

The Regional Annex to the Recommended Framework for Decision-Making

EASTERN AFRICA REGION

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1 INTRODUCTION

Municipal wastewater discharges are considered one of the most significant threats to sustainable coastal developments worldwide. This is due to the fact that if improperly discharged to freshwater and coastal environments, municipal waste could lead to serious problems, including human health problems, pollution and degradation of these environments.

In recognition of their strategic importance, water supply and sanitation services have been discussed in different international and regional fora. For example, Chapter 18 of Agenda 21 deals with water and related aspects. Among the main programme areas of importance to sewage issues are: The section on drinking water supply and sanitation and water and sustainable urban development. The programme area on drinking water supply and sanitation highlights the need to provide, on a sustainable basis, access to safe water in sufficient quantities and proper sanitation for all. The programme area on water and sustainable urban development gives recommendations for national and international actions on strengthening the protection of water resources from depletion and pollution, institutions and laws, public participation, access to sanitary services, etc.

The Global Program of Action for the Protection of the Marine Environment from Land-based Activities was adopted by an intergovernmental conference held in Washington, D.C., USA, in 1995. The goal of the Global Programme of Action (GPA) is to prevent the degradation of the marine environment from land-based activities, by facilitating the realisation by States of their duty to preserve and protect the marine environment.

To facilitate implementation of GPA around the world, UNEP organised, during the period 1996-1998, in co-operation with relevant regional organisations, a series of regional technical workshops of government-designated experts, as well as representatives of international organisations, the private sector and experts from non-governmental organisations.

Seven regional technical workshops were convened by UNEP in the framework of the Regional Seas Programme and all of them identified the priority for addressing sewage.

Municipal wastewater means all discharge from households, commercial facilities, hotels, and any other entity whose discharge includes the following:

- *Toilet flushing (black water);*
- *Discharges from showers, water basins, kitchens and laundries (grey water); or*
- *Discharges from small industries, provided that their composition and quantity are compatible with treatment in a domestic wastewater system*

In order to meet the above request the UNEP/GPA Coordination Office developed a Strategic Action Plan on sewage whose principal aim is to support efforts of States to address problems associated with pollution emanating from the disposal of untreated or inadequately treated waste water into the environment. The action plan is a proposal jointly put forward by UNEP, WHO, Habitat

(UNCHS) and the Water Supply and Sanitation Collaborative Council (WSSCC). The Strategic Action Plan has three principal components: (i) assessment, whose aim is to identify the problems to be addressed and opportunities as well as cost benefits (ii) management component, which assesses measures for addressing the problem at national, regional and global levels (iii) co-ordination at local and global levels and (iv) timetable for its implementation.

An important element of this action plan will be a series of regional meetings in the context of GPA Strategic Action Plan on Sewage. Proposed inputs to these meetings include:

- (i) A regional annex to the Framework for Action containing recommended approaches as adapted to regional priorities, capacities, and needs of stakeholders in the region
- (ii) Proposal on capacity-building activities in the region and
- (iii) Proposal on urban waste water demonstration activities in the region

Chapter 18 in Agenda 21 includes the following seven main programme areas:

- *Integrated water resources development and management*
- *Water resources assessment*
- *Protection of water resources*
- *Drinking water supply and sanitation*
- *Water and sustainable urban development*
- *Water for sustainable food production and rural development*
- *Impacts of climate change on water resources*

This report is an Eastern African regional annex to the Recommended

Framework for Decision-Making on municipal wastewater. The report is structured as follows: section two describes the current situation in the region, specifically, highlighting the major sources of sewage pollution and their impacts on the coastal and marine environment as well as their impacts on socio-economic activities. Existing sewage management practices are discussed in section three and recommended management approaches to address sewage problems are in section four. This section also proposes more specific strategies to deal with the municipal wastewater problems in the region.

This report is based on the following, amongst others:

- i) Overview of socio-economic opportunities related to sewage management of the coastal urban centers of the Eastern Africa region
- ii) Costs-benefit analysis case studies - Mombasa (Kenya); Dar es Salaam and Beau Vallon (Seychelles)
- iii) Reports on management approaches for municipal wastewater for four coastal towns, namely Mombasa (Kenya); Dar es Salaam and Zanzibar Town (Tanzania); Maputo (Mozambique); and Mahe (Seychelles).

The draft report was presented and discussed in Regional Consultative Meeting on Municipal Wastewater in Eastern Africa Region held from 11-15 June 2001 in Dar es Salaam, Tanzania. Participants provided extensive comments on the report report, which were incorporated into the revised report as appropriate.

2 BACKGROUND

The Western Indian Ocean (WIO) Region is comprised of the coastal States of Kenya, Mozambique, Somalia, South Africa, and Tanzania and the island States of Comoros, Madagascar, Mauritius, Reunion, and Seychelles. Eight of these Western Indian Ocean states are developing nations at different stages of both political and economic development. These differences are reflected in the range of individual economic indicators from those with a *per capita* gross national product of over \$ 3,500 per annum, to those with less than \$ 500. Moreover, such factors as urbanisation pressures, poverty, structural adjustments problems and weak informal sector activities, are far more dominant in the mainland states, as compared to the island states, especially Mauritius and Seychelles. On the other hand, the island states (except Madagascar) due to their geographical size, are much more exposed as a whole to the marine environment, relative to the mainland states.

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.

The coastal area of the Eastern African region is an area of great ecological diversity. Coral reefs, lagoons, mangroves and beaches are natural assets to the countries of the region. These ecosystems are important repository of biodiversity, both flora and fauna. Furthermore, based on 52 tropical inshore fishes, it has been found that in term of endemism, the region accounts for 22% compared to, for example, the Red Sea (13%) and Eastern Indian Ocean (6%). Five of the world's seven turtles nest on beaches of the region and more than 20 cetacean species are found there.

Coastal and marine environment sustain major social and economic activities in the region. These include fisheries, aquaculture and tourism. They also provide recreational opportunities as well as areas for human settlements.

In recent years, the coastal areas of the Eastern African region have witnessed intensive development activities that include industrial, agricultural, mining, trade and tourism, among others. In addition, the Eastern African region is experiencing rapidly increasing coastal population. These economic and socioeconomic activities exert intense pressure on the coastal environment, including pressure on resources. The impact on the natural environment from various land-based sources of pollution, for example, is evident in

virtually all the countries in the region. These sources include agricultural run-off (including nutrients and agrochemicals), industrial wastes, municipal waste, sediments and other products of man's activities. Rapid expansion of coastal tourism has been a source of concern to various governments in the region as it threatens the very coastal attributes that are contributing to its growth.

Of major concern is the immense urban development that has occurred in many coastal areas placing heavy demands on social services including waste disposal services. As a consequence, uncontrolled release of waste from human activities has been a major issue in all countries of the region. The main discharge sources include unsewered or inadequately sewerred urban settlements and direct discharges from pit latrines and septic tanks in urban and peri-urban areas. In some countries, tourist hotels are a major point source of municipal waste. The countries also suffer from uncontrolled disposal of solid waste including dumping of waste on mangroves and other wetlands leading to their degradation. Solid waste disposal onto beaches and intertidal platforms is common in some countries. This practice has resulted in the degradation of coastal habitats especially seagrasses and coral reefs.

Another threat to the coastal environment has been unregulated discharge of industrial waste, leading to pollution from heavy metals, nutrients, hazardous wastes and significant quantities of oils. Of particular significance is high BOD generated by such industries as bakeries, sugar industries and breweries.

These adverse impacts pose serious threats to coastal activities such as fisheries, mariculture and tourism. In addition, the socio-economic consequences are also immense considering that a large sector of the local population live within the coastal area and heavily depend on coastal resources for their sustenance. Furthermore, the economies of many of the countries in the region are sustained by the exploitation of coastal resources such as fisheries, oil and gas, mariculture and tourism.

2.1 Situational Analysis: Perceived Problems, Causes and Impacts on Sewage Pollution

2.1.1 Major sources of sewage

In general, marine pollution in the region emanates principally from land-based activities, including coastal urbanisation and coastal development, industries, tourism, agriculture, and mineral exploitation. However, further assessment of the problem has shown that sewage, especially that emanating from municipal sources, is the principal source of pollution threatening human and ecosystem health in the region.

Sewage pollution is attributed to the presence of organic compounds, nutrients, pathogens, and toxic substances in the effluents. The potential for sewage to cause impact

depends on the volume of the waste, whether treated before disposal, treatment processes employed and the manner in which it is disposed.

The amount of organic material present in effluents is quantified by measuring its Biological Oxygen Demand (BOD), while phosphates and nitrates are indicative of the amount of nutrients in the effluent. Pathogens are indicated by the presence of coliform bacteria and the risks of its contamination is estimated by measuring the faecal coliform levels.

