of effluent. The whole wastewater collection and treatment system in Mauritius also includes the operation 50 pumps. The total average daily volume of wastewater collected and treated including industrial wastewater is 87,788m^3/day

There are 29 treatment plants in Seychelles used for treatment of domestic sewage from residential houses and hotels. Twenty four treatment plants including, activated sludge systems (8 treatment plants), Bio-Disc (9 treatment plants), waste stabilization ponds (only one), SBR (one treatment plant), USB (one treatment plant) and fixed film (one treatment plant) are installed in the hotels for wastewater treatment. There are five treatment plants used to treat wastewater generated from the community. The treatment plant installed for domestic wastewater treatment includes three activated sludge systems and two bio-discs.

In South Africa there are over 60 licensed pipelines discharging effluent along the South African coast: one third discharge domestic sewage - about 66 million liters per day (66ML/d), half discharge industrial wastes (230ML/d), and the remainder discharge mixed effluent (360ML/d). The type of technology used is as follows; activated sludge system, Biological rotating disc, waste stabilization ponds, upward sludge blanket, and biological fixed film. The treatment plants have been built recently and there are no data on their performance.

In Mozambique the treatment plant is consist of a series of anaerobic and facultative tanks, which are designed to treat organic matter (Buuren and Heide, 1995). The treatment plant was designed to treat sewage from 50% of the population of Maputo. The treatment plant is no functioning due to operational and maintenance problems.

3.2.4 Management of stormwater

Most of the urban areas in the WIO Lab countries are installed with open drain along the roads for collection of stormwater. Sometimes the open channels are used to flush sullage from the urban areas to the ocean. Stormwater in the region, originating from the centre of the urban area must be regarded as potential source of pollution of marine environment. Industrial wastewater is discharged into the open channels draining wastewater direct into the streams and finally to the ocean. Example in Tanzania, Msimbazi River receives wastewater from several industries and hence it is heavily polluted. Figure 3.12 shows one of the streams crossing the urban area in Dar es Salaam being polluted by industrial wastewater and sullage from the households. Also Figure 3.12 shows one of the stream in Mikindani are in Mombasa discharging domestic wastewater to the ocean. Generally stormwater collected from the urban centre in the region do not undergo any type of treatment before disposed in the streams or direct to the ocean. The major river discharge hotspot areas are Tana and Sabaki Rivers in Kenya, Rufiji in Tanzania, Ruvuma on the border of Tanzania and Mozambique, and Zambezi in Mozambique.

Figure 3.12 Stream carrying domestic and industrial wastewater in Dar es Salaam and a stream carrying domestic wastewater from Mikindani area in Mombasa

3.2.2 Sludge management from pit latrines and septic tanks

Sludge, representing the solids portion encountered from excreta disposal is interchangeably used to address solids accumulated in the wastewater stabilization ponds, primary and secondary sedimentation tanks, concentrated discharge from the septic tanks and the content of the pit-latrines (or other forms of onsite sanitation) after reaching their full capacity. The amount of faeces and urine excreted daily by individuals varies considerably depending on water consumption, climate, diet and occupation. Anal cleaning materials vary widely around the world. Where excrete are stored for short periods only, such as in double pit latrines or composting toilets, the reduction process may not be complete before the sludge is removed.

In Seychelles, areas with ready road access, the sludge from septic tanks are transported using vacuum tankers and taken away from the site for disposal; whereas in areas inaccessible to larger vehicles the sludge is manually removed and placed in a pit on site. Previously sludge from septic tanks was delivered to the landfill site, where it was discharged into special pits and left to dry out. The drying process was naturally dependent on weather and since the volume of sludge was high the processes of drying was not complete and hence resulted in persistent odors. Currently at the GVSP and BVSP treatment plants, there is a provision for sludge disposal station. The sludge receiving station consists of manual bar screens to prevent large objects from entering the treatment plants. Depending on the operator, in Seychelles the cost of vacuuming $3.0m^3$ of sludge is between SCR 1000 and SCR 1250 (USD 175 and USD 200), the cost of which has to be borne by the homeowner or the plant owner. In Tanzania the currently pit emptying charges range between US$ 65 - 85 per trip. In Dar es Salaam and Maputo the sludge collected from septic tanks and pit latrine is usually dumped in the anaerobic waste stabilization ponds. Figure 3.13 shows the cesspit emptier discharging sludge from households to waste stabilization pond in Maputo.

Figure 3.13 Cesspit emptier discharging wastewater containing sludge to waste stabilization ponds in Maputo

In Tanzania sludge from pit latrines is either emptied using tankers, though only practiced by fewer households and majority opt digging new pits on a different locations (Melania, 2007). Sludge management is more systematic in Mauritius where the generation of sludge from the four treatment plants is 1060 tone per month and is usually treated through sanitary land fill. The volume of septage from desludging of individual cesspits/septic tanks and from industrial wastewater carted away to the public wastewater system by tankers is estimated at about 1, 374 m^3 per day. Cesspit emptying in squatter areas has experienced difficult due to lack of access roads and most of pits are unlined, thus they collapse when the cesspit emptier is used.

3.3 Industrial Wastewater

Industrial wastewater commonly originates in designated development zones or, as in many developing countries, from numerous small-scale industries within residential areas. Industrial water demand and wastewater production are sector-specific. Industries may require large volumes of water for cooling (power plants, steel mills, and distillation industries), processing (breweries, pulp and paper mills), cleaning (textile mills, abattoirs), transporting products (beet and sugar mills) and flushing wastes. Depending on the industrial process, the concentration and composition of the waste flows can vary significantly. Industrial wastewater may have a wide variety of micro contaminants which add to the complexity of wastewater treatment (Helmer and Hespanhol, 1997).

3.3.1 Industrial wastewater flow rate and pollution loading

There are many industrial activities along the coast that contribute to pollution and contamination of ocean water. Most of Industries are located in coastal urban centers discharge their wastes – untreated or partial treated - into coastal waters through various rivers and streams. Due to poor enforcement of regulation on effluents discharge most of these industries operate without any treatment facility. Most of the major manufacturing industries in (over 90 %) along the Kenyan coastal area are located in the industrial areas of Mombasa and extend towards Mazeras and Mariakani in Kilifi District along the Mombasa – Nairobi Road. Industries in Mombasa generally do not pre-treat their effluents before discharge, with the exception of a few which include the petroleum refinery.

Stormwater drains are one of the infrastructures used for collection of some of the industrial establishments in Mombasa and are allowed to discharge their liquid effluent into the municipal storm-water sewer system which drains wastewater into inshore water areas, particularly Kilindini/Port Reitz creek. Other industrial establishments have been allowed to discharge their liquid effluent into vertical drains which tend to contaminate the groundwater (Mwaguni, 2007).

Most of industries in Tanzania are centered in municipal towns of Tanga, Unguja and Dar es Salaam. In Tanzania industries have no infrastructures for industrial wastewater collection and treatment. Most industries in Dar es Salaam discharge untreated or partially treated wastewater into neighboring surface water bodies such as rivers and ocean. The industrial wastewater collected is discharged along the open drains or the streams to the ocean (Melania, 2007). The type of industries located in Dar es Salaam City include: textiles, breweries, distilleries, beverages, bags, cigarettes, cement, paints, pharmaceuticals, plastic, metal products, steel, grain milling, chemicals, timber and wood products, confectionery, food products, petroleum products, edible oil, dairy products, domestic utensils, tea blenders, batteries, radiators, body building, printing and publishing, paper products, garments, electricity generation and glass. Figure 3.13 shows industrial wastewater being discharged in Mikocheni River which drains to the ocean.

Figure 3. 13 Industrial wastewater discharged in Mikocheni River draining to the ocean

In Dar es Salaam most industries discharge their wastes into the Msimbazi and Mzinga creeks making them the most heavily polluted spots in Dar es Salaam (Mgana and Mahongo, 1977). The estimated flow rate from the industries located in Dar es Salaam is 689,666 m^3/day. The average flow rate of industrial wastewater from the Zanzibar Island is 23m^3/day carrying an estimated pollution load of 25 tone/year BOD5, 16 tone/year suspended solids, 2 tone/year nitrogen and 0.2 tone/year of phosphorous (Mohammed *et al*., 2005). From Tanga the average industrial flow rate is 3998m^3/day carrying a loading of 78.tone/year of BOD5, 0.73 tone/year of phosphorous and 50 tone/year of nitrogen.

In Madagascar the main industrial enterprises include sugar cane industry, tuna, seafood (shrimp, prawn, and oyster), oil and soap, brewery, and tannery. Due to poor enforcement of regulation on effluents discharge most of these industries operate without any treatment facility. The primary treatment being used, if any, consists of coagulation and decantation, or only decantation before discharging into sewerage system or directly into the sea (Monk, 2007). The average volume of wastewater from industries discharged to the ocean is 12083m^3/day with corresponding loading of 15197.2 tone/year BOD_5, 8359.4 tone/year of suspended solids, 655 tone/year of lubricant and oil, 168.6 tone/year of nitrogen and 0.27 tone/year of phosphorous.

Mauritius has 31 industries which produce in total of 20493 m^3/day of wastewater. Most of it undergoes primary or secondary treatment operation and processes. The pollution loading to the ocean after pretreatment and secondary treatment of industrial wastewater is as follows; 1154.39 tone/year BOD_5, 2310.94 tone/year suspended solids, 0.79474 tone/year Nitrogen and 81.39146 tone/year phosphorous. This indicates that most of the nitrogen is removed during the treatment compared to the phosphorous.

The main industries in Seychelles is concentrated on the processing of fish products with the largest unit being the Indian Ocean Tuna (IOT) canning factory and other small enterprises, such as Oceana Fisheries and Sea Harvest. All these plants are connected to the central treatment works of GVSP although for the IOT factory only the domestic effluents are conveyed to the GVSP plant for treat. Other industries include, the Seychelles Breweries (drinks manufacture), SMB abattoir (slaughterhouse for chickens, pigs and cattle) and Penlac (paint manufacture). Until recently, all wastewater from these industries was being discharged into the lagoon located between the Mahé and the reclamation area, with only nominal pre-treatment at source. The pre-treatment infrastructures used for respective industries are as follows; (i) Seychelles Breweries sedimentation to remove broken glass and other solids, (ii) SMB abattoir settling tank to remove feathers and some of the oils and fats (on days with low production system tended to turn anaerobic) and (iii) Penlac a decantation tank for the separation of volatiles from the wastewater.

In Mozambique, more than 100 factories in and around Maputo do not have waste treatment plants and drain toxic wastes, poisons, non-degradable substances and organic matter into coastal waters (Chenje and Johnson 1996). Data on the quality and quantity of industrial wastewater were not available.

Most industrial installations are concentrated in the cities Durban, Port Elizabeth, East London and Cape Town. The effluents of industrial installations are (without or with preliminary treatment) discharged with pipelines to the ocean or in estuaries. The most important substances emitted are phosphates, ammonium, COD, suspended solids, faecal coliform and other toxic substances, mainly caused by the fish-, chemical-, oil refinery-, paper-, sugar- and textile industries (Dubula, 2007). The volume of pretreated industrial wastewater discharged direct to sea outfall is 598,308 m^3/day and the volume of industrial wastewater discharged via surf zone and estuarine zone is 191161 m^3/day (Phillips, 2007). Figure 3.14 shows the volume of industrial wastewater generated by industries along the coast.