Table 1: Access to clean water and sanitation in Kenya, Madagascar, Mauritius, Mozambique and Tanzania

Country	Safe water			Sanitation		
	Access % total 1988-93	Access % urban 1988-93	Access % rural 1988-93	Access % total 1988-93	Access % urban 1988-93	Access % rural 1988-93
Kenya	49	74	43	43	69	35
Madagascar	23	55	9	3	12	3
Mauritius	97	98	96	99	99	99
Mozambique	22	44	17	20	61	11
Tanzania	50	67	46	64	74	62

Source: UNDP, Human Development Report, 1995

Measurements of pollution loads and pollutants (coliform bacteria, BOD, COD, heavy metals, suspended solids and inorganic nutrients) both in the marine environment and on ground water sources have shown high concentrations. In Mombasa, for example, domestic sewage contributes about 4369 ton/year of BOD, 3964 ton/year of suspended solids, 622 ton/year of N and 94 ton/year of P. Industrial sewage contribute 16249 ton/year BOD, 21837ton/year suspended solids, 103 ton/year oils, 45 tons/year N and 6 tons/year P (Mwaguni and Munga, 1997). An assessment of municipal waste from the Mombasa area has shown levels of up to 1800+ coliforms per 100 ml and *E. coli* levels of up to 550 per 100 ml (Mwaguni and Munga, 1997). Sewage pollution in Mombasa is blamed for increased incidences of pollution related diseases such as typhoid in the district.

In Seychelles, contamination of land and human populations is not a major issue. However, contamination of water sources continues to raise concerns. Potable water sources in the Beau Vallon area come from the Rhodas and Le Niol rivers. Water from both these rivers has been found to be polluted from non-point sources such as household septic tanks. Levels of up to 200 cells per 100 ml of total and faecal coliform have been recorded in both rivers. The sources of such pollution are undoubtedly associated with human settlements further upstream (PUC, 1998).

In Tanzania, different surveys have shown that both surface water sources (Table 2) as well as coastal waters in the Dar es Salaam area are heavily polluted. With more than 118,822 tons of polluted water discharged to the ground each day, the majority of

ground-water sources within the built up area are contaminated as a result of poor sanitary arrangements (Table 3).

According to a number of studies, there appear to be a significant increase in the levels of pollution along the coastal waters of Tanzania and Zanzibar island during the past few years (van Bruggen, 1990; Machiwa, 1992; Daffa, 1996; Ferletta, et. al., 1996; and Engdahl, et. al., 1998). Ferletta, et. al. (1996) who conducted a baseline study on heavy metal contents in seaweeds collected from different parts of Zanzibar and Dar es Salaam close and away from the source of waste effluents found that in some algal species heavy metal content have increased ten times since 1989. Bjork, et. al. (1995) working on coralline algae observed high levels of nitrates, ammonium and phosphate in areas close to the sources of waste effluents from Zanzibar town. Significant levels of aluminium and cadmium have been observed in the macroalgae collected from Chapwani and Changuu Islands off Zanzibar (Engdahl, et. al., 1998).

Table 2: Pollution load to surface water resources (kg/day) in Dar es Salaam

Type	Industrial Effluent	Pit latrines	Septic tanks	Without facilities	Total
BOD	28,330	15,282	3,275	9,897	56,784
COD	29,904	16,131	3,457	10,447	49,776
Suspended solids	47,216	25,470	5,458	16,495	78,429
Dissolved solids	83,940	45,280	9,830	29,325	138,923
Total N	4,145	2,236	479	1,448	6,859
Total P	787	425	91	275	1,302

Source: Sustainable Development Programme (1992)

Table 3: Pollution loads to ground water sources (kg/day) in Dar es Salaam

Type	No facility	Pit latrines	Septic tanks	Sewer Domestic	Losses industry	Total (tons)
BOD	1,100	15,282	7,641	1,221	1,899	27
COD	1,161	16,131	8,068	1,289	1,1994	29
Suspended Solids	1,833	6,116	3,832	2,035	3,148	18
Dissolved Solids	3,258	97,857	61,128	3,618	5,596	196
Total N	120	4,829	3,018	3,618	5,596	10
Total P	23	915	572	34	52	2

Source: Sustainable Development Programme (1992)

In Zanzibar, both ground water and seawater in the Zanzibar Town area are contaminated with organic pollutants. Total and faecal levels of 11000+ and 1500+ cells per ml respectively have been recorded in the waters fronting the town area. Other pollution indicators, BOD and COD, are also high. High coliform levels are also found in surface streams running across the town area. Faecal and total coliform levels of 1555 and 5500 cell per ml have been recorded in Mto Upepo, 62000 and 96000 cell per ml in Mto Mpepo, and 29000 and 73000 cell per ml at Gulioni respectively (van Bruggen, 1990).

In Maputo, about 71% of the total BOD produced is of domestic origin. Industrial activities contribute 50% of BOD mainly from beverage factories and slaughterhouse of

Maputo City. Estimated pollution loads from the city are shown in Table 4 and 5 below. Table 6 gives estimated contributions of pollution loads from sewerred and non-sewerred populations.

Table 4: Estimated municipal pollution loads from Maputo City

	Prod	BOD	OIL	N
	Tn/Y	Tn/Y	Tn/Y	Kg/u Tn/Y
Domestic Liquid	8521	16926.8	3245.4	394.5
Leachate from Domestic waste	3.030.5			
Sub Total	12307.8	17339.8	3245.4	394.5

Table 5: Estimated industrial pollution loads from Maputo City

	BOD		SS		OIL		N	
	Tn/Y	%	Tn/Y	%	Tn/Y	%	Tn/Y	%
Agro-Industry	367.4	19.8	2778	5.2	81.8	16.1	25.8	74.4
Food Manufacturing	522.5	12.6	305.9	0.6	98.4	46.6	21.2	4.2
Beverage	668.7	36	289.1	0.5				
Textile	43.1	232	6.6	0.1				
Leather	123.8	6.7	202.8	0.4	112.8	53.4	23.4	4.6
Paper	17.1	0.9	15.5	0.3				
Chemical	238.0	128	320.3	0.6			380.5	75.1
Glass	165.6	8.9	49680	927				
TOTAL	2166.2	100	53598.2	100	211.2	100	450.9	100

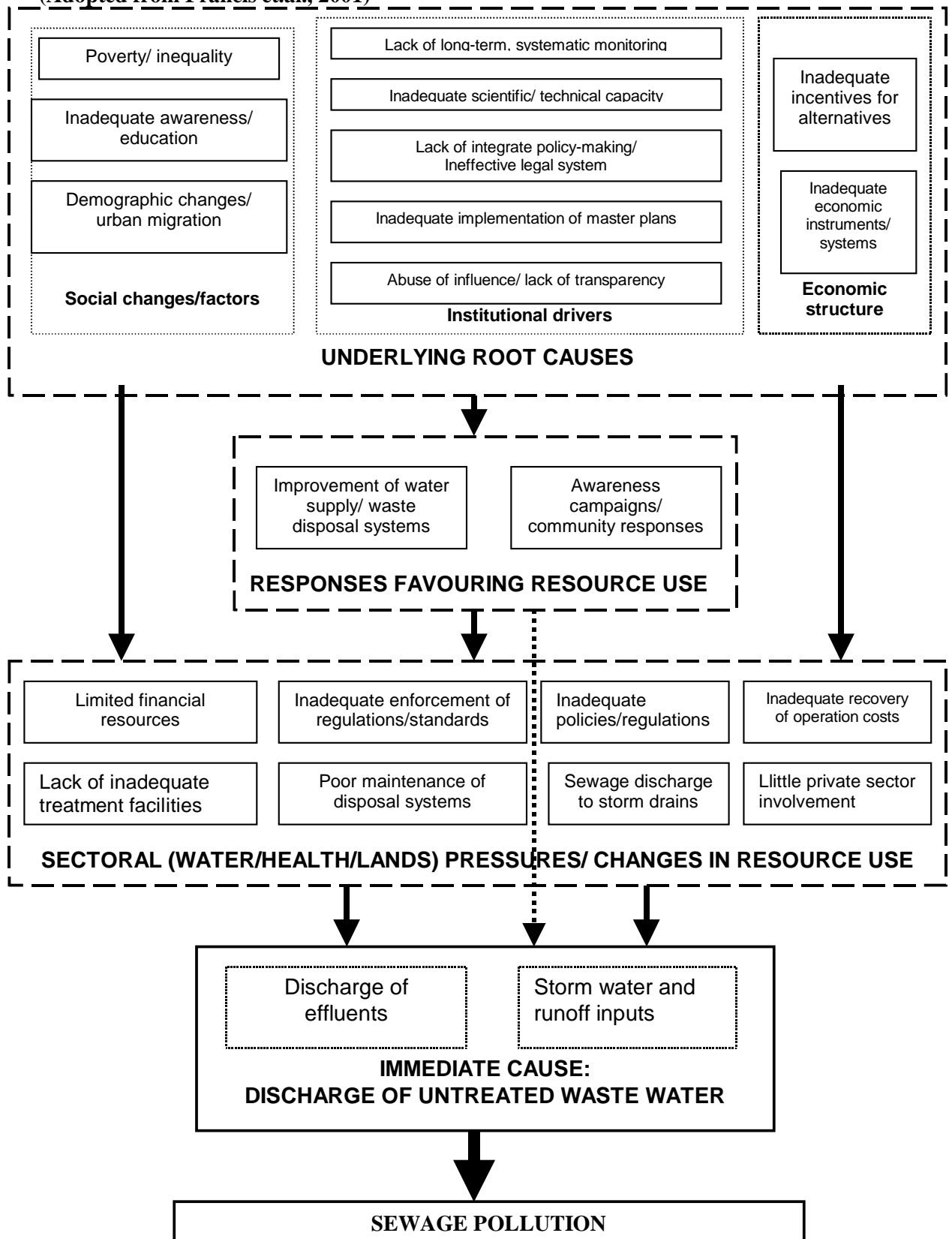
Table 6: Estimated contributions of pollution loads from sewerred and non-sewerred populations in Maputo City.

	BOD		SS		OIL		N	
	Tn/Y	Kg/U	Tn/Y	Kg/U	Tn/Y	Kg/U	Tn/Y	Kg/U
Sewerred	295.8	12.7	3757.9	20	5918	3.3	967.5	0.4
Non-sewerred	690.3	6.9	4763.1	16	11044.8	3.3	2278.0	0.4
Total	986.1	19.6	8521	36	16962.8	6.6	3245.5	0.8

2.1.2 Activities contributing to sewage problems in the region

Sewage pollution in the region is principally caused by poor waste disposal practices (Figure 1). This includes direct discharge of untreated sewage into coastal habitats such as mangroves and beaches, and discharge of untreated or inadequately treated waste water into coastal waters through sewers, streams and storm water drains. Wide use of pit latrines and septic tank facilities and direct defecation on beaches and other areas have also contributed to pollution of coastal and fresh waters. Furthermore, many of the countries in the region lack proper facilities for the disposal of waste at their ports. Consequently, ship waste, including toilet waste, is generally discharged directly into coastal waters.

Figure 1: Causal Chain Analysis for Microbial Pollution
 (Adopted from Francis et.al., 2001)



The root causes of the above practices can be traced to unplanned development in coastal areas. There is an accelerated rate of urban growth in virtually all the countries in the region. In addition, all the countries in the region are pursuing industrial and tourism development as a means of fostering economic development. By contrast, the necessary environmental management infrastructure to match this growth has been slow to develop leading to inadequate waste collection and disposal. Furthermore, poor planning in urban development, industry, tourism, agriculture and in the fisheries sector at the national level further aggravates the pollution problem.

Population Growth and Coastal Urbanization

Over 95% of the estimated at 25 million people residing in the nine countries in the East African region, live in Kenya, Mozambique, Tanzania and Madagascar (see table 7). The population growth rates of the mainland states, the Comoros and Madagascar are generally high, particularly in Kenya (3.3%), Tanzania (2.8%) and Mozambique (2.8%). This growth rate represents a doubling of population about every twenty-five years. Rates of urbanisation are greater than population growth rates, implying a continuing shift of people away from rural areas to urban dwellings and employment. Consequently, growth rates in the large coastal cities, such as Dar es Salaam (6.7% per annum), Maputo (7.2% per annum) and Mombasa (5.0% per annum), are higher due to rural-urban migration (UN 1992).

The outcome of this growth in these major coastal cities has been the proliferation of unplanned and unserviced areas. In Dar es Salaam, an estimated 75% of residents live in squatter areas, and 65% of new housing is being built in these areas. Key squatter areas of high population density include Manzese, Temeke, Mbagala, Buguruni, and Vingunguti. Conditions of squatter areas vary greatly, but access roads are generally narrow and in very poor condition, and basic service provision is frequently not available.

Large, rapidly expanding coastal urban populations produce large quantities of domestic sewage, which pose a threat to potable water and to near-shore coastal waters.

Table 7: Population and population density for the countries of the region

Country	Population (millions)	Coastal Population	% of coastal population	Population growth rate
1. Comoros	0.63	0.63	100%	2.70
2. Kenya	25.84	1.66	6.42%	3.30
3. Madagascar	13.05	4.80	36.78%	3.00
4. Mauritius	1.10	1.10	100%	1.20
5. Mozambique	16.6	5.62	33.86%	2.80
6. Seychelles	0.07	0.07	100%	1.50
7. Tanzania	28.39	4.61	16.24%	2.80

Source: Hatziolos, et. al., 1996

Table 8: Urbanisation Trends: percentage of urban population 1960,1994 and 2000

Country	1960	1994	2000
Kenya	7	27	32
Tanzania	5	24	28
Mozambique	4	33	41
Madagascar	11	39	42
Comoros	10	30	34
Mauritius	33	41	42
Seychelles	25	54	59

Source: *Human Development Report, 1997*

Tourism development

Tourism is a growing economic activity in the region and is increasingly viewed as an important economic opportunity at local, national and regional levels. The direct contribution of the tourism industry to the national economies range from 5.1 per cent of the Gross National Product (GNP) for Kenya to 20 per cent of the GNP for Seychelles. With greater political stability now existing in the region, this important economic activity is likely to continue to increase over future years.

However, a number of serious environmental problems have started to appear with increased tourism activities in the countries of the region. Construction of tourism related facilities such as hotels, restaurants, and recreation facilities, directly on the shore has been responsible for increased loading of sewage in coastal waters. Disposal of untreated sewage from coastal hotels threatens to undermine the very resources the tourists come to enjoy. Intensification of tourism is leading to increased urbanisation of coastal areas and pressure on resources such as safe drinking water and clean bathing beaches. Contamination of fish and shellfish has occurred as a result of inadequate sewage treatment prior to disposal.

Most hotels in Mombasa, Kenya do not have wastewater treatment facilities, with exception of a few. They employ septic tanks and soakage pits for the disposal of their sewage. In many cases, septic tanks are used for only wastewater from the toilets and kitchen, while wastewater from laundries is channeled into deep, unlined wells, which may reach the water table.

According to Skanda and Mwanguni (2001) only four hotels in the whole of the Kenya's coastal belt have treatment plants. These are Severin Sea Lodge, Travellers Beach Hotel and Bamburi Beach Hotel. Of these, three are in Mombasa District, namely, the Severin Sea Lodge, which has a mechanized biological sewage treatment plant; and both Bamburi and Travellers Beach Hotels use waste stabilization pond systems for their sewage treatment. These hotels re-use treated wastewater for watering their hotel's parks and gardens.

2.1.3 Impacts of sewage pollution on coastal and marine environment

The impact of sewage on ecosystem health has been reported in all the countries of the region. Effects of excessive loading of nutrients on reefs, that include decrease in coralline algal cover, increased community metabolism and gross production and general stress on corals have been reported in different countries in the region.

Various studies conducted in the region have shown that untreated municipal sewage has caused eutrophication of coastal waters and destruction of important habitats such as coral reefs. For example, off Reunion, eutrophication has resulted in infestation of boring sponges (clionids), reduced calcification rates, and competition with corals by both calcareous and fleshy algae leading to algal overgrowth and development of algal-bacterial mats (Cuet, 1994; Montaggioni et al., 1994; and Naim, 1994). Also organic matter discharged from sugarcane industry is degrading coral reefs off Reunion (Cuet and Naim, 1994). Eutrophication associated with the release of inorganic nutrients into coastal waters from domestic sewage around Zanzibar has been identified as the possible cause of the decreased cover of reef-building algae (Bjork, et. al., 1995). Furthermore, Bjork, et. al., (1996) showed that calcareous algae are sensitive to phosphate and they disappear from phosphate-rich areas. Algal blooms are observed annually at Trou aux Biches, and isolated cases have been reported at the sewer outfall at Bain des Dames near Port Louis, Mauritius.

Surveys of coastal waters in the Beau Vallon Bay area, Seychelles have shown evidence of organic contamination of water and deterioration of coral reefs, attributable to sewage discharge (SETOI, 1990).

Sewage pollution in Dar es Salaam has been an issue of concern for several years. For example, Munissi (2000) showed that, with increasing distance from the main sewage pipe at Ocean Road, dissolved oxygen increased significantly from 5.79 to 12.93 mg O₂/l, while BOD decreased significantly from 4.4 to 1.88 mg O₂/l. *Ulva* spp. and *Enteromorpha* spp., used as bioindicators showed a marginally significant difference at various distances from the sewage pipe. *Ulva* was most abundant at the site closest to the sewage pipe, while *Enteromorpha* was most abundant at the site second closest to the sewage pipe showing the effect of sewage-induced eutrophication.