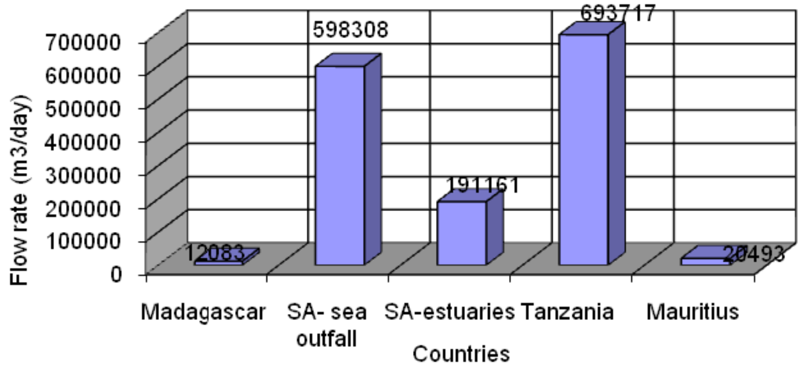

Figure 3.14 Volume of industrial wastewater from WIO Lab countries

Most of the industrial wastewater generated from Seychelles, Mauritius and South Africa is either pretreated or undergo secondary treatment before discharged into rivers draining to the ocean or direct through sea outfall. The pollution loading estimated from Mauritius was low compared to other countries due to level of the treatment. Figure 3.15 shows the pollution loading from Madagascar, Mauritius and Tanzania. The pollution loading for other countries was not computed due to lack of data on concentration of pollutants.

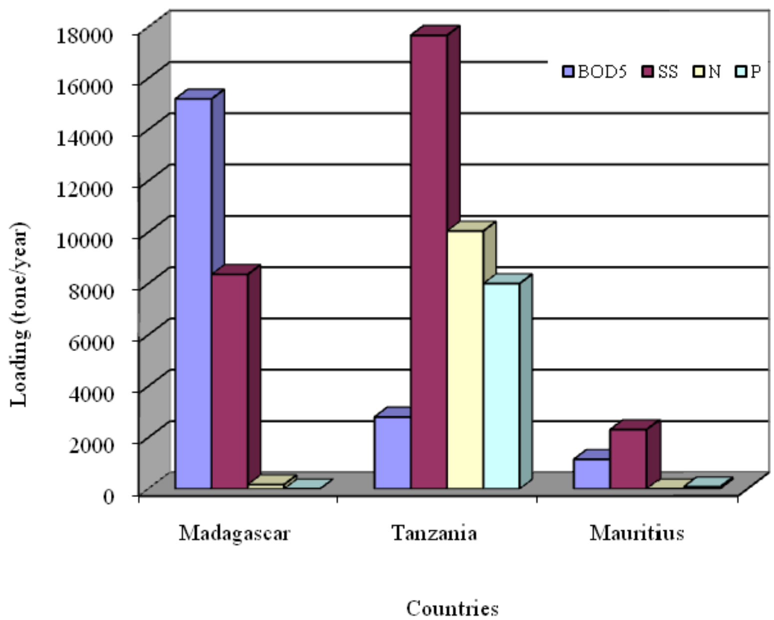

Figure 3.15 Pollution loading from industries located in Tanzania, Madagascar and Mauritius

3.3.2 Industrial wastewater treatment infrastructures

Wastewater collected from industries located in Tanzania, Comoro, Mozambique, Kenya and Madagascar discharge raw wastewater to Indian Ocean without any treatment. In Seychelles and Mauritius wastewater from industries has to be pretreated or undergo secondary treatment before discharged to the ocean. In Seychelles and Mauritius activated sludge systems are used as biological treatment methods. Oxidation ponds, retention ponds and sedimentation tanks are used as pre treatment units. In Seychelles the pre treated industrial wastewater is discharged direct to the municipal wastewater treatment plants for further biological treatment.

3.4 Conclusions

Based on the data from the National Reports, the most commonly used infrastructure for wastewater collection in the region is traditional pit latrine. The percentage usage of pit latrine differs from one country to another. However the usage of septic tank as onsite sanitary infrastructure is high in Mauritius and Seychelles compared to other WIO Lab countries.

Coverage of sewerage system for collection of domestic wastewater is very low and hence the amount of wastewater collected and treated in the region is small. Some of the sewerage systems installed in the region are not connected to treatment plants. The conditions of sewerage system in some countries are not good due to lack of maintenance and operation. Lack of technical manpower for operation and maintenance of sewerage system and wastewater treatment in WIO Lab Countries resulted in many installed sewerage systems and treatment plants not to function according to design.

Sewage treatment technologies vary considerably among the WIO Lab countries. South Africa, Seychelles and Mauritius use non conventional and conventional wastewater treatment technologies for domestic and industrial wastewater treatment. The application of conventional wastewater treatment technology in South Africa, Seychelles and Mauritius has been successful mainly due to good economy and reliable energy. In Tanzania and Mozambique most of the installed waste stabilization ponds in Dar es Salaam has failed to operate due to lack of proper operation and maintenance.

There is need to plan and implement a comprehensive monitoring programme to fill the data gaps. Most of the countries do not have performance data for wastewater treatment plants beside of having effluent standards. This implies that there is no monitoring programme for determining the level of efficiency of treatment. Such data can be used to assess and evaluate the state of the system, carrying capacity and to help predict potential impacts of development. The possibilities of developing predictive environmental models to aid in decision making and environmental management should be considered. Most of the countries have indicated the presence of effluent standards. However the monitoring of the efficiency of the treatment plants is not in place as indicated by lack of performance data from many countries.

Discharge of untreated domestic wastewater has been identified as a major source of environmental pollution in most WIO Lab countries. Only a fraction of domestic and industrial wastewater is being collected and treated. Urban centers are the major source of sewage in the coastal areas of WIO Lab region, with sewage production directly related to population increase. Treatment facilities and infrastructure have not kept pace with population growth and the number of people without the benefit of wastewater treatment will continue to increase, unless the means are found to overcome existing constraints. The coastal urbanization and the associated industrial sector are growing rapidly in the region.

Chapter 4 ASSESSMENT OF MWW MANAGEMENT PRACTICES AND METHODS

4.1. Overview of existing MWW management practices and methods

Municipal wastewater management has four components namely; collection, treatment disposal and reuse. The Governments in WIO Region are essentially a service provider and the traditional Supply-driven wastewater management approach is normally adopted. The responsibility to manage municipal wastewater in the region lies primarily with Central Government, which through the Ministry of responsible for water, health, land or works delegates its responsibilities with respect to the wastewater sector to the Wastewater Management Authorities (Ridhay, 2007, Melania, 2007 and Mwaguni, 2007). Example in Mauritius the WMA Act 2000 give whole responsibility for the wastewater sector to the WMA. Responsibility for the sector is thus highly centralized. The WMA is responsible for: Project Management of all feasibility studies, detailed design, consultancy supervision and Works contracts for extending the sewer network nationally and for construction of wastewater treatment plants; Operation and Maintenance of all public sewer networks in Mauritius; Pollution Control by way of approval of wastewater management schemes of all proposed infrastructural development, issue of effluent discharge permits, application of “Polluter Pays Principle”, post-monitoring through inspections, visits and effluent sampling and analyses; Securing the generation of revenue, mainly through tariff, so as to ensure self-sustainability and Advise the GoM and other institutions on all matters relating to the wastewater sector.

Sewerage system, until recently, was directly managed by Government which meant long bureaucratic procedures in purchases and payments, therefore adversely efficiency in operation and maintenance. Mobilization of financial resources from the private sector has therefore not been possible. Countries like South Africa sewerage coverage is high and almost all wastewater collected receive primary or secondary treatment before discharged to the ocean or rivers draining to the ocean. The wastewater collected by central sewerage system is sometimes treated in waste stabilization ponds (Tanzania), in aerated lagoon (Kenya), in activated sludge systems (South Africa, Mauritius and Seychelles) or direct disposed to the ocean via sewer outfall. The level of investment on wastewater treatment technology varies between one country to another. Example, Seychelles, Mauritius and South Africa have invested much on conventional technology for wastewater treatment than other countries in the region. In one hand it may be safely concluded that these three countries did have a strong and well defined policy on wastewater management than others. Since the pollution is mobile there is a need to all countries to collective address the problem of municipal wastewater management than to let each country to struggle at their own. The lesson learnt from Mauritius, Seychelles and South Africa on the methods used for municipal wastewater management should be a catalyst of change to the rest of countries.

4.1.2 Inadequate Legal and Regulatory Framework

All WIO Lab countries have legal and regulatory frameworks for MWW management. However in some countries in the region the disseminated to the user level is not yet done. This may be observed through the pace which is taking place in the respective countries on addressing the problem of MWWM. Example each country has effluent standards for wastewater monitoring, however only few countries have reported the performance of the installed wastewater treatment plants. This indicate that some of the countries have standards and are not used based on the regulatory framework developed. This calls for all countries to work together for enforcing and performing based on the framework in place. Penalties for polluting water source due to discharge of wastewater are not open to public. The existing legal and regulatory framework as well does not encourage private sector participation in the delivery of water and sanitation services (Melania, 2007). Many countries in the region have started to decentralize activities on wastewater management to private sector. However the private sector is not well equipped in terms of financial, knowledge on municipal wastewater management and skilled personnel.

4.1.3 Low Political Commitment and Financial Resources

The political commitment for addressing the MWW management problem in the region has began after a realization that addressing the problem would contribute to the country's economic development. The formulation of the environmental policy frameworks in respective WIO Lab countries is a clear indication of commitments. Example in Kenya the Environmental Management and Coordination Act (1999) introduced the Polluter Pays principle into municipal wastewater management with the EMCA (Water Quality) Regulation 2006, providing the mechanisms of transferring the burden of managing pollution officially to those who cause pollution. This is contributing immensely to addressing the Municipal Wastewater problem in the country. In this way, the country is assured of raising funds domestically, while encouraging polluters to treat their waste at source.

4.1.4 Lack of Coherent Institutional Arrangements

Strong institutional arrangements are a key to successful municipal wastewater management. So is coordination and allocation of roles and responsibilities. All countries have initiated autonomous authorities for wastewater management. Example in Tanzania Urban Water and Sanitation Authorities (UWSA) has been formed and they are responsible for wastewater management. The authorities usually sign a performance agreement with the government and they are given performance indicators. In Seychelles all public infrastructure for the collection and treatment of wastewater is directly managed by the Public Utilities Corporation (PUC), more specifically the Sewerage Section of that Corporation. The influence of institutional arrangement within the region in management of municipal wastewater might give positive observation in future if the governments in the region will not interfere. In Mauritius the responsibility MWW management lies primarily with Central Government, which through the Ministry of Public Utilities, has delegated its responsibilities with respect to the wastewater sector to the Wastewater Management Authority. A Parastatals organization, the WMA has been set up, equipped with the necessary technical, legal, institutional and financial framework necessary for sustainable development of the sector (Radhay, 2007). Besides handing over the responsibilities to authorities still the governments has to support them financially and sometimes technically. Hence if the government is too beucratic then the implementation will be affected.

Service level coverage for sewerage is fairly low in urban areas and non-existent in rural areas, and that the sanitation facilities in rural areas consist mainly of pit latrines. If environmental impact is to be minimized, then sanitation improvement in slum urban areas is necessary since the large number of residents in an urban community who do not have adequate sewage disposal can adversely impact the environmental health of water resources and affect those who do have sewerage.

4.1.4 Lack of Knowledge on Selection of Appropriate Technology

There has been very little investments on research to enable the countries choose an appropriate technology for investment in wastewater management. The countries therefore have been stuck with the use of the traditional pit latrine, the septic tank and soakage pit systems. None of which have proved very appropriate where water conservation and pollution prevention issues are concerned. The governments in the region need to encourage research on sustainable technologies based on the economic scale of the respective countries. Sharing research information will considerable reduce duplication of efforts within the region.

4.1.5 Low Stakeholder Involvement

The existing MWW management methods and practice foresees a role for the involvement of stakeholders. In all WIO Lab countries a situation has been created by the Policies whereby the private sector, NGOs and communities will play a greater role in the water sector including water resources management and pollution prevention. This would require that the new actors undergo capacity building in order to be sensitized and mobilized towards sustainable water and wastewater management. NGOs and other stakeholders have been involved in water resources management activities but in most cases their efforts have not been made public. The problems associated with MWW management have made the Government to recognize the challenge of bringing stakeholder on board in the management and provision of water and wastewater management services. Selection of stakeholder has to view the water sector in its wide spectrum rather than selecting a group of interest only. Stakeholder must be given their role on applying alternative management options and technologies that are participatory rather than those that are wholly recipient.

4.1.6 Lack of Financial Stability and Sustainability

Investment in water and sanitation programmes has been declining when compared to the levels of the 1970s and 1980s, to a point where maintaining existing schemes is a challenge let alone entering into new investment projects. There is a decline in funding for operation and maintenance of MWW management infrastructure. To ensure financial stability, there is need to link water and wastewater management issues with the other sectors of the economy. Treated wastewater may be sold for agricultural activities and hence generate income for operation and maintenance of system. In the past revenue collected for wastewater was not adding any value on wastewater management. Funds collected were diverted for other uses and hence the water sector has to depend on the government allocation.

4 .2Assessment of Existing Constraints in MWW Management Practices and Methods

The Existing constraints in MWW management practices and methods in the region are numerous and most of the time, remain unresolved by governments effort in water and sanitation sector. These constraints range from insufficient financial capacity; human resources; Lack of capacity within the institutional arrangements; poor implementation of organizational structures; lack of clear allocation of responsibilities and interference to otherwise supposedly autonomous institutions by other arms of governments.

Selection of appropriate technology in the region is one of the constraints due to the fact that the expert and knowledge in the field of MWW management are few. Example the main technologies applied in Mauritius are waterborne sanitation, conventional activated sludge process wastewater treatment. Conventional treatment methods require capital investment and trained skilled labour to operate and maintain. This results in high costs of investment in sewerage infrastructure. The urban setting in the region requires a combination of technologies for MWW management. Example all towns in the region have slum areas where conventional sewerage system may not easily apply. On the absence of alternative technology the community will continue to use pit latrine which has adverse effects to the environment. In the region the application of small bore sewer or shallow sewerage system for wastewater collection from slum areas is not yet seen as a solution.

Sanitation in slum areas is rarely taken into consideration in the municipal planning besides being the sources of large volume of wastewater generation. Without improving the sanitation in the slum areas along the coast, the volume of wastewater generated and being discharged through the drains and then to the rivers will continue to pollute the ocean.

The policies and regulatory frameworks on MWW management in the region recognize the involvement of stakeholder in planning of MWW projects. However the regulations are not well defined and criteria and guidelines for stakeholder involvements are not well stipulated. After all the stakeholders in the region are not aware on the opportunities for participation and even investing in sanitation. In Seychelles and Mauritius involvement of private sector in wastewater and water supply is high and thus the coverage is high. Most of the WIO Lab countries have followed the trend of many developing countries in that the water sector has been heavily developed compared to the wastewater sector.

Infrastructures are not expanded to cover the population due to lack of funds. The wastewater projects are not attached with incentives of income generation which could be sourced from the reuse of effluent and sludge for agricultural activities. Planning for reduction of water volume used at household level in the region is not seen as an alternative to reduce the costs of treatment. If the volume of wastewater is reduced by using alternative sanitary technologies that use small volume of water, then the cost of wastewater management in the region will be reduced.

4.3 Recommendations for Improved MWW Management Practices and Methods

It has been realized that in order to improve wastewater management in the region, communities should be considered as the main stakeholders. Recognizing that wastewater management cannot be realized with technical and regulatory frameworks alone, then the universal waste management can be achieved through: true political commitment and public awareness, good and working institutional arrangement and legal framework, strong financial arrangements, and appropriate technical options for wastewater treatment, disposal and reuse.

There should be a creation of awareness on the wastewater management problem and involvement of all stakeholders in realizing the solution to the problem. The region should enhance awareness programs to ensure effective understanding of laws and regulations and creation of an enabling atmosphere for the devolved regional and local authority institutions and empower them to manage the water and sanitation services effectively.

The country synthesis report on municipal wastewater management indicates that, if the GPA guidelines and principles are adopted wholly in the region, there will be a high improvement of aquatic environment. The emphasis should also focus on the management of slum areas as these constitute a large percentage of population in the region. The government should encourage the private sector through economic incentives to adopt ecological engineering for sewage treatment, a technology that is available in the market. Since conventional sewerage undertakings are expensive to establish and run for poor economies with inadequate financial resources, other innovations have to be sought.

Reuse of sewage effluent offers another technical option to be considered. Citizens could to be educated in order to change their attitude and accept that sludge from sewage has nutrient value, while the treated effluent can be used in other ways. Such uses include the composting of the sludge to form manure for agricultural uses or the use of the effluent for the watering of gardens or farmlands. As attitude begins to be positive towards this re-use value, a “no-discharge” policy regarding sewage should be encouraged. As the use of sewage effluents becomes effective, the no-discharge policy can be enforced;

Because the enforcement of laws and regulations requires a system of quality monitoring for standards compliance, it is important that adequate technical and financial capacities are developed within the local authorities, which are mandated for wastewater management. The use of cheap, but appropriate and efficient technology, developed elsewhere should be pursued, and where appropriate, the transfer of such technology, should be encouraged.

The sewage effluent could then be channeled for the watering of the extensive gardens of the hotels. In fact resource recovery and re-use approaches could, in addition to water savings, result in financial incentives which can be used to cover part of the cost of wastewater treatment. Hence the urban water and waste management situation could also be addressed from a 'Cleaner Production' angle (Gijzen, 1999, 2001; Gijzen and Bijlsma, 2000). A holistic approach is required where waste should be seen as a resource, and its management should be linked to that of water resources and of nutrients.

High water consumption has serious implications on the sizing of water and wastewater facilities and their efficiency. Reduction in wastewater generation is therefore necessary in view of the importance of conserving resources, investments and energy. Water from bathing, washing machine, dish washer and kitchen could be collected separately and be reused for purposes that do not require drinking water quality; e.g. garden irrigation, car washing. Waste minimization involves not only technology, but also planning, good housekeeping, and implementation of environmentally sound management practices (cleaner production). It also involves a special attitude of the users (education, demand management). The 'polluter pays' concept and discharge limitations are some of the instruments used to control user practices. The 'polluter pays principle' should be put into full operation to act as a precautionary measure against wanton pollution and deter potential polluters from risking the financial penalty. Sewage tariffs should be reviewed on a regular basis to keep up with inflation and other costs.

Capacity building in the region is required if proper management of municipal wastewater has to be achieved. This should be done through local technical and universities in the region. Special programmes may be prepared by WIO Lab countries in collaboration with training institutions for preparation of specific curriculum for sanitary engineering.

Chapter 5: REVIEW EXISTING TECHNOLOGIES USED FOR MWW MANAGEMENT

5.0 Background

This chapter looks at the technologies currently being used in the WIO Region and their adequacy in meeting the treatment requirements to ensure the protection of public health and the preservation of the aquatic environments. In the following subsections the technologies applied in the region are discussed and their environmental impacts. Technology selection eventually depends upon wastewater characteristics and on the treatment objectives as translated into desired effluent quality. The latter depends on the expected use of the receiving waters. Standards or guidelines may differ between countries as the case in WIO Lab countries. The first issue to be addressed is whether sanitary treatment and disposal should be provided on-site (at the level of a household or apartment block) or whether collection and centralized, off-site treatment is more appropriate. The trend of development is from dry on-site to wet off-site sanitation (Veenstra, 1996). In wealthier urban situations, off-site solutions are often more appropriate because the population density does not allow for percolation of large quantities of wastewater into the soil.

5.1.1 Overview of existing technologies in WIO region

Wastewater is a general term used for all kinds of wet wastes, including those generated by industries and institutions. The existing technologies in the region are based the methods of collections treatment and disposal of effluent. Wastewater collection in the region has been influenced by onsite waste water disposal basically by using traditional pit latrines and septic tanks followed by soak way pits. About 78% of the population in the WIO Region use pit latrine for disposal of wastewater.

5.1.1.1 Onsite wastewater using traditional pit latrine

Traditional pit latrine and other types of latrine such as ventilated pit latrines, composting latrine, urine diverting toilets have been used in almost all countries in the region. The technologies of wastewater collection in the region are mainly onsite treatment. The only country which recommends the application of pit latrine with specific modification is Madagascar. The country has provided the guideline on the construction of the pit latrine along the coast so as not to cause any contamination of groundwater sources (Mong, 2007). The application of pit latrine in Mauritius and Seychelles is minimum and hence in future most of the population will be using septic tank and other disposal facilities.

However all the countries in the region have pointed out the major problems associated by the use of traditional pit latrines in the coastal areas. These are; (i) Over flooding during the rain season when is located in high water table areas, (ii) handling of sludge when the pit latrine is full, (ii) pollution of groundwater (iv) bad smell generated from the pit latrines. Most of the pit latrines are used in the unplanned area where access of cesspit emptier is almost impossible. Note that the decision to construct pit latrine lies in the hands of individual and not from government or government institutions. Hence the design and construction quality varies from one person to another. The governments in the region do not have standard design of sanitary facilities to be used by different settlement in the region. The application of standard toilets such as ventilated improved pit latrine is uncommon in the region. Very few VIP Latrines have been constructed in WIO region and are mainly used as demonstration units. Based on the National Reports it may be safely concluded that, the application of pit latrine is unavoidable. The major concern is the standardization of the design and guideline on the construction of various types of toilets. Lack of knowledge on the selection of the type sanitary facilities to be used in the area has resulted on construction of the pit latrines even in areas of high water table.

5.1.1.2 Application of septic tanks

The synthesis of the National Reports indicates that septic tanks in the region are usually constructed from reinforced concrete and reinforced block wall. Also fiber glass septic tanks are available in the market. The effluent from the septic tank is discharged into soak way pit or leaching field. In Mauritius and Seychelles leaching fields are only used for areas with low water table. Cesspits technology for wastewater collection is used in Mauritius and it drains black wastewater from toilets. It is reported that cesspits may stay more than 30 years without requiring any emptying. This further strengthens the general public attitude of “out of sight, out of mind” towards sanitation. In Mauritius grey water from kitchen sink, wash hand basin, bathrooms and washing machines are normally disposed into individual soak ways. This practice helps to maintain a septic tank to operate for a long period as it only receives black wastewater. Since the effluent from septic tanks is usually drained through soak way pit or leaching fields, many countries in the region have indicated that it is one of the source of pollution of groundwater. When the septic tank is not properly lined and is constructed in sandy area, wastewater may percolate to groundwater and thus causing pollution. If the soak way pit is constructed in areas where the water table is high, the effluent from the soak way pit will flow into the groundwater. Also soak way pit constructed in areas where the soil composition is mainly clay will result in overflow of effluent to the environment as the case reported by Melania (2007). Septic tank and sewerage system being water borne sanitary facility it will also contribute for nutrients and suspended solids to water bodies. The quantification of the pollution loading resulting from the population using onsite sanitation may be estimated based on the method used by WHO (1989). The same method has been used to estimate the pollution loading to the ocean due to the usage of septic tanks in the region. Table 5.1 shows the values used for computation of the pollution loading from pit latrines, septic tanks and sewerage system based on population equivalent.