Contamination of recreational areas, including bathing areas, and contamination of freshwater sources (surface and ground-water sources) are other consequences of poor waste collection and disposal practices. Analyses of water in Mombasa, Kenya indicated that out of 23 wells sampled only 3 passed drinking water standards and the rest were contaminated with coliform bacteria (Mwaguni and Munga, 1997). Also analysis conducted on water quality in the boreholes and wells from different coastal provinces in Mozambique have revealed that a significant number of them are contaminated (Fernandes and Hauengue, 1997).

Risk to humans through use of contaminated water and seafood is another concern in the region. As a consequence, waterborne diseases such as cholera, dysentery, gastro

enteritis and diarrhea are prevalent in Zanzibar, Dar es Salaam, Mombasa and Maputo. According to Fernandes and Hauengue, (1997), studies on the sewage pollution in Mozambique has revealed the following:

- In Maputo Bay, *faecal coliform*, *faecal streptococci* and *E. coli* were detected in both coastal waters and shellfish tissues, with levels consistently higher in shellfish
- The bacteria *Vibrio parahaemolyticus* and *Vibrio minicus* were isolated from clams at Incomati, Polana and Matola. The *Vibrio* sp. are known to cause severe gastrointestinal illness

2.1.4 Impact on economic, social and recreational use of coastal environment

The economic and social impacts of poor sewage management practices are evident in all the countries in the region. In Mombasa, disposal of untreated sewage in the Kipevu area has wiped out oyster harvesting which used to be a common feature in the area. Fisheries enjoy an important position in the economic sector of Mombasa District. Unfortunately the fishing industry has been the most affected by the problems associated with poor sewage management. The European Union has, for example, banned the import of fish from Kenya citing sewage pollution as the main reason to affect the ban (Mwaguni, 2000). Pollution has also affected recreational use of some parts of Mombasa coast including swimming. Furthermore, studies conducted in Kenya have indicated that all groundwater sources developed alongside human settlements does not pass international water standards (Mwaguni, 2000).

The high levels of total coliform in the Maputo Bay indicate that the waters in some parts of the Bay such as the Miramar Point are not safe for swimming (Fernandes and Haungue, 1997).

JICA (1997) in its assessment of public health in Dar es Salaam observed the following:

- i) Water related diseases constituted 62% of total of all disease incidences in 1995, from an estimated 46% in 1991
- ii) Water-borne and faecal related diseases (including cholera, dysentery, typhoid and diarrhea) grew from 8% to 12 % of total diseases between 1991 and 1995.

These types of diseases are strongly associated with the conditions arising from poor water quality and inadequate sanitation.

Decline in water quality and loss of scenic and aesthetic qualities of beaches and coastal waters through waste disposal and beach fouling has also affected recreation activities and the tourism industry in Kenya, Tanzania and Mozambique. In Mombasa, for example, dhow cruises for tourists in the Tudor and Mtwapa Creeks were part of the tourism scene. However, with sewage discharges in these areas the cruises are becoming less popular thereby affecting the tourism trade. In Zanzibar, high coliform levels in the waters fronting the historic Stone Town have rendered these waters unfit for bathing (van

Bruggen, 1990). In Seychelles the coastal areas close to the Mare Anglaise and the Sullivan Rivers has the highest level of faecal contamination at least for 1.3 months in each year and deemed unbatheable according to European standards for bathing water (Payet, 1996). The unsuitable levels generally occur after periods of heavy rains. Furthermore, water quality studies using faecal coliform as an indicator show that the water quality around the Beau Vallon coast is 60% unsatisfactory for recreational use according to WHO standards (Payet, 1996).

3 EXISTING MUNICIPAL WASTEWATER MANAGEMENT PRACTICES

3.1 Approaches and Policy Steps to Manage Municipal Wastewater

The various countries in the region have traditionally opted for the *supply-driven approach* with regard to waste management where the need for sanitation is first assessed by utility planners and the type of sanitation is then provided on the basis of this assessment. The adoption of this approach has generally been driven by national policies that aimed at satisfying the basic needs of the populations in the overall development strategy. For example, the 1993 constitution of Seychelles defines the provision of adequate sanitation as a basic right of all Seychellois. The principal objective is to serve all population with sanitation systems by the year 2010. The goal is that 90% of the population of greater Victoria and 70% of the population of Beau Vallon area representing about 30% of Mahé's population will be served with water-borne sewerage systems. The rest of the population, representing about 60% of Mahé's population, shall be served by individual sanitation systems, mainly septic tanks,. Under this program, the usage of pit latrines shall be reduced to 10% by the year 2010 (EMPS 2000 – 2010).

In the case of Mombasa population increase and industrialization without matching facilities to manage the wastes generated in the district has been the source of considerable concern as a result of their impact on the environment. Out of this concern, a new sewer system is under construction to serve the Changamwe Division in the municipality. This system will be commissioned within the coming next few months. This will significantly increase both the percentage of population under water borne sewerage and area covered. Furthermore, the treatment plant in Changamwe that had been out of use for several years has since been re-designed and is now being rehabilitated to serve a larger population.

For several years the Zanzibar Municipality had suffered under the effects of a dilapidated sewerage system that was not only grossly inadequate to serve the over two hundred thousands people living in the municipality but has also had passed its usefulness. For example, it was a common occurrence to observe wastewater spewing out of blocked or broken sewer pipes into the streets, especially in the Old Stone Town area. In order to arrest this situation the Zanzibar Municipal Council decided to

rehabilitate and improve the municipality's sewerage, drainage and solid waste disposal systems with the help of funding from Kreditanstalt fuer Wiederaufbau (Germany) amounting DEM 15,000,000. The rehabilitation work of the sewage network included the cleaning, repair and extension of the existing drainage system at the Old Stone Town by means of reconstruction / renovation of the existing pavement and putting up of new sewage delivery pipes. The rehabilitation work was completed in 1998.

3.2 Technical Options

The cost of putting in place conventional wastewater delivery and treatment facilities is too prohibitive for nearly all the countries in the region such that almost all of them have adopted other less costly waste management technologies.

Lack of maintenance of sewage disposal and treatment infrastructure in most of the coastal towns has left them in a state of disrepair and under utilised. In most of the major coastal cities, population growth and urban migration has outgrown the carrying capacity of existing sewerage systems and most of them require redesigning to meet current and projected demands. None of the cities and towns bordering the western Indian Ocean has adequate waste treatment facilities. Consequently, untreated sewage is discharged into water bodies thus posing a serious threat to these systems. In most of these towns there are few, if any, public toilets and where available, cleanliness standards do not exist. Insufficient public/private toilets could potentially result in contamination of water bodies and therefore contributing to the increase of water-borne diseases.

In most major cities a mixture of technological options that consist of water-borne delivery systems and dry sanitation for waste management are in practice. However, by far dry sanitation, especially in peri-urban areas, has been the preferred option. This essentially includes those sanitation practices that treat waste on site thus avoiding costly off-site transportation. Consequently, pit latrines and septic tank-soakage pit systems are the more popular sewage disposal systems.

In general water borne sanitation systems are few and only serve a fraction of the region's population. For example in Mombasa only 13% of the population is served by a water-borne sewerage system while 74% use pit latrines, 16% use septic tank-soakage pit systems and the rest have no toilet facilities at all. Mombasa municipality has separate sewerage systems for domestic sewage and storm water run-off. It should be noted, however, that residents in some areas have done illegal connection of sewer lines to storm water drains thus emptying domestic waste, include toilet waste, into the later. The Municipality has two treatment plants, one located on the Island and the other in Changamwe Division. Both plants have been out of use for many years, which means that domestic waste from the sewered population enters the marine environment untreated. However, the plant in Changamwe has been re-designed and is now under construction to serve a larger population. This plant, which is to be commissioned soon, will greatly improve sewage management in Mombasa. Very few industries in Mombasa have

facilities for pre-treating effluent before disposal. Most industries use septic tank-soakage pits, vertical drains or direct discharge into the sea.

Maputo, is the only city in Mozambique that has waste treatment facilities. The facilities, however, treat only about 50% of the city's sewage. The treatment plant in Maputo is comprised of a series of anaerobic and facultative tanks designed to treat organic matter. The plant receives storm water and sewage from only some parts of the city's households. The partly treated waste from these ponds is then discharged into a nearby river system.

Only three hotels in the whole of the Kenya's coastal belt have treatment plants, namely: Severin Sea Lodge, Travellers Beach Hotel and Bamburi Beach Hotel. The Severin Sea Lodge has a mechanized biological sewage treatment plant; and both Bamburi and Travellers Beach Hotels use waste stabilization pond systems for their sewage treatment. These hotels re-use the treated wastewater for watering their hotel's parks and gardens.

The sewage treatment plant for Severin Sea Lodge is mainly biological treatment by aeration where sewage is oxidized by use of compressors. Sewage is centrally collected by gravity to a central point and then pumped to the treatment plant. A certain proportion of the sewage is recycled, chlorinated and chlorine is then removed by carbon-filtration and the water used for garden irrigation. In dry weather flow, 100% of the sewage is recycled. In wet weather (10% to 20%) is recycled as during rains, the hotels do not need the water for their gardens.