Table 5 1 : Factor used for computation of pollution loading (WHO, 1989)

Disposal System	Volume	BOD	SS	N	P
	WV	Kg/cy	Kg/cy	Kg/cy	Kg/cy
Pit latrines		5.1			
Septic tank/ Soakage pits		6.9	16	3.3	0.4
Central Sewer	35.4	17.9	18.6	1.6	0.4

Where; Kg/cy is Kilogram per capita per year, and WV is the wastewater volume (m^3/year).

Figure 5.1 shows the average total pollution loading from the six WIO Lab countries which are mainly using onsite sanitation facilities.

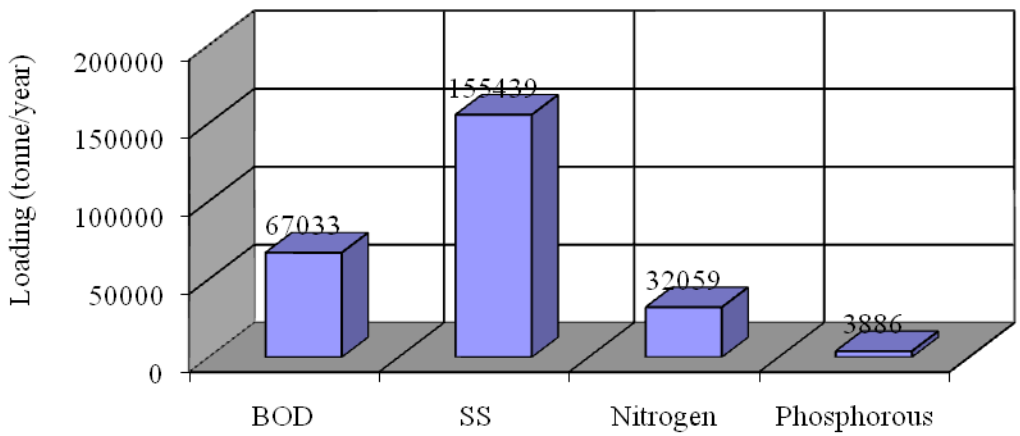

Figure 5: 1 Total pollution loading due to septic tank from the WIO Region

The overall pollution shown in Figure 5.1 may reach the water bodies if septic tanks and the subsequent treatment units are not properly designed and constructed.

5.1.2 Offsite wastewater collection technologies

Sewerage system has been used as one of the offsite technology for wastewater collection. Separate sewerage systems are those which convey only sewage, while combined sewerage systems conveys both sewage and stormwater. Most of the countries in the region have adopted separate sewerage system for collection of domestic wastewater. Depending on the topography a sewerage system may be installed with pump stations as the case in Tanzania and Mauritius. In Kenya the sewerage system installed also serves to convey industrial wastewater to the ocean (Mwaguni, 2007). In Mauritius small bore sewers are used collection of wastewater overflowing from the septic tanks and are discharged to rotating bio-contacts for treatment. This technology is used by about 350 villas which have been constructed along the coast.

At regional level the sewerage coverage is only 2% of the population. The total sewage collected by sewerage system from the region is as shown in Figure 5.2.

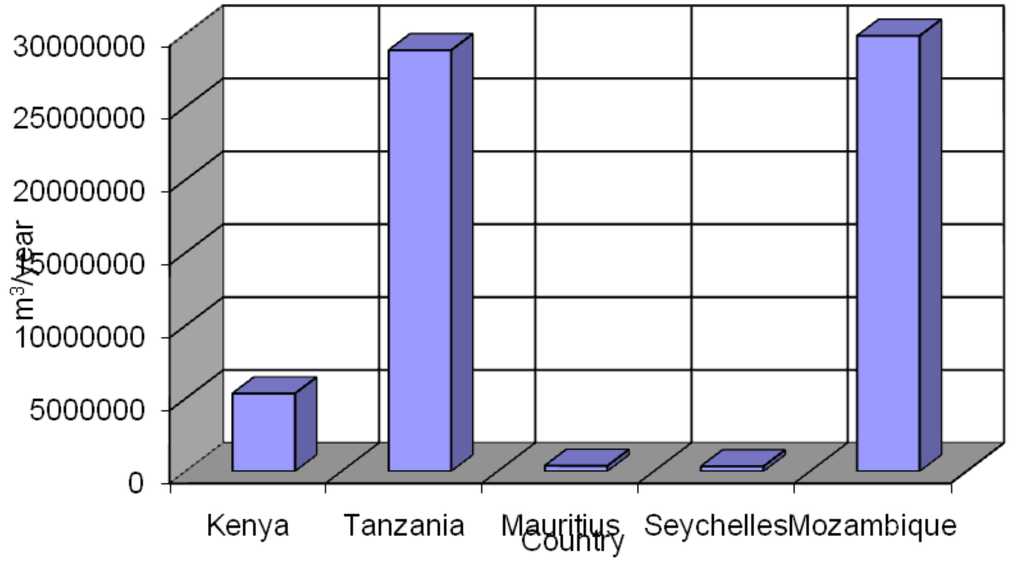

Figure 5: 2 Total volume of wastewater collected in the region through sewerage system.

High municipal wastewater is collected by sewerage system from Mozambique and Tanzania due to the fact that the population is high beside that the coverage is very low compared to Seychelles and Mauritius. The application of sewerage system has an advantage that it covers a large population and that the wastewater is not treated within the vicinity of the community. However collection alone without treatment may increase the pollution loading to the ocean as shown in Figure 5.3.

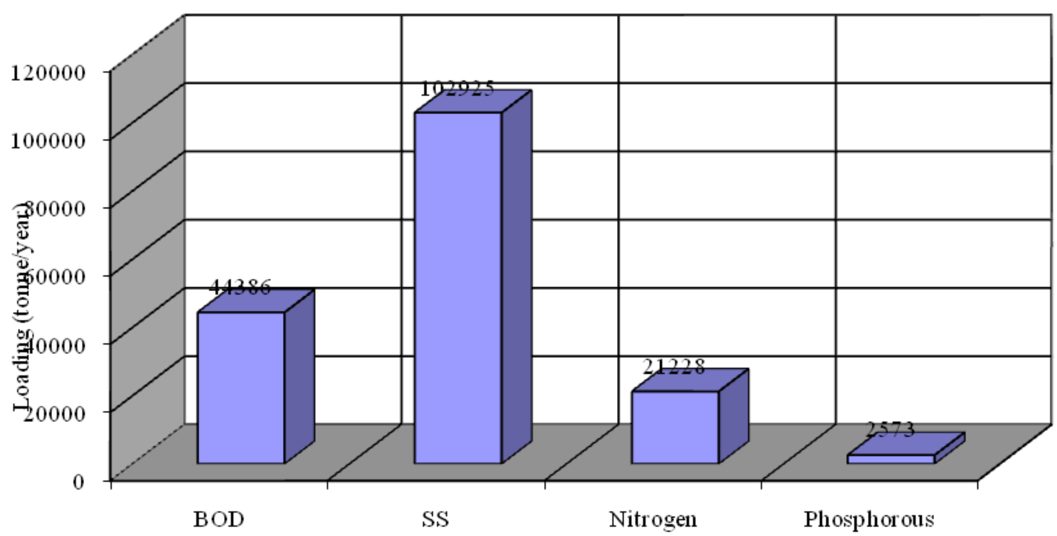

Figure 5: 3 Total pollution loading from sewerage system.

The status of the sewerage systems used for collection of sewage from the community in the region was built many years ago and has not been properly maintained and operated. Many of the pipes are old and suffer from frequent blockages and collapses. Sometimes manholes have been used as a dumping area for solid waste. The dumped solid waste causes the blockage of sewers resulting into over flooding of sewage to residential areas. Poor management of sewerage system in the region is due to lack of ownership, knowledge and poverty. Figure 5.4 shows one of the sewerage inspection chamber filled with stones. Disposal of solid wastes in the inspection chamber as well as in the stormwater channels is a common phenomenon in the urban areas of WIO Lab countries.

Figure 5: 4 Stone packed in the sewer inspection chamber

Lack of understanding on the benefit of wastewater collection has also prevented the expansion of sewerage system to cover enough population. The lack of element of regular maintenance of the sanitary facilities used in the region will continue to pollute the water resources.

5.1.3 Wastewater Treatment technologies and their impacts

5.1.3.1 Waste Stabilization ponds

Waste stabilization ponds are low cost technologies used for wastewater treatment in Mauritius, Tanzania and Mozambique. Waste stabilization ponds may achieve high level of treatment based on the standards adopted. The major problems encountered during the operation of the ponds located in Dar es Salaam are as follows; (i) The pond floors are not sealed and hence lose wastewater through seepage (ii) Variable influent flows and losses allow littoral weed growth (iii) Embankment damage due to erosion and soil slips (iv) Insufficient capacity to achieve bacteriological effluent standards (v) Lack of routine performance sampling and analysis data (vi) Non-frequent dislodging (vii) Treatment sites are not secured with boundary fences and many are encroached by squatter housing leaving no room for future expansion and (viii) No control over the discharge of toxic matter or inhibiting industrial effluents. Note that effluent from the waste stabilization ponds contains high concentration of suspended solids (SS) due to algae. The effluent from the waste stabilization ponds finally lands into the sea water.

The advantages of waste stabilization ponds are; (i) moderately effective in removing settleable solids, BOD, pathogens, fecal coliform, and ammonia. (ii) Easy to operate. (iii) Require little energy, with systems designed to operate with gravity flow. (iv) The quantity of removed material will be relatively small compared to other secondary treatment processes. The major disadvantages of waste stabilization ponds are; (i) Settled sludge and inert material require periodic removal. (ii) Difficult to control or predict ammonia levels in effluent. (iii) Sludge accumulation will be higher in cold climates due to reduced microbial activity. (iv) Mosquitoes and similar insect vectors can be a problem if emergent vegetation is not controlled. (v) Requires relatively large areas of land.

5.1.3 Conventional wastewater treatment technologies

Conventional wastewater treatment plants in the WIO Region have been intensively used in Mauritius, Seychelles and South Africa for domestic and industrial wastewater treatment. The activated sludge process has been employed extensively in Mauritius, Seychelles and South Africa in its conventional form and modified forms, all of which are capable of meeting secondary treatment effluent limits. In Mauritius all public wastewater systems convey wastewater to wastewater treatment plants which are essentially activated sludge systems with, or without biological nutrient removal. Secondary treatment consists of activated sludge process with, or without, biological nutrient removal. After a sufficient aeration period, the flocculent activated sludge solids are separated from the wastewater in a secondary clarifier. The clarified wastewater flows forward for further treatment or discharge. Figure 5.5 shows one of the activated sludge system in South Africa

Figure 5: 5 Activated sludge system in South Africa

Conventional wastewater treatment also uses trickling filters and aerated lagoons. Trickling filters (TFs) are used to remove organic matter from wastewater. They are also known as fixed film technologies which include trickling filters and Rotating Biological Contactors (RBC’s). These systems are known as attached-growth processes. In contrast, systems in which microorganisms are sustained in a liquid are known as suspended-growth processes. In Seychelles RBC’s is the preferred choice for most of the new developments. The TF is an aerobic treatment system that utilizes microorganisms attached to a medium to remove organic matter from wastewater. A TF consists of permeable medium made of a bed of rock, slag, or plastic over which wastewater is distributed to trickle through, as shown in Figure 5.6

Figure 5: 6 Typical Trickling filter in South Africa

5.2 Assessment of Existing Constraints in MWW Technologies

One of the major constraints in MWW technologies in the region based on National Report is the lack of local expertise in process engineering. Traditionally, the governments in the region have relied on the recommendations of international consulting engineering firms without involving the local experts. This has resulted in high costs of operation and maintenance of the systems not locally adopted. In the past, wastewater treatment plants were built without consideration that necessary expertise should be acquired for operation and maintenance.