However the sewage system in Maputo, like in most other cities, suffers from lack of maintenance. Furthermore, considering the large increase of population, the system is far from adequate. As a result, use of pit latrines and septic tanks is common, with pit latrines being by far the predominant excreta disposal system in use. Use of pit latrines range from 70% in the Maxaquene B district to 100% in the Urbanização Mahotas e Ferroviario district.

Sewage from tourist hotels is piped into septic tanks and these are not necessarily concreted.

In Dar es Salaam, 80 per cent of the population is served by on-site sanitation systems: septic tanks, soak-away pit, and traditional and ventilated pit latrines. The soak-away pits and septic tanks have severe problems with overflows particularly during the rainy seasons.

The Dar es Salaam sewerage system is an old system built in the late 1950s. Though the system was rehabilitated in the 1980s (under the Dar es Salaam Sewerage and Sanitation Project financed by the World Bank) it is increasingly proving inadequate to serve the ever-increasing population of the city. Only 15% of the total population of the city is served by the central sewage system. The areas served by this system include the City Centre, parts of Sinza, Ubungo and Vingunguti. The system is linked to eight oxidation ponds located at Mabibo, Kurasini, Mikocheni, Lugalo military camp, Gerezani, Ukonga air force, Vingunguti and University of Dar-es-salaam. Due to limited financial resources only four of these (i.e. those at University of Dar-es-salaam, Kurasini, Mikocheni and Vingunguti) are currently operating. Sewage is discharged through a 1.6 km long sea

outfall near Ocean Road Hospital. The outfall is exposed during low tide and leaks in several points due to lack of maintenance.

In Zanzibar, out of 290,000 individuals living in the Municipality, only 19% are served by sewers (mostly in the old Stone Town), as compare to the 78% who use pit latrines or septic tanks with soak pits while about 3% of the population have no access to toilets. Zanzibar does not have sewage treatment facilities. In Zanzibar, only 12 out 24 tourist hotels surveyed in 1998 had fully concreted septic tanks, while the rest had open ones leaking into fissures and caves. Treatment of any kind is generally not provided (Gossling, in press).

On the surface, the situation in Seychelles may look far different from the rest the other countries in the region in terms of sewage disposal practices. For example, seventy four percent of dwellings on Mahé are served by modern sanitation systems. The percentage in Beau Vallon area, north west of Mahé, is higher with some 80%. However, this figure conceals major deficiencies. For example, the major urban concentrations in Seychelles are located in the Greater Victoria area with a total population of 23,000. Sewage discharges from Greater Victoria area is estimated at about 9,000 m³/day, with only 1700 m³/day collected and treated by a public collection system and treated before discharge at sea.

No major centralized wastewater treatment work had been built in Seychelles in the last 10 years prior to 1999. In the absence of collective sewerage infrastructures, the existing dwellings are equipped with simple septic tanks followed by a cesspool or a dry-pit from which the overflow waters seep into the ground and rivers. About 20% of the houses are equipped with latrines. However, the situation will soon change. Two major sewage works have been undertaken: the greater Victoria Sewerage project is currently under implementation and the Beau Vallon Sewerage project is ready for implementation. The Beau Vallon Sewerage project includes the designing and construction of new wastewater conveyance and treatment and disposal facilities to serve the sewerage needs of the northern portion of the island through the year 2010. It will also have a centralized wastewater treatment plant. The feasibility study for the project examined three technical options for waste treatment. These are:

- Simple pre-treatment
- Primary treatment following pre-treatment
- Secondary biological treatment (low loading rate or extended aeration activated sludge processes)

With regard to the treatment of sludge, the following the following technical options were considered:

- Treatment through gravity thickening
- Stabilization using lime for primary sludge
- Drying beds
- Filter presses with injection of polymers

Hotel establishments over a certain size for instance are bound by law in Seychelles to install centralized wastewater treatment systems prior to disposing wastewater into the environment (see examples in Table 9). However, package treatment plants of the larger hotels are not functioning adequately. In addition, all the other establishments use septic tank systems, which notoriously leak (Shah, 1998). As a consequence, about 17 % of the pollution in the Beau Vallon Bay, is caused by the tourism sector (SOGREH, 1994).

Table 9: An overview of the major hotels and their respective sewerage treatment facilities.

Sewerage treatment plants of major hotels				
Hotel	Year installed	No. of rooms	of	Population equivalent
				1997
Berjaya Beau Vallon	1974	182		664
Coral Strand	1996	103		381
Le Meridien Fisherman's Cove	1997	48		191

Source: Henri, 1997

Table 10: Most common sewage system for some selected countries

Country	Common sewage systems	Treatment/Disposal mechanisms
Kenya	<ul style="list-style-type: none"> ▪ Central sewage system ▪ Septic tanks ▪ Pit latrines 	
Mauritius	<ul style="list-style-type: none"> ▪ Central sewage system ▪ Soakage pits ▪ Septic tanks 	<ul style="list-style-type: none"> ▪ Ocean outfall
Mozambique	<ul style="list-style-type: none"> ▪ Central sewage system ▪ Septic tanks ▪ Pit latrines 	<ul style="list-style-type: none"> ▪ Treatment plant ▪ Ocean outfall
Seychelles	<ul style="list-style-type: none"> ▪ Central sewage system ▪ Septic tank 	<ul style="list-style-type: none"> ▪ Treatment plants ▪ Ocean outfall
Tanzania	<ul style="list-style-type: none"> ▪ Central sewage systems ▪ Septic tank ▪ Waste stabilisation ponds ▪ Soak-away pits 	<ul style="list-style-type: none"> ▪ Ocean outfall

3.3 Institutional Arrangements

Legal and institutional frameworks are among the important mechanisms employed in waste management. Effective implementation of policies at the national level largely depends on effective institutional mechanisms.

The countries in the region have adopted a wide range of approaches within their legal and regulatory framework aimed at the protection of coastal and marine environment against sewage problems. These include:

- ❖ Setting up of environmental quality standards
- ❖ Protection of key habitats such as coral reefs and mangroves
- ❖ Environmental Impact Assessment
- ❖ Pollutant discharge fee
- ❖ Monitoring, surveillance and inspection
- ❖ Penalties

Setting up of environmental quality standards has a number of limitations. In Tanzania, for example, the following limitations have been highlighted:

- ◆ Limited understanding/knowledge among government agencies of the existence and their applicability of water quality standards
- ◆ The absence of municipal sewage treatment plants; it has been difficult to institute and implement technically sound effluent standards for domestic and municipal sewage.
- ◆ There is no monitoring programmes of the standards to assess their effectiveness

More seriously, water quality standards have been developed for the purpose of dealing with individual acts of pollution rather than long-term impacts.

Sewage management in most of the countries in the region is fragmented, involving multiple agencies. Consequently, enforcement functions are spread thinly. Lack of coordination among ministries, or even among departments within ministries is common. Poor dialogue between those polluting the environment and those trying to prevent it from happening does not create the necessary environment to help foster cooperation and coordination among sectors responsible for environmental management. For example, in Tanzania there are several bodies that have legal authority to regulate waste discharge. These include: Regional Water and Sanitation Authorities, the Rufiji Basin Development Authority, Tanzania Bureau of Standards, the National Environment Management Council and municipal councils. At the ministerial level there are several ministries dealing with sewage and related aspect. These include ministries responsible for land, health, water, environment and local government.

Table 11: Relevant policies/legislation for some selected countries

Country	Relevant Legislation/Policies	Brief description
Kenya	The Water Act (Cap 732)	Implemented through the Ministry of Land Reclamation, Regional and Water Development, prohibits pollution of water resources and controls the discharge of municipal effluents into rivers and the ocean
Mozambique	The Water Act, 1991	The Act establishes the principle of polluter pays, defines the concept of water contamination and stipulates that water projects shall be subjected to social, economic and environmental analysis
	The National Water Policy 1995	Based on the concept of integrated water resources management in order to maximise benefits
	Decree No 495/73, September 1973	Determines a set of protection measures against water pollution, pollution of beaches and coastal areas
Seychelles	Public Utilities Corporation (Sewerage) Regulations (SI 9 of 1987)	Provides authority for managing sewerage and treatment
	Environment Protection (Standard Regulations 1995)	Sets standards for water and air quality.
	Environment Protection Act, 1994	Defines activities for coastal management, Environmental Impact Assessment, and pollution control
	Environment Protection (Impact Assessment) Regulations 1996	Lists protected areas, which need authorisation for any project or activity.
Tanzania	Water Policy 1991	Domestic and industrial effluent treatment before discharging into receiving water bodies
	National Environmental Policy	Prevention, reduction and control of pollution of the marine and coastal waters, including that from land-based sources of pollution
	National Land Policy	Advocates that coastline development shall be done after EIA study has been carried out
	Water Utilisation (Control and Regulation) Act 1974	Deals mainly with water distribution and utilisation through licensing of water use
	Water Utilisation (Control and Regulation)(Amendment) Act No. 10 of 1980	Provides legal powers for application of temporary water quality standards for effluent and receiving water standards, namely, those for direct discharge into receiving waters and those for indirect via municipal treatment works
	Water Laws (Miscellaneous amendments) Act, 1999	Strengthened the institutional arrangements for managing and integrating water supply and sewerage services
	Public Health (Sewerage and Drainage) Ordinance	Empower urban authorities to prohibit discharging of certain substances into public sewers.