The existing constraints in MWW technologies are many. Some of the constraint relate to the technology in use, while others relate to the heavy capital investment, technical expertise, and political will required. Developing countries face a heavier burden because they have fewer resources and weaker institutions (UN, 1997). It is important to note that no one type of technology is likely to be appropriate to the needs of coastal communities over all time.

The relatively high cost of construction of septic tanks, absorption pits and leaching fields, as well as the cost and concern of desludging a septic tank every three years or so, is a deterrent to the use of such systems. However one may use Table 5.6 below to have good comparative costs of selection of technologies.

Table 5: 1 : Cost Range per Capita for on-site and sewered (with conventional treatment) options (Kalbermatten *et al.*, 1982, Alaerts *et. al*., 1990).

Economy	Option	Capital cost (US$ per capita)	Total cost (Capital + Operation & Maintenance) US$ per capita per year)
Low-income economies	On-site sanitation	10-100	3-10

	Treatment Plant[1]	20-80	5-15
	Sewer + Treatment[1]	200-400	10-40
	Treatment Plant	60-80[1]	-
Middle-income and transitional economies	Sewer + Treatment	30-50[2]	-
	Treatment plant	300-500[2]	30-60[3]
Industrialized countries	Sewer + Treatment	150-300[1]	-
		100-200[2]	100-150[3]

[1] For primary plus secondary treatment, including land purchase and simple sludge treatment, for a capacity of 30, 000-40, 000 persons. Lower values pertain to low-cost options, such as waste stabilization ponds; higher values pertain to mechanized treatment, such as oxidation ditches and activated sludge treatment plants

[2] for plant capacity of 100, 000- 250, 000 persons

[3] for industrialized countries, this includes tertiary treatment and full sludge treatment; for other countries, this includes basic secondary treatment

The National Reports also indicates that wastewater collection and treatment is expensive. The high investment, operation and maintenance costs required to development and sustain wastewater infrastructure constitute one of the major problems in the development wastewater treatment infrastructure, capital, which is lacking in developing countries. This fact is more evident in cases where investment in collection networks are needed to serve small communities, whereby the benefits to the community are only marginal e.g. upgrading from septic tanks to central sewerage network.

The access to better technology such as septic tank is very expensive leading to low income population to adopt unhygienic sanitation. Onsite sanitation requires a safe disposal of sludge whenever pit is full. Most of coastal urban centres do not have public or private service for disludging and safely disposing sludge.

The cost of conventional wastewater infrastructure is prohibitive in view of other socio-economic and development issues by the Local Authorities. Therefore affordability is a major criterion in the choice of these technologies. Statistics indicate that more than 77% of the coastal communities use the pit latrines most of which are sub-standard and offensive. Table 5.6 presents comparative qualitative costs for the various wastewater treatment technologies. Availability of water influences the choice of MWW technology. Where little or no piped water is available, excreta and other household wastewater can be disposed off in pit latrines, VIP latrines and other dry sanitation systems. On the other hand, where there is adequate water supply, conventional sewerage system or wetlands/lagoons may be applicable.

The lack of an effective institutional framework for integrated water supply and sanitation has led to overlapping roles and responsibilities between various institutions leading to inefficient use of human and financial resources, duplication of effort, and gaps in effective provision of services.

The implantation of new technologies, especially those featuring chemical treatment processes, can be problematic especially when these chemicals are not readily available on the local market and their importation is restricted by the lack of readily available hard currency. The requirement for replacement parts can be a problem for some wastewater treatment plants once the initial stock of spares is used up. There is tendency to by-pass and modify the automatic control at some wastewater treatment units, which may result in either reduced treatment efficiency or increased operation costs for these establishments.

Conventional treatment methods require trained skilled labour, availability of uninterrupted electrical energy to run the plants, and heavy investment in capital expenditure. All these may be lacking or inadequate in the country posing major constraints in the proper treatment of wastewater. Due to high maintenance costs of conventional sewerage infrastructure, poor maintenance may lead to inefficient treatment system of waste water resulting in poor nutrient removal. In such a state, the nutrients go ahead to create pollution problem from an inadequately treated discharge.

At the house hold level, where on-site wastewater treatment is achieved through the use of pit latrines, it has been observed that while improvement have been done to the traditional pit latrine, these improvements have not been adapted due to a number of reasons, chief among which, being resistance to change due to lack of awareness. To address this problem, education and awareness is required among the community so that they can adapt to the changed appropriate and affordable technologies now available. There are however, some constraints which are beyond the capacity of the individuals to resolve. These may include situations where residences are located areas with shallow water tables making them prone to over-flowing.

On the other hand, non-conventional wastewater treatment systems require less skilled personnel and capital investment, making them ideal for the country. Such technologies in the form of waste stabilization ponds, the septic tank/soakage-pit systems; and constructed wetlands are very ideal for the country as they efficiently remove pathogens in wastewater. However, it has been found that the main constraint to the successful operation of these systems lie in maintenance problems. It has been found that these systems work efficiently when privately managed, but work inefficiently on public management.

5.3 Lessons Learnt from other Projects

The introduction of too complex technologies in an environment where the stakeholders and beneficiaries do not perceive the advantages or importance of having such systems in place should be avoided. A typical case would be the implantation of a demonstration project where insufficient attention is given to the post commissioning care and maintenance, such as the reed bed project.

The lack of involvement of stakeholders and public information campaigns for public wastewater projects resulted in landowners not fully understanding the requirements for laying of sewers and connection chambers on their properties resulted in some difficulties for project field agents to obtain the necessary roads for the execution of works on private properties. The move towards pubic meetings at the design stage of the project, as was the case for the BVSP in Mauritius, resulted in better co-operation between the homeowners and the implementing contractor. Also lack of stakeholder participation has led to vandalism of sewerage system in the region by disposing solid wastes in the sewer inspection chambers.

Very few beach hotels along the coast of Mozambique, Comoro, Tanzania, Madagascar and Kenya have onsite wastewater treatment. Some hotels along the coast collect and treat wastewater and the effluent is used for irrigation of gardens hence giving incentives for cost reduction on the usage water. All clusters of hotels along the coast of each country could pull their resources to establish sewage treatment plants of appropriate capacities. Investment, operational and maintenance costs could be shared out among the benefiting hotel establishments with the government giving tax waivers for importation of the required plant and equipments

In slum areas where toilets are usually very shallow, the oil drums and containers type of toilet is recommended particularly where water is not used as the anal cleansing materials. This type of technology will however be appropriate, only if the local water and sewerage companies have developed a sustainable collection and disposal system for the human wastes, or, has found use for it.

The choice of technology for municipal wastewater management must be able to meet the twin goals of environmental pollution prevention; and, it must be one that optimizes the use of resources in terms of nutrients, water and energy. The technology chosen will be considered appropriate if it meets the needs of the user, is simple to use, to maintain and repair; it is replicable and affordable; it can be adapted to local conditions and adaptable to changing environment.

Community participation right from the start of the project is an essential component for the implementation and success of any project. Communities differ and therefore different approaches and methodologies should e used accordingly. In addition, it helps impart the sense of ownership and responsibility thus providing enabling environment for the sustainability of the project. In this regard, an institutional framework should guide responsibilities among stakeholders.

3.7 Recommendations for Appropriate Technology

Over the past decades we have seen various large scale attempts to achieve full coverage of water supply and sanitation services world-wide. The aim of water supply and sanitation for all could not be achieved during the so called Water Decade (1980-1990), at the end of which the absolute number of people without appropriate sanitation facilities had actually increased. Achieving full coverage appeared also impossible by the year

2000 as defined under the Safe Water 2000 programme. Vision21, the water supply and sanitation paragraph of the recently formulated World Water Vision has again defined a target to achieve full coverage of these services (Cosgrove and Rijsberman, 2000). This time the target date is the year 2025. The Millennium Development Goals, agreed during the 2002 World Summit on Sustainable Development in Johannesburg, defined intermediate targets for the year 2015, aiming at a 50% reduction of the number of people without safe water supply or appropriate sanitation. According to WHO data, this means that world-wide daily 310,000 people will need to receive improved water supply and about 460,000 improved sanitation (WHO, 2000). To judge whether this will be at all feasible, one should compare the required number of new connections per day with the actual number of new connections achieved at the moment. An immediate consequence of any success on the water supply front is that the volume of sewage produced will proportionally increase. Today sewage presents the main point source water pollutant on a global scale. For most countries in developing regions only a small fraction of the sewage produced receives any treatment. This is because, current mainstream technologies, such as the activated sludge process with N and P removal, are too costly to provide a satisfactory solution for the growing wastewater problems in developing regions (Grau, 1994; Gijzen and Ikramullah, 1999). A waste minimization approach, aimed at reducing water consumption could yield substantial savings, both at the supply end as well as on the sanitation end of the pipe (Gijzen, 2001).

Appropriate technologies should be selected based on whether they are affordable, operable, and reliable. The selection of individual unit processes and systems should, at a minimum, be based on those three factors. Although managing is obviously far more complicated than assessing whether the systems are affordable, operable and reliable, an initial screening using these criteria is a critical element of good planning. The national reports have recommended the use of the following technologies;

- Off-site treatment using artificial wetland may be the best low-cost technology for coastal areas to treat wastewater from sewerage systems, as all conditions to run such facilities (low budget, sun, space, low qualification staff…) are available. However, this kind of technology could be appropriate provided that coastal urban centres prioritize sewerage extension and rehabilitation into their Master Development Plan.
- In water shortage area, the amount of tap water required to transport pollutants to the treatment facility is hardly affordable, therefore disposal of excreta and other house hold wastewaters could opt for VIP latrines or composting latrines. In the Tanzania coastal urban areas, access to sewerage system is very limited (<15%), therefore most communities rely on on-site sanitation in its various forms, which happens to be a relevant and viable option, meeting a very string demand.
- On the other hand, where there is adequate water supply, simplified sewerage system, conventional sewerage system or settled sewerage system (wetlands/lagoons) may be applicable. This will be appropriate to solve the problem of wastewater collection and treatment even in slum areas
- Constructed wetlands and waste stabilization ponds are potentially good, low-cost, appropriate technological systems for domestic wastewater for both

household and institutional/communal levels. Better still, they can be integrated into agricultural and fish production systems where the products are useable and/or recycled for optimal efficiency. However, currently, constructed wetlands are rarely installed in the coastal zone. The use of constructed wetlands for wastewater treatment for urban areas is gaining increasing attention and these have been identified as a much more cost effective option than sewerage treatment plants.

- Application of conventional wastewater treatment systems requires reliable mechanical energy, while non conventional systems do not require mechanical energy. Where the land is available then non conventional treatment system will be suitable. However if the land is not available then conventional systems of wastewater treatment should be adopted so long as mechanical energy is reliable.
- For more difficulty wastewater e.g. industrial wastewater, an application of combined technologies may be used so as to maximize the treatment efficiency. Example instead of using a series of waste stabilization ponds, only anaerobic pond may be used and be coupled with subsurface flow constructed wetland for biological treatment of wastewater.

- Along the coast, most of the areas are in high water table. Usage of soak way pit and pit latrine do constitute further pollution of ground and surface water. Hence application of lined pit is recommended. Application of constructed wetland coupled with septic tank offers a better alternative to prevention of pollution to water resources
- Usage of separate flows in the households is another alternative technology that minimizes generation of large volume of wastewater. This may be achieved by separating grey water from black water.
- Where possible effluent reuse should be integrated in all designed wastewater treatment systems. This offers an advantage on treating wastewater as economic good.

Hence in WIO Lab countries, several alternative technologies may be used and their selection must be based on the composition of wastewater to be treated, the standard required and the requirements for reuse. The availability of land constitutes a pressure on the selection of the technology. Where the land is limited then combination of conventional and non conventional treatment systems may be used. Another aspect on the selection of the technology lies on the knowledge of wastewater processes. In the absence of experts in wastewater management, selection of appropriate technology will be also limited.

Chapter:6 APPLICABILITY OF THE GPA GUIDELINES

6.1 Background on GPA Guidelines

Many parts of the world sewage is discharged directly into open water without treatment. Such uncontrolled discharge is one of the most serious threats to the productivity and biodiversity of the world's oceans. At the same time it causes serious environmental and human health problems and threatens sustainable coastal development. In response to the daunting challenge faced by many governments in addressing municipal wastewater problems, the GPA has developed guidelines for municipal wastewater management, jointly with WHO, UN-Habitat, and WSSCC. The guidelines provide practical guidance on how to plan appropriate and environmentally sound municipal wastewater management systems. The guidelines are meant for decision-makers, operational professionals in government institutions, and in the private sector, development banks and related organizations.

The guidelines focus on four elements: approaches and policies, institutional arrangements, technological choices, and financing options. Each element is supported by a practical checklist. The guidelines address and stress the need to link water supply and the provision of household sanitation, wastewater collection, treatment and re-use, cost-recovery, and re-allocation to the natural environment. Local participation is advocated and stepwise approach to technology and financing, starting at modest levels, expanding if and when more resources become available. The guidelines are summarized in 10 keys for action covering: political commitment; action at national and local level; going beyond taps and toilets; integrated management; long-term perspectives with step-by-step approaches; time-bound targets and indicators; appropriate technology; demand-driven approaches; stakeholder involvement; transparency; and financial stability and sustainability. In this section a summary of a situational analysis for WIO Lab countries is presented and focusing their capability of adopting the GPA guideline.

6.2 An Enabling Policy Environment for Sustainable Wastewater Management

6.2.1 Creating an enabling environment for sustainable solution

In many parts of the world Governments are these days ceasing to be providers of services. Instead, they focus on initiating, stimulating and facilitating, on enabling a policy environment in which the various institutional levels can function most effectively. Most WIO Lab countries have enabling policies for municipal wastewater management. Each country has a water and sanitation policy or policy which cross cut several sectors. The presence of the policy in the region is one of the key factors to adopt the GPA guidelines on municipal wastewater management in the region. Some policies in the region do not explicitly mention the management of wastewater for protection of marine environment. Example in Tanzania they have longed a policy which address the protection of marine environment. However the WIO Lab countries require a unified policy to address the protection of marine environment. Most of the policies have been drafted back in 1990's hence there are many elements which are required to be included in the respective policies. A policy must be clear and having basic principles, ground rules and management frameworks. There are policies addressing wastewater management in the region but the policy for the disposal of land-derived water containing waste to the marine environment only exists in South Africa, Tanzania and Mauritius. Hence policies in respective countries must be reviewed periodically to reflect the current activities in the countries or catchment area. The Governments in the region have shown to be active in the environmental pollution management by creating policies and also allowing institutions to participate in implementing the policies.

The pollution loading emanating from one country differ in terms of quantity and quality, hence there is a need to have unified policy within the region which addresses the specific sources of the pollution, adapted strategies on the collection and treatment of wastewater and the unified effluent standards. Holistic approach is lacking among WIO Lab region which stress equal opportunity for water and wastewater facilities. South Africa, Seychelles and Mauritius have made advancement on provision of policy which spell out what type of wastewater treatment or collection should be installed. Despite the unknown degree and boundary of autonomy given to public and private institutions by the above framework, the GPA guideline elements defining autonomy are already taken into consideration for most of the WIO Lab countries.

6.2.2 Supply driven approach

In the region the "supply-driven" approach was traditionally adopted for water and sanitation management where the need for water supply and sanitation was first integrated into the annual government budget without reliable assessment**.** This approach was also weakened by the lack of clear policy leading to unclear commitment and the lack of planning. As result, access rate to water and sanitation was amongst the lowest in Africa, particularly in rural areas. The "demand-driven" approach is being adopted within the framework, and the assessment of demands from local community through municipal and regional development Plans constitutes the starting point of the water and sanitation project cycle in the manual of procedure for most countries in the region. This approach is more effective in water supply projects rather than in wastewater management due to the fact that many countries have not yet standardized the technologies for wastewater collection, treatment and disposal to be used in the region. Hence to be more effective to wastewater management the stakeholders must be enlightened and sensitised on the importance of demand driven approach. The stakeholder involvement is advocated in the most WIO Lab country's policy frameworks. Sometimes Non Governmental Organizations (NGO's) are more active than private sector. Private sector in most cases is handicapped by insufficient access to information, access to credit, and insufficient competence in water and sanitation services. Capacity building and improving access to information are fundamental conditions for stimulating private sector.

6.2.3 Applying a logical policy framework

Regardless of the approach chosen, each wastewater management situation asks for flexible, tailor made set up, in which necessary steps can be taken at different points in time, depending on available resources and capabilities. In principle each cycle consist of for major phases; problem identification, planning, implementation and enforcement and evaluation. This approach demands systematic understanding of the project cycle. Earlier installation of sewerage systems was decided by the central governments and community was not involved at any stage. This has resulted to poor operation and management of many projects such as the wastewater treatment plant in Mombasa (Mwaguni, 2007).Many projects in developing countries that have been implement as "supply-driven" have shown failure due to lack of ownership (Melania, 2007). Most of the policies in the region have logical framework showing several stages of implementation. The weakness of these frameworks is that it does not define what qualification of the actor will be involved in the respective stages in the frameworks. In light of the different aspects discussed above, the enabling policy environment for sustainable wastewater management is already there and in line with GPA guidelines, but political will and effective implementation are required in order to succeed.

6.3 Institutional arrangements and social participation

6.3.1 Partners and institutional arrangements

Traditionally, there was no coordination for water and sanitation sector, and practically stakeholders undertook whatever they thought better for the selected site, according to whatever interest but not automatically to local population interest. Experience in developing countries has shown that some of the existing institutional arrangements dealing with MWW management have failed to fulfill their functions for a number of reasons including overlapping mandates for both vertical (national, regional, local) and horizontal (among stakeholders and sectors); weak communication, cooperation and coordination; and lack of experience in institutional management particularly in identifying non-core activities to be outsourced as a way of enhancing efficiency in service delivery.

Some countries within the region have realized that overlapping of responsibilities will not help on solving problems and have reviewed their policies and have defined responsibility of each actor. Example in Kenya, the Water Act (2002) provides clear separation of regulatory functions, asset ownership and operation of water and sanitation facilities and services. It also provides a clear separation of water resources management and provision of water supply and sanitation services (Mwaguni, 2007). The degree of participation among the institutional may differ from one country to another.

The major concern within the partnership is on the legislation to determine the division of responsibilities and authority, performance standards, system for regulation and incentives, financial flow and others. To a large extend within the WIO Lab region there is no restrictive and enabling regulations which stimulate the stakeholders to participate effectively in wastewater projects. Note that restrictive and enabling regulations are agreed procedures through which stakeholders are motivated or stimulated to participate actively in the sanitation projects. Stakeholders are not supposed to be informed about the presence of the policy rather they should be the sources of information to be included in the policy. Actually, different agencies seems to ignore the important duties that should have been undertaken at community level in order to effectively enforce wastewater regulations when the central agencies do not have necessary human resources to act.

6.3.2 Design of institutional arrangements

In WIO Lab countries there is a strong and extensive central government agency. There is no doughty that at the government level most of the regulation and water quality standards are well known. This is due to the fact that the governments in the region are responsible for formulation of policies. At low level, municipality, regional offices and community level they have minimal information on the policy formulated. Hence adjustment of the existing structures and capabilities is important to all WIO Lab countries. Proper assessment is required to empower the institutional frameworks to equal level on understanding the wastewater management benefits. Implementing agencies need to be empowered with management tools in the form of regulatory and economic or market based instruments in WIO Lab region. While the legal frameworks for setting up institutional arrangement and social participation are in place there are still some practical problems when it comes to implementation. In the region there should be a strong understanding on planning by bottom to top approach.

6.3.3 Building institutional capacity and public awareness

Weaknesses in institutions or institutional arrangements are a major cause of under performance in wastewater management sector. Capacity building is one of the major factors contributing to underperformance of the sector. In many developing countries a lack of capacity in terms of human resources inhibits development, particularly at a decentralized level. While the water sector has tended to be dominated by engineers who feel comfortable with technical problems and tend to lean towards technical solutions, household sanitation requires softer, people-based skills and takes engineers into areas where they feel uncomfortable and unfamiliar. Promoting behavior change at household level is an area where most countries have few skills and limited capacity. Most public agencies are unfamiliar with or ill-suited for this role' (Evans 2005). This may be solved in WIO Lab countries by introducing additional or new procedures and skills, such as technological expertise, accounting, communication with local communities, or cost recovery mechanisms. The strong institutional arrangements in WIO Lab countries is a starting point on providing them with regulations that will allow them to act accordingly on wastewater management projects.

6.4 Planning sustainable and cost-effective technologies

The method advocated by GPA guidelines for selecting a sanitation technology gives wide range of choice from prevention and simple low-input to sophisticated high-input systems. The strength of the approach consists of not only taking into consideration physical local conditions (geological, hydro geological, water table depth), economic and social condition, but also considering global vision of wastewater issues. Appropriate technological selection is important due to the fact if local conditions are taken into consideration then the chances of the technology to fail is minimum.

During selection of the technology, the following major issues must be considered; (i) environmentally sound; (ii) appropriate to local conditions; (ii) applicable and efficient in the context of the entire river basin; (iv) affordable to those who must pay for the services. Other aspects to consider during the technology selection process are; (i) awareness and the need for changes in behavior; (ii) workable policies and regulations; (iii) possibilities for enforcement; (iv) technical performance and reliability (under variable wastewater flows, compositions and operational problems); (v) institutional manageability (planning, design, construction, operation and maintenance capacity, including local availability of skilled human resources) and (vi) investment, operation, and maintenance costs. Failure of some technologies used might be due to non coordinated actions undertaken by different stakeholders without any consideration of local environment, economic, and cultural situation.

The high cost of wastewater treatment warrants a careful search for low cost technologies that tackle pollution prevention, water conservation, and the efficient use of water in a sustainable way. A stepwise approach to technology selection and planning is outlined, addressing pollution prevention, on-site treatment, off-site transportation and treatment, including natural treatment, re-use and conventional treatment. The aspect of re-use receives specific attention.

Example Kenya has realized that the basic solution to the problems of water and wastewater management lies in the choice of sustainable and cost effective technologies (Mwaguni, 2007). Hence it is recommended that this has to be guided by better training and information regarding alternative technologies and their corresponding management needs and costs. Special attention should also be given to those types of technology that are relevant to the needs of communities. All countries recommend the use of low technology so long as they meet the requirement of not polluting the environment.

With an exception of Mauritius, other countries have not stated what types of treatment technologies are required for domestic and industrial wastewaters. It is strongly recommended that during the processes of changing some institutional arrangements in the WIO Lab countries, to cope with GPA guideline, the procedures of technological selection should be common for the whole WIO Lab region.

6.4.1 Choosing a sanitation technology (on-site and off-site sanitation)

The selection of technology for WIO Lab countries should focus on the five sanitation technological approaches (GPA guideline). The procedure assumes on mixed settlements in urban areas where onsite and off site sanitation may be applied. The types of settlements in WIO Lab urban areas are composed of slum and planned settlements. Obviously the procedure for selecting technologies for industrial wastewater treatment should follow GPA guidelines. Offsite sanitation usually is very expensive and is more beneficial to accommodate large population than onsite sanitation. Off site sanitation should be adopted to well planed settlement while on site sanitation should be used for unplanned area. This could be in combination of communal septic tank followed by subsurface flow constructed wetlands or small bore/shallow sewerage system followed by waste stabilization ponds or anaerobic pond followed by sub surface flow constructed wetland.