Table 12: Organisational Arrangements for the Different Functions in Water Pollution Control in Seychelles, Kenya, Mozambique, Tanzania and Zanzibar

	Seychelles	Kenya	Mozambique	Tanzania	Zanzibar
Policy	National: broad policy River basins and Regions: region specific policies	National: broad policy River basins and Regions: region specific policies	National: broad policy	National: broad policy River basins and Regions: region specific policies	National: broad policy Regions: region specific policies
Regulation	National: general standards	National (National Environmental Management Authority): general standards Regional Development Authority; Local authorities (City Councils, Municipal Councils, Urban Councils or County Council): local application	National: general standards	National: general standards	National: general standards Zanzibar Municipal Council: local application, monitoring
Operational management of on-site sanitation initiatives in peri-urban areas		Local Authorities (Municipal Councils, Urban Councils or County Councils)		Local Authorities (eg. Dar es Salaam City Council), private operators	Zanzibar Municipal Council; Private operators

Operational management of public wastewater infrastructure	Sewers	Public Utility Corporation	Local Authorities	Local Authorities	Local Authorities (eg. Dar es Salaam City Council), private operators	Zanzibar Municipal Council
	Treatment plants and pumping stations	Public Utility Corporation	Local authorities	Local Authorities	Local Authorities (eg. Dar es Salaam City Council), private operators	

Kenya has adopted a 'stick and carrot' approach in dealing with waste management problems. This is provided for in the recently enacted Environmental Management and Coordination Act of 1999 which sets administrative framework for environmental management in the country. The Act provides for environmental planning, sets out environmental standards and enforcement and review of the standards for water, air, wastes and noxious smell, among others. The Act:

- calls for the prohibition of water pollution
- requires any one who wishes to discharge effluent into sewer systems to seek permission before doing so and sets conditions for the acceptance of effluent for discharge
- specifies that any one wishing to discharge effluent must be licensed and has adopted the polluter pays principle. Similar requirements have been specified for the discharge of wastes.
- provides for the protection and conservation of environmental resources that include conservation of biological diversity, biological and genetic resources, protection of environmentally sensitive areas and coastal areas.
- provides for institutional arrangements to administer the EIA mechanism. At present EIA activities are being implemented through a variety of instruments including sectoral laws, policy statements and other administrative means e.g. permits and licenses. However, this situation is bound to change once the institutions provided for in the Act become operational.

Importantly, the Act provides for environmental restoration orders which effectively upholds the 'polluter pay' principle. The Act states that where if a person by virtue of his actions has damaged or adversely affected segment of the environment in any areas, then such a person may be required to either restore the environment, pay compensation to other persons whose environment has been harmed or meet the costs for restoration by the relevant persons/organization. The Act also establishes an Environmental Tribunal to deal with environmental offences, including pollution offences.

Further, the Act provides for an Environmental Management Fund whose objective is to facilitate research intended to further the requirements of environmental management, to facilitate the production of environmental publications to assist in public education, and to fund capacity building and scholarships and grant schemes. The fund is also used to offer environmental awards to individuals and institutions that have excelled in activities aimed at conserving the environment.

With regard to providing sanitation services in Kenya, this is the statutory responsibility of the Ministry of Local Government through the Local Authority Government Act (Cap 265). The Ministry executes the said responsibility through City Councils, Municipal Councils, Urban Councils or County Council. This Act provides for local councils to establish and maintain sewage and drainage systems. This responsibility however, does not empower the Councils to be the sole providers of the service. Community involvement and private participation has long been advocated for and is now being practiced. Waste management in Mombasa is the responsibility of the Municipal Department of Environment. The department was established as an arm of the Council to deal with sewage problems and to enforce the recently concluded Environmental Management and Coordination Bill. The department carries out the supervision of drainage and sewerage systems on a zone basis covering the whole of the municipality. A Drainage Section under the department carries out short-term management of septic tanks, soakage pits and pit latrines. Operations and running expenses, is budgeted for and provided by the Municipal Council.

Generally, Seychelles uses regulatory tools in environmental management. In this regard it has enacted various legislation with the view to combat pollution, including that emanating from sewage. The principal legislative instruments for control of pollution in coastal and marine areas in the country include the Public Utilities Corporation (Sewage) Regulations of 1987 which provides authority for managing sewerage control and treatment. The National Parks and Nature Conservancy Act (Chap 141) provides authority for protected areas including pollution control. Environment Protection (Standard Regulations 1995) sets standards for water and air quality while the Environment Protection Act, 1994 defines activities for coastal management, Environmental Impact Assessment, and pollution control. On the other hand, the discharge of waste from ships is controlled by the Marine Pollution Regulations (SI 51 of 1981). Dumping at Sea Act (Overseas Territories) Order (SI 36 of 1976) prevents dumping of waste at sea (Shah, 1997). In recent months the Ministry of Environment and the SWAC have recently taken a stronger stance towards acts of pollution with threats of stronger penalties to those committing the offence.

The technical organisation responsible for control of pollution in Seychelles is the Environmental Assessment and Pollution Control Division under the Ministry of Environment. However, the agency that is directly responsible for the provision of adequate sanitation for the people of Seychelles is the Public Utilities Co. (PUC), a government parastatal which also manages sewage collection and disposal. The PUC was created in 1985 by an Act parliament. Subsequent Regulations (Public Utilities Corporation (Sewerage) Regulations, SI 9 of 1987) defined its powers. The parastatal controls all centralised sewerage systems in Seychelles. Other sectoral institutions responsible for pollution control include the Seychelles Bureau of Standards which is mandated to develop environmental standards and the Ports and Marine Services Division of the Ministry of Tourism and Transport which is responsible for marine pollution from ships and in the harbour. The Seychelles Coast Guard is responsible for the Oil Spill Contingency Plan. Managing waste water effluents and sludge disposal and monitoring of the quality of both liquid and solid wastes, is the responsibility of the Division of Environment.

The Ministry of Health through its Environmental Health Division has the responsibility for monitoring and improving hygiene conditions throughout the country, advising and educating the public in good sanitary practices, and controlling the quality of portable water. A health inspector stationed at each of the local health centres throughout the country carries out monitoring and inspections and also responds to people's complaints on any health and sanitation related problems.

In Mozambique, an Environmental Act of 1991 was enacted with the view to curb pollution of the environment. Under this Act, no one is allowed to willfully pollute the environment and that polluters are liable to pay for clean up costs. The Act specifies pollution prevention measures including environmental management programs that state clearly mitigation measures. In addition, regulations have been issued under relevant ministries to manage sewage pollution. These include regulations issued by the Ministry of Health, Ministry of Public Works and Housing and Ministry for the Coordination of Environmental Affairs, among others, aiming to secure wise use of water resources, protect the quality of drinking water and prevent pollution of all environmental compartments. Decree No 495/73, September 1973 determines a set of protection measures against water pollution, pollution of beaches and coastal areas. The Ministry of Health, through its Environmental Health Department and a provincial network of laboratories, has been monitoring the quality of drinking water and, in the case of Maputo and Beira, the quality of sea water particularly in

recreation areas. Other measures include the preparation of standards and regulations for pollution control. This activity is coordinated by the Ministry for the Coordination of Environmental Affairs.

Recently EIA regulations have been issued which makes it mandatory to carry out environmental impact assessment for any potentially environmental harmful project/process. This includes all potentially polluting activities.

In order to eliminate the pollution problem associated with hospital waste, the Ministry of Health, in coordination, with the Ministry for the Coordination of Environmental Affairs is preparing a National Regulation of Strategy for the Management of Medical Wastes. The country is preparing a Clean Technology Initiative with the view to promote the adoption of cleaner industrial production methodologies.

In Tanzania, the National Environmental Policy calls for the prevention, reduction and control of pollution of the marine and coastal waters, including that from land-based sources. The national policy complements the 1991 Water Policy which advocated treatment of both industrial and domestic effluent before discharge into receiving bodies. To support these policy declarations, a number of legal instruments have been enacted to control pollution. These include the Water Utilisation (Control and Regulation)(Amendment) Act No. 10 of 1980 which provide legal powers for application of temporary water quality standards for effluent and receiving water standards, namely, those for direct discharge into receiving waters and those for indirect via municipal treatment works. The other is the Public Health (Sewerage and Drainage) Ordinance which empowers urban authorities to prohibit draining of certain substances into public sewers.

The Water Laws (Miscellaneous amendments) Act of 1999 has enabled in depth institutional reform within Dar es Salaam Water and Sewerage Authority (DAWASA). DAWASA, as a Public Granting Authority will sub-contract technical and commercial operations of the water supply and sewerage service to a commercial Private Operator (PO) under a ten year "Lease Contract". The Operator will be responsible for operational management of the infrastructure and facilities, including installation of meters, reducing the unaccounted for water and improving cost recovery through enhanced collection of water and sanitation charges. Also the Operator will provide initial working capital.

Despite the various legal instruments existing in all countries in the region, serious gaps remain in the implementation of policy, law and regulations. For example, previous experiences clearly show that enacting environmental laws with the accompanying penalties is one thing, enforcing and implementing them is another. More often than not, the problem lies in enforcement. Limited financial and human resources, lack of technological capacity as well as the practical problems of administering environmental regulations are the main factors contributing to weak enforcement. There is also a shortage of reliable information to guide implementation of both policy and legislation.

3.4 Financing Options

In the past, sewerage services, like water supplies, in most of the countries in the region have been free or subsidized. This practice still exists in Zanzibar where the population is not charged water and sewage tariffs.

The cost recovery in water supply and sewerage services in the region uses mainly two main approaches namely, use of State Corporation or delegated management. In Tanzania, DAWASA and its predecessor authorities, as state corporations, assumed the role of provider of fresh water and disposal of wastewater at minimal costs to its customers. This approach has proved to be very cost intensive, associated with negative returns and to have persistently generated losses to these agencies (Temu, 2001).

The second approach of delegated management seeks to attain the objective of maximum coverage within economic self-sufficiency in the delivery of water supply and sewerage services through the involvement of professional private sector operator (Temu, 2001).

In Mauritius, the Mauritius Wastewater Management Authority Bill of 2000, shall be responsible for collection, treatment and disposal of wastewater throughout Mauritius. The duties of the Authority shall amongst others be: “*recover through tariffs user fees that may be claimed in respect of the lease of assets under a “Contract de Delegation”*”

Some countries in the region are now moving gradually towards full-cost recovery programs. However, despite the introduction of water and sewage tariffs in most of the countries, there have been large operating deficits for both the water and sewage service agencies due to a number of reasons, including inadequate collection of bills, poor quality of Water and Sewerage services, and poor reporting system. In addition, illegal connections to sewer lines are also common, further depriving municipalities badly needed operational funds.

The authorities in Seychelles levy user charges upon discharge of waste water into the country’s sewerage system. The country has established a uniform tariff for the whole country irrespective of volume discharged or characteristics of the effluent. The tariff, which is linked to the water tariff (Table 13), has been effective since 1st January 1995. The tariff helps to partly offset operation and maintenance costs of sewer networks.

Table 13: Water and sewage tariffs in Seychelles

Water charges and sewerage supplement inclusive of 5% Trade Tax	Water charge (SR)	Sewerage Charge (SR)
<i>Trade Premise</i>		
In respect of monthly consumption of water:		
i) Not exceeding 5m ³ , a fixed charge of	42.10	
ii) Between 5 m ³ and 100 m ³	8.42/m ³	11.25
iii) Exceeding 100 m ³	13.16/m ³	2.37/m ³
Plus a fixed monthly charge of:	5.26	3.68/m ³
Premises other than trade premise		
In respect of monthly consumption of water:		
i) Not exceeding 5m ³ , a fixed charge of	10.55	3.75
ii) Between 5 m ³ and 15 m ³	2.11/m ³	0.75/m ³
iii) Between 15 m ³ and 50 m ³	6.31/m ³	1.84/m ³
iv) Between 50 m ³ and 100 m ³	7.37/m ³	2.10/m ³
v) Exceeding 100 m ³	9.47/m ³	2.90/m ³
Plus a fixed monthly charge of:	5.26	

However, commercial and industrial developments are required to pre-treat their wastes so as to ensure that effluent discharges from enterprises into public sewers conform to stipulated standards. This is not only aimed at reducing the destructive impacts of untreated sewage on the environment but is seen to facilitate the efficient operation of the system, which is primarily designed to handle domestic sewage

Capital investments in sewerage infrastructure are funded through either government finances or/and external financial opportunities. For example, the rehabilitation of the Le Niol Water Treatment Works was funded by the European Union in 1977. Another project, the construction of the Beau Vallon Bay Sewerage which is estimated to cost SR 45,800,000, will be implemented by a British company (SATEC) under a Build Operate Transfer (BOT) scheme. The Beau Vallon Bay sewerage includes the design and construction of new wastewater conveyance, treatment and disposal facilities to serve the sewerage needs of northern portion of the island through the year 2010.

This project was preceded by a feasibility study conducted by a French Consultant SOGREAH and jointly funded by Caise Francaise de Developpement (CFD) and the government of Seychelles. The Greater Victoria Sewerage Project was financed with a loan from African Development Bank (ADB).

The Government of Mauritius has developed a National Sewerage Master Plan, which defined an investment programme and other accompanying measures over a twenty year's period. The first phase of the programme which is already being implemented is expected to cost about Rs4 billion over the next five years. This programme comprises:

- i) Construction of new treatment facilities
- ii) Extension of networks, construction of new networks and house connections
- iii) Institutional, legislative and financial measures, including rationalisation of tariffs based on amount of fresh water used.

In Kenya, the Mombasa Municipal Council levies effluent charges for emptying septic tanks, soakage pits and pit latrines. It has two portable sewerage pumps, sludge emptier and a pickup for this work. In general, operational costs and running expenses, is budgeted for and provided by the Municipal Council. Since the service offered by the councils does not satisfy demand, it licenses private pit emptier to supplement this service. However, complaints of overcharging and lack of professionalism have been voiced by customers.

Capital projects are funded by the central government. For example, the government funded the extension of the existing sewerage system in Mombasa Island to cover the entire island and provide for pre-treatment of the sewage before disposal at deep sea. In north Mainland, there are plans to collect all the sewage from the entire mainland to a treatment plant located at Bamburi and dispose the pretreated sewage to the deep sea outside the reef. This was to be implemented in stage I. Stage II would see the extension of the sewer system to Port Tudor and the enlargement of the treatment plant. Stage III would see the extensions to the Bamburi works and an additional out-fall pipe. However, these proposals are yet to be implemented. Other capital projects include the improvement of the sewerage systems in West and South Mainland.

In Zanzibar, desludging services in the Municipality is provided by the Zanzibar municipality's sewerage, drainage and solid waste disposal section. A minimal fee is charged for this service. This service is available in the areas outside the Stone Town that are not

served by a sewer system. However, the council has only one truck for desludging activities and generally the service is not adequate. It is therefore common for residents of the municipality to contract individuals to empty their pit latrines for a fee. This is done manually. There are no charges for sewage discharge into the sewer networks.

Capital projects have generally been funded through donor funding. An example is the recently completed rehabilitation and improvement of the Zanzibar sewerage system funded by DEM 15,000,000 German grant.

Other novel approaches are needed to support funding of waste discharged and disposal projects. For example, there is a need for the establishment of a partnership between the public and private sectors in pollution management. Such a partnership can join hands to identify priority concerns - both environmental and social - as well as suggest appropriate management measures to combat the waste problem. Public-private partnership offers opportunities in joint investment in problem solving including the development and financing of sustainable waste management programs, facilities and services as well as the evaluation of management options. This calls for a change in thinking with regard to waste management: Countries in the region should start considering waste (both liquid and solid) as a resource rather than unwanted by-product of human (and animal) activities. For example, organic matter and nutrients should be taken as inputs in production rather than as unwanted waste for disposal. In this regard, waste management can be viewed not only as a measure to protect the environment and human health but also as an opportunity to develop the social well-being of coastal populations through the creation of new commercial activities and possibly to create new jobs. Joint private-public association in waste management can also help direct efforts in combating waste away from *ad hoc* and crisis oriented management approaches to more focused measures.

Private sector involvement can help to:

- i) increase operational efficiencies in the water sector
- ii) provide capital funds for investments

There are a number of options for private sector involvement. These range from private management of existing facilities to the complete sale of water utilities to private sector companies (Kee, 1997; Wong, 1997; Inocentes, 1997; and Rosales, 1997).

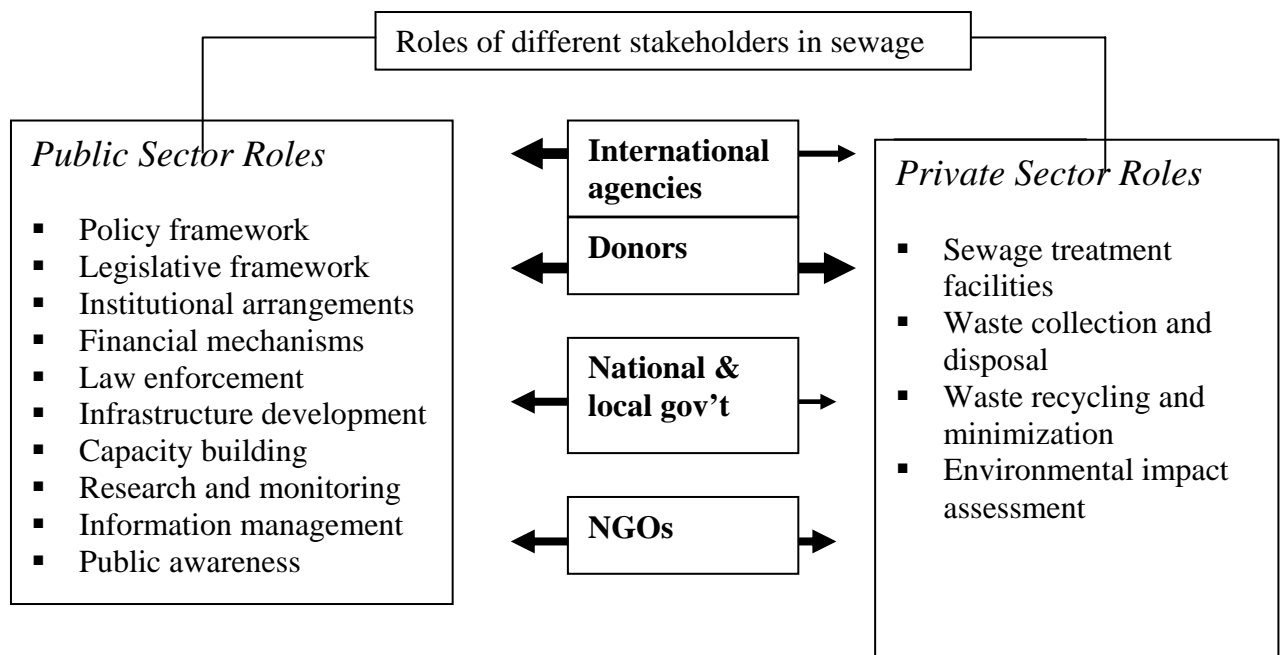


Figure 2: Potential roles and responsibilities of different stakeholders in supporting public–private sector partnership (adopted from Chua, 1997).

4 RECOMMENDED APPROACHES

Analysis of the issues, needs, constraints and challenges with respect to sewage problems in the region provides the basis for identification of several management approaches and measures that could help alleviate the sewage pollution problems in the region. These approaches are broadly categorized into six major areas:

- i) Policy and Integrated Approach
- ii) Stakeholder Involvement and Public Awareness
- iii) Institutional and legal framework
- iv) Financing
- v) Technology
- vi) Regional Initiatives

These categories are discussed in the context of their applicability and relevance to management municipal wastewater in the region.

POLICY AND INTEGRATED APPROACH

Political commitment is critical to the process of formulation and adoption of appropriate policies and enforcement of relevant laws and regulations. All countries in the region have shown high commitment through development of environmental laws and standards, all aiming at addressing sewage pollution and its related problems.

It is the obligation of governments to commit necessary resources to combat the pollution problem in their respective countries including the allocation of sufficient funds in their national budgets.

Recommendations

- i) Incorporate wastewater management within Integrated Coastal Management (ICM) approach. The ICM approach provides the necessary mechanisms, including options and measures with respect to environmental management, in dealing with cross-sectoral co-ordination and integration (Chua, 1993).
- ii) For the purpose of consolidating the functions of different authorities dealing with sewage matters and to establish clearly a set of realistic and enforceable standards, regulatory and enforcement authority, the regulatory and operational functions should be separated and that all the corresponding Acts are amended to reflect this change
- iii) Enactment of Environmental Protection Act which will provide clear effluent and emissions compliance standards and corresponding mechanisms for enforcements of such controls.
- iv) Integration of water supply and sanitation services schemes. Most of the governments in the region have directed more efforts in water supply programmes than in the provision of adequate sanitation services. This has led to sanitation services to lag far behind water supply development programmes.
- v) Integration of solid and wastewater management services. In the absence of an effective waste management service, a significant proportion of solid waste is disposed of in to sewerage systems and this is a primary cause of blockages within the systems
- vi) Appropriate site selection procedures for major investments on the coastal zone should be developed. They should include recommended procedures for wastewater discharge and its proper disposal.

STAKEHOLDER INVOLVEMENT AND PUBLIC AWARENESS

Raising public awareness and knowledge about sanitary practices and conditions must continue to be a central feature of environmental sanitation projects. For sanitation projects to succeed, educational/public awareness programmes should be conducted during planning and implementation of projects.

Extensive education and information campaigns are needed on the threats and impacts of sewage pollution to coastal and marine environments to secure greater public awareness and support. Such awareness campaigns may take the form of cleanliness contest and media exposure.

Recommendations

- i) Support the development of community stakeholder groups with the mandate to participate in environmental improvement and management
- ii) Create awareness among stakeholders to ensure that key concepts are understood and that people have a strong sense of connection with their own use of water.

INSTITUTIONAL AND LEGAL FRAMEWORK

Effective sewage management requires adequate legislation, such that laws cover every aspect that needs to be regulated. The effectiveness of such laws and regulations is dependent on whether they are enforceable. An important prerequisite for ensuring the enforcement of laws requires that there be in place a system to monitor the quantity and quality of effluent discharged into the waters. Although this is a legal requirement, most regulatory and enforcement agencies in the region do not have adequate technical and financial capacities to develop a system of monitoring the quantity and quality of sewage effluent discharged into waterways. Without the setting up of such a system, such agencies cannot determine whether or not treatment plants, for example, are in compliance with water pollution effluent standards or not.

Recommendations

- i) Effort should be made to provide models for consideration in defining management approach including policies and laws that are relevant to the regional situation. On a case by case basis, to consider the amalgamation or separation of water and wastewater management where necessary
- ii) Collection, collation and synthesizing of appropriate information with the specific intention of devising ways to more equitably distribute the burden and gains derived from effective wastewater management
- iii) To encourage Public – Private Partnership (PPP) in wastewater management by establishing proper policy and legal framework; through capacity building and by creating the required awareness
- iv) There should be initiated pilot or case studies targeted at testing or examining key aspects of wastewater management in the WIO region as a way to promoting alternative wastewater management approaches
- v) There should be established an environmental monitoring programme being an essential ingredient for determining the pressure on resources, trends in environmental quality, and compliance with regulatory provisions. It also provides the mechanisms for determining the likely effects of alternative future development strategies

FINANCING

Given the limited financial resources of the countries in the region, innovative domestic as well as international financing options should be sought. For example, in addition to the financing opportunity offered by the public-private partnership, other domestic financing options such as those that can be achieved through linking pollution management program to public investment plans need to be investigated. Other options including the application of the polluter pays principle. Adoption of this principle has a strong appeal since it can also act as a precautionary measure against wanton pollution given the fact that a potential polluter will avoid risking a financial penalty on polluting the environment. Other local sources of financial and material support include commercial enterprises such as major ports and industrial complexes. On the other hand, donor funds can be solicited to support institutional strengthening, human resource development and to support research.

Recommendations

- i) In light of the limited financial resources of national and local governments in the region, it is necessary that financial resources are mobilised to support sewerage development and rehabilitation programmes, from international organisations, international institutions and bilateral donors. African Development Bank and World Bank have provided loans to support a number of water supply and sewerage development programmes in the region. For example, the African Development Bank (ADB) provided a loan to construct the Greater Victoria Sewerage Project, while the World Bank provided a loan to Government of Tanzania to rehabilitate the sewage system in Dar es Salaam.
- ii) The use of a realistic billing system is essential for customer compliance. To achieve this, it is important to establish realistic tariffs, use of good quality meters and to improve quality of service. This will ensure effective cost recovery, which is essential for the sustainable delivery of water supply and sewerage services.
- iii) Countries with water supply and sewerage services under public institutions should move gradually towards privatization. Access more information on successful privatized system to support on going processes
- iv) Assessment of socio-economic impacts has not been sufficiently looked into socio-economic class differences and there is a need to elucidate differences for use in user pay strategies.

TECHNOLOGY

The handling and treatment of different types of wastes demands increasing economic resources. Infrastructural and technical developments to reduce waste formation, improve recycling and improve waste logistics (avoiding dilution and mixing if possible) as well as waste transformation and safe final disposal, should significantly improve the situation, and should have immediate positive effects on waste management costs.

Recommendations

- i) Tested non-conventional wastewater treatment technologies should be adopted. These include natural and artificial soil filtration and multi-level biological systems based on natural and artificial wetlands. Other biological systems include those based on macro-and microphyte and microbial based systems for selective uptake and concentrations of pollutants such as nutrients and heavy metals.
- ii) Another recommended approach is the use of self-designed or engineered eco-systems (ecological engineering) for waste treatment. In order to facilitate access to such technologies, governments