The initial cost, availability of land, water availability, and density of population, and physical conditions affect the choices on technologies for wastewater treatment. Due to low coverage on sewage system within WIO Lab countries on-site treatment is always first consideration than other treatment. Such on-site technologies include pit latrines. The communities in the WIO Lab countries have no been give a new alternative to traditional pit latrine. Hence mass education should be conducted in WIO Lab region on the types of onsite sanitation. Reuse of effluent is not particularly advocated in the existing wastewater management framework for all WIO Lab countries.

6.4.2 Opportunities for pollution prevention

Reducing water utility at the source may have impact on the type and size of wastewater treatment. There are sanitary facilities developed in other countries which use small volume of water for toilet flushing. The WIO Lab regional environmental experts should come up with a common design of sanitary facilities which uses small volume of flushing water. For industries located within WIO Lab region they should practice cleaner technology so as to reduce the volume of wastewater. Community education is important to achieve pollution prevention at the source.

6.4.3 Planning and constraints for reuse of wastewater effluent

Before a sound decision can be taken on re-use of wastewater a number of issues need to be considered and assessed. There are common planning aspects such as technological and economic feasibility, legal issues and other institutional arrangements, such as staffing requirements. But more specifically, the perception of wastewater re-uses needs to be assessed, both among the general public, potential professional users and in government institutions. In a survey issues like attitudes towards re-use, existing water rights and consequences of re-use, willingness and capability to pay, capacity to participate in planning, implementation, management, quality and quantity requirements of treated re-useable products should be considered. Currently the WIO Lab countries have not included as one of the major issue on the management of wastewater.

6.5 Financial mechanism for wastewater management

Developing countries are particularly faced with the challenge of many competing national development needs (such as agriculture development, education, health services, and infrastructure) in the midst of critical financial constraints resulting into low priority to MWW management. The financial system to recover costs of wastewater management should balance three critical and interrelated aspects: (1) quality of the service, (2) investment costs, and (3) tariffs that users are willing and able to pay. Users should receive an adequate service sensitive to their ability to pay and to their contributions to pollution: “water user pays” and “polluter pays” principles are prerequisites for achieving sustainability. Low and middle-income countries cannot afford capital-intensive conventional, engineered solutions. Investments should go step-by-step. Partnerships between public and private sectors are potentially useful tools to assist local governments in financing and operating infrastructure for wastewater management. The emphasis on capital-intensive conventional technology, the low level of cost recovery and a dependency on government grants and subsidies and increasing pressures from urbanization are among the problems of financing wastewater management projects.

6.5.1 Cost recovery mechanisms (investment, quality and tariffs)

Traditionally, investments for wastewater management infrastructure have been met solely from public grants financing, foreign aid, or multilateral lending. The largest funding sources are local, originating from governments (who obtain funds through various local and national fiscal flows), users (paying for their own on-site systems or paying bills to official service providers), and local banks and donors (including private voluntary contributions). Based on the economic scale each WIO Lab country should first view wastewater as having economic value and thus planning for tariffs should centre at cost recovery. Target levels for water quality and wastewater management determine the required investment. The investment level, with its operational and maintenance costs, determines the costs that need to be recovered through a combination of tariffs or taxes.

6.5.2 Willingness to pay and cost sharing

Any sustainable wastewater management system must address the key issues of financing and cost recovery on the one hand while ensuring equity on the other. This concerns local community-based sanitation initiatives as well as large-scale programmes funded by international donor organizations. For an intervention to be successful, participation of beneficiaries in the planning and decision making process is always essential. This increases the sense of responsibility among beneficiaries to pay wastewater bills once the service is operating. WIO Lab countries have not yet started for cost sharing targeting on cost recovery. Mass education and mobilization will be required in the WIO Lab region for community to understand what they are paying for. Mong (2007) stated observed that, "Field experience from different projects show that for willingness to pay to be higher beneficiaries (at community level) must take part in the whole project cycle. Water related projects have been using this approach in order to make projects sustainable. Failures may occur when communication and information are not well established, leading to reluctant participation by users. On the other hand Cost sharing is not a new approach and the setting up of basin committees is a better mechanism to apply it.

6.5.3 The application of user/polluter pays principle

Currently in most WIO Lab countries industries are not paying for the pollution they impose in the ocean. Little assessment has been made on how the potential farmer in the catchment basin contributes to pollution of the ocean. This problem of major polluters not paying their share is typical worldwide. WIO Lab countries should prepare regulatory instruments to enforce the polluter pays principle and to foster a willingness to pay among polluters, including industry and government institutes. Concrete action with true partnership between the private and public sector should be encouraged within WIO Lab region. In Madagascar it is proposed that the user pay principle will be adopted for water management at the level of basin committee (Mong, 2007). In other countries the polluter pays principle is already adopted for managing industrial pollution. Although concept is fair and straightforward, strong regulation enforcement and good communication with potential polluters are prerequisite for it success. Experience has shown that lack of clear policy and commitment from the sector staff, confusing regulations have contributed to potential polluters being unwilling to pay.

6.5.4 Investment options for wastewater infrastructure

While public funding remains important, especially in developing countries, more governments are nowadays delegating financial responsibilities to local authorities and are interested in public-private offers. Most of the WIO Lab countries do not have funds for implementing wastewater treatment systems. It is important for WIO Lab countries to source funds from other donors and especially using the local community in raising funds for wastewater management projects.

6.5.5 Opportunities for public private partnership in wastewater management

Public-private partnerships help in moving a society towards sustainability in many different ways: (i) **institutionally:** They allow governments to attract private sector funding and involvement without incurring the adverse effects of full scale privatization. Governments can, for instance, retain a significant role so that they maintain the essential 'public' character of infrastructure. (ii)**Economically:** They promote efficiency and indirectly economic growth through decentralization of services, corporatism of municipal utilities, cost recovery through user charges, economic efficiency in resource use and allocation. (iii) **Socially:** They meet people's needs by offering better water supply and sanitation services. This helps in raising living standards and in alleviating poverty, and (iv) **Environmentally:** They can be used for the transfer of environmentally innovative technology and can help in raising environmental controls to national and/or international standards. This opportunity has not yet used by the WIO Lab countries. Many documentations call for public private partnership in wastewater management, however it is not yet put into practice.

Chapter 7: MECHANISMS FOR DOMESTICATION OF THE REGIONAL GUIDELINES

7.1 Mechanisms for Domestication

In this chapter an analysis has been made on how to domesticate the GPA guidelines at regional level taking into account the opportunities and impediments that exist for the domestication. The GPA guideline contains ten keys and each key requires mechanisms for adopting for municipal wastewater management in the region. In order to analyze the mechanisms of domestication of the GPA guidelines, each key in the guideline is discussed so as to compare with the available situation in the region. All the Ten Keys for local and national actions on municipal wastewater management are applicable in the WIO lab countries. In this section, the applicability of each Key Principle is discussed offering the circumstances and mechanisms for which their domestication possible.

7.1.1 Securing political commitment and domestic financial resources

WIO Lab countries have shown tremendous interest and political commitment at different levels and raising domestic resources for MWW management through various policy statements. The countries have water and environmental policy guiding the actions towards municipal wastewater management. These Policy papers and subsequent activities have put high priority on improved water supply and sanitation as one of the preconditions for economic growth and poverty alleviation. Most of the government in the region commit themselves through policy in

- Increased coverage and access to water supply and sanitation services especially to the poor;
- Developing financing systems for provision of water supply and sanitation services to the poor;

Hence the policy developed in the region provides the mechanisms for domesticating the GPA guideline. As a result of the Policy Papers, mechanisms for mobilizing domestic resources to develop the country's water and sanitation sectors for the benefit of all Kenyans are there as a Policy. Similarly, by the Government realizing that lack of access to Water and Sanitation Services by the poor has undermined efforts to reduce poverty and taking action to remedy this, is itself proof that of political commitment for MWW management. The policy papers and subsequent activities have put high priority on improved water supply and sanitation as one of the preconditions for economic recovery and poverty alleviation.

This narrative shows that the political goodwill in availing domestic finances to invest in wastewater treatment, which is in general conformity to the first key principle of the GPA guidelines and therefore offers mechanisms for its domestication. Example in Mauritius political commitment to develop the wastewater sector is obvious from the progress made over the past fifteen years, institutionally, legally, and in terms of extension of sewer networks and pollution abatement.

7.1.2 Enabling environment at national and local levels

The reforms that have been taking place in the region, in the water sector provide an enabling environment at all levels in MWW Management. Many institutions are involved in the water sector, with the majority of them offering a centralized management approach to the development and delivery of services by the sector. In many countries in the region have established three levels namely National, Catchment and Sub catchment level (Mwaguni, 2007, Melania, 2007). Required Institutions have been formed, strengthened and allocated clear mandates, defining the roles of each and how they relate to each other through the framework documents.

Thus at the national level the Ministry in the respective country is only responsible for giving policy direction to the sector. The management of water supply and sanitation services have been devolved to regional boards in the country, while direct water and sanitation services, have been parceled out to Water and Sewerage Companies in the region. Example in Tanzania water supply and sanitation for urban areas is channeled to Urban Water and Sanitation Authorities (UWASA). Thus by devolving responsibilities to the appropriate levels of governance, national level for policy formulation, while setting institutions for legal, regulatory, management and financial frameworks to support the delivery of services at the local level in a transparent, participatory and decentralized manner, are the major requirements for domestication of second key principle in the GPA guideline.

7.1.3 Not to restrict water supply and sanitation to taps and toilets

WIO Lab countries have adopted the principles of Integrated Water Resources Management (IWRM) in which the management is termed at the source of the problem. The IWRM philosophy has made water services to be linked to the sector policies, the efforts that have helped the countries to lay the foundation for rational and efficient framework for meeting the water needs of economic development, poverty alleviation, environmental protection and social well-being of the people. With this approach, the countries are not just limiting its efforts in water and sanitation to taps and toilets; rather, it is looking at water holistically. What the countries have already put in place therefore offers sufficient mechanisms for domesticating this third Principle Key on MWW Management.

7.1.4 Integrated urban WSS management systems.

Governments in the region have taken steps to reform the water and sanitation sectors with a view to improving the overall performance of the utilities through the enlistment of Private Sector Participation. The policy adopted by governments in the region has taken a holistic approach in water resources development and management. This integrated approach puts emphasis on the provision of appropriate sanitation services to overcome past neglect. Thus the management of water supply is combined with sanitation and other relevant environmental functions, since it is recognized that the end product of water supplied, is wastewater. The level of integration differs from one government to another.

7.1.5 Taking action step by step

The policies developed in the region, provides sufficient safeguards for cost recovery and re-investment in the sector. The long term perspective is that the sector should be able to sustain itself and to expand to new areas, a process that offers an avenue for domesticating this key principle. Example in Mauritius provision of sewerage facilities to highly populated urban areas and improvement of access of the poor to suitable sanitation has been planned over an extended time frame and has been implemented stepwise.

7.1.6: Defined time-lines, and time-bound targets and indicators

In performance contracting, different sectors of the economy develop work plans and activity schedules defining timelines for achieving set activities, ensuring that set objectives are met through verifiable selected indicators that show attainment of set targets. This offers the mechanism that ensures the ease of domestication of this principle. The overall performance and progress of the wastewater sector is already monitored by a series of key performance indicators. Example in Tanzania, all UWASAs' sign a performance contract with the government with given clear indicators. Each end of the year the evaluation is done in order to verify if they are performing according to the contract.

7.1.7 Selection of appropriate technology

The Strategy on IWRM has recognized the need for applied research and technology by the countries in water resources development and management. Research has been recognized to be essential if the WIO Lab countries have to achieve their long term development targets. Effective and efficient methods of catchment protection, pollution control, conservation efficient use of water are key in water resources development and management. Many countries have indicated weakness on understanding what type of technology is sustainable based on their environment. However in most of the policies in the region, it is advocated that selection of appropriate technology for wastewater management is very important. Also in the policies it is stated clearly that training for expert in the area of wastewater management is more needed in order to implement the policy effectively. Hence the strength on the domestication of this key principle lies on realization of the need of appropriate technologies for wastewater management and reuse.

7.1. 8: Demand driven approaches

It was common for many countries to apply supply driven approaches for most of water supply and sanitation projects. This has resulted in introduction of technologies which were unknown and cannot be operated by local community or few expertises available in the respective countries. Example most of the sewerage system in urban area along the coast has clogged due to disposal of solid waste in the chambers by the community. The community did not feel that they are possessing the infrastructures. Currently all the governments in the region have realized the need to apply demand driven approaches so as to make all the projects sustainable and useful for beneficiaries. Many of the projects in the region will be owned by the user rather than by the Governments.

7.1.9 Stakeholders involvement

The Strategy on IWRM promotes stakeholder involvement right from project inception. The strategy calls for pro-active participation and contribution of government, non-governmental stakeholders and communities in project identification development and management. The countries have adopted this strategy as a way of conferring ownership to stakeholders making them more responsible in the projects they helped develop. The private sector is invited to participate by ensuring that bureaucracy within the institutional set up is eliminated and legislation reformed to facilitate their participation in the water and wastewater sector. In Mauritius most stakeholders are already involved on wastewater projects. These include the public, media, industrial sector, funding agencies and other governmental institutions. A public awareness campaign can significantly improve stakeholder involvement

There might be a low response from the stakeholder due to lack of dissemination of the policy. One has to note the difference of having the policy in paper and the working policy in the field. The working policy in the field is the one in which the stakeholders understand and implement. That is the stakeholders are aware of the demand of the policy. In Seychelles during formulation of the policy the consultative meeting involved stakeholders from the government, private sector and NGO's. This approach made the policy to be well domesticated in the country. After the formulation of the policy community in Seychelles has been educated on wastewater management through, primary education, workshops, local meetings and through national and local media. Hence communities in Seychelles are well informed on wastewater management projects. The same procedures were used in Mauritius for domestication of their policy. Seychelles and Mauritius may be taken as a learning centre on how to domesticate even the national policy of wastewater management. Hence the domestication procedures used during the dissemination of the policy to the stakeholders in the respective countries may be used for domestication of GPA guidelines. Information exchange and experience sharing through professional and scientific Forums, Conference and Associations could be one of the methods of domestication of GPA guideline in the region.

7.1. 10: Financial stability and sustainability

Wastewater management projects require reliable sources of funds. Many governments in the region are more eager to fund for water supply and not for wastewater. This might be due to the background of many governments that in the past the population along the coast and in the urban areas was small compared to the current pressure. Hence use of onsite sanitation funded by household was most appropriate. With high improvement in water supply in urban areas, there is also high increase of wastewater generated. High funds must be available for conventional sewerage system. At least all governments have realized the need of full cost recovery for any project of wastewater. All sectors of the economy that discharge wastewater into the environment must now, by law, pay effluent discharge fees. This brings in polluters into meeting the costs of municipal wastewater management. Similarly, the fees paid by sewerage service providers as they clean up effluents from the various sectors of the economy links them to municipal wastewater management. Funds accumulated from the charge are ploughed back for monitoring and investment into the extension of sewerage infrastructure, and to meet the operational and maintenance costs of sewerage treatment plants and networks. This arrangement offers an opportunity for linking wastewater management with other sectors of the economy. Similarly, the polluter pays principle is already a source of municipal wastewater management. Example in Kenya through waste discharge fees, NEMA has been able to raise funds, which it uses on monitoring activities, a contribution to generating information that can be used for further intervention on pollution sources. It should however, be realized that the universal application of the polluter pays principle is difficult to achieve and that the sector must brave itself in overcoming the challenges the principle posses, if solidarity as advocated in the principle is to be achieved.

7.2 Opportunities for Domestication

Opportunities for domestication of the GPA guidelines for Wastewater management exist in all countries in the region. In the region there is a strong political commitment and support to develop the wastewater sector; the donor community has shown interest in developing the water and sanitation sector (Melania, 2007); the countries have a clear policy on wastewater management; an enabling policy and regulatory environment for the sector is in place (Melania, 2007; Mwaguni, 2007, Ridhay, 2007; Mong, 2007, Phillip, 2007 and Montano, 2007). The government in the region has made strategies on how to implement the policies and also have created policy frameworks indicating different players and their roles. The policies also tied up to MDG, National Poverty Reduction Strategies as for case of Tanzania.

Another opportunity for GPA guidelines domestication is the priority given to water and sanitation sector by governments in their set visions ranging from Vision 2015 for Madagascar, and vision 2025 for Tanzania. The similarity between existing approaches initiated in the region and that stipulated in the GPA guidelines offer an opportunity for the domestication.

The level of domestication might differ between one country to another due to availability of resources, urban setup and technological selections. Countries like South Africa, Seychelles and Mauritius are already at advanced level on the use of advanced technology on wastewater treatment and on implementing their policy on wastewater management. Other countries like Tanzania, Kenya and Madagascar may use the opportunity of learning from the advanced countries in the same area of interest.

The important aspect is not only to have the policy and environment that allow the domestication of GPA guidelines but also to disseminate this to the respect countries on the approach demanded by the guideline. This implies that if all government in the region agrees to adopt the GPA guideline, then the analysis of the problem of wastewater management will be similar, the difference will lie on the type of technologies used to solve the problem. Analysis from the national reports show that several information dissemination pathways exist that could be utilized for dissemination of GPA Guidelines in the region. Present public information tools and mechanisms that are in place in some countries include: publication materials such as brochures, newsletters, booklets, stickers, fliers, posters etc; radio programmes; television programmes;

seminars/workshops/meetings; District/Village/community Environmental Committees; commemoration of World Environment Day. Hence together with the presence of the policy in the countries the participating parties have to understand in whole the guidelines to MWW management.

Devolution of responsibilities for the sector which requires an enabling environment both at national and local levels has been recognized in the region and therefore offering room for its domestication. The fact that all countries in the region emphasize on conservation of water resources and promotion of sustainable development and infrastructure development and by defining clear roles and responsibilities of the actors offer an opportunity for domesticating GPA guidelines. Also, by recognizing the need for Private sector participation, a policy framework has been set out to bring about a culture that promotes comprehensive water resources development and management with the private sector and community participation as prime movers in the WIO Lab countries.

7.3 Impediments to Domestication

Though the countries have opportunities for domesticating the GPA Guidelines on Municipal Wastewater management, there are many impediments, which need to be overcome first before the domestication is possible. The synthesis of national reports indicates similar factors that will result on impediment for domestication of the GPA guidelines in the region, though at different level. These are; (i) lack/low public and stakeholder awareness on the municipal wastewater management problem; (ii) the countries are yet to choose and adopt a desired technology in MWW Management; (iii) lack of capacity both in equipment and trained personnel to enforce the water quality regulations and standards; (iv) weak coordination among actors in the wastewater management; (v) weak financial management resulting in poor investment decisions; (vi) Low awareness among different sectors and the general public may interfere internalization of the Guidelines; (vii) lack of institutional capacity to implement and enforce regulations; (viii) lack of Regulations and enforcing mechanism for on-site disposal systems and (ix) lack of equipped laboratories for monitoring water quality. Domesticating the GPA guidelines requires countries allocate sufficient domestic financial resources if sustainable wastewater management is to be achieved. Such resources are not easily available where many sectors of the economy compete for the same resources in development. The national reports indicate that, the governments give low priority to wastewater management. If low priority will be given to problems related to water and sanitation at regional and communal levels then this might jeopardize domestication of GPA guidelines.

On the other hand the impediment might occur if the policy is not well known to the public. It should be known that the interested party on wastewater policy should be the community at all levels and not at the government level. The tariffs set for wastewater management must reflect the capital cost recovery and there should be openness on the preparation of the tariffs. The technologies for low income areas should be environmentally sound and affordable. Professional should describe the type of technology which they are sure that it will work in the community and allow the community to select based on the guidance given by the professionals. Trained professionals in the field of wastewater should be given opportunity to work with the community projects. Existing information dissemination pathways lack focus on MWW management and there is deficiency of MWW technical expertise in the media. The absence of a team-based approach to the implementation of programmes may adversely affect the continuity of the programme such as when project officers are nominated for overseas training (long-term) or are transferred to other departments or yet again resign from their current positions. Without trained manpower in the area of environmental science the domestication of GPA guideline will impeded.

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Annex A:

Table 0.1A: Guidelines for coastal water quality

Classification	***Principal Beneficial uses/objectives***
Category A – Conservation	
Class A1 – Conservation of coral community	A1 – Conservation of coral community
Class A2- Conservation of natural areas	A2 – Conservation of natural areas such as mangroves, sea grass, wild life habitat and marine spawning, nursing and feeding grounds.
Category B – Recreation	
Class B1 – Primary contact	B1 – Water sports like swimming, diving, surfing where there is direct contact.
Class B2 – Secondary contact	B2 – Water sports such as boating, fishing and other activities involving less body contact or where direct contact with water may occur but the probability of body immersion is minimal.
Category C – Fisheries	
Class C1 – Aquaculture	C1 – Propagation of marine life such as fish, crabs, shrimps, and other marine fauna.
Class C2 – Shellfish	C2 – Culture of shellfish – oysters, mussels, clams.
Category D – Industrial	
Class D – industrial and others	D – Natural water resources used as a receiving water body for industrial and agricultural discharges (harbours, power station and other industrial activities). There should be no unpleasant odor to people residing nearby

Table 0.1 B: Coastal water quality requirements for various categories

CATEGORY		**A Conservation**		**B Recreation**		**C Fisheries**		**D Industrial**
Class		A1 Coral Community	A2 Natural Areas	B1 Primary Contact	B2 Secondary Contact	C1 Aqua-culture	C2 **Shellfish**	D **Industrial& others**
Parameters	Unit							
pH	-	7.5-8.5	7.5-8.5	7.5-8.5	7.5-8.5	7.0-8.5	7.0-8.5	7.0-9.0
Temperature	^0C	ambient	ambient	ambient	ambient	ambient	ambient	ambient
Suspended Solids	mg/l	5	5	5	10	15	15	15
Dissolved Oxygen	mg/l	>5	>5	>5	>5	>5	>5	>2
Chemical Oxygen Demand[1]	mg/l	2	2	3	3	5	5	5
Total Coliform	CFU[3] /100 ml	1000	1000	1000	5000	1000	70[2]	---
Faecal Coliform	CFU/100 ml	200	200	200	1000	200	14[2]	---
Nitrate-Nitrogen	mg/l	0.2	0.3	0.8	0.8	0.8	0.8	1.0
Phosphate	mg/l	0.04	0.05	0.08	0.08	0.08	0.08	0.1
Oil & Grease	mg/l	Not detectable by N-hexane extraction method						
Phenol	mg/l	0.05						
Arsenic	mg/l	0.05						
Cadmium	mg/l	0.02						
Cyanide	mg/l	0.01						
Chromium	mg/l	0.05						
Copper	mg/l	0.05						
Lead	mg/l	0.05						
Total Mercury	mg/l	0.0005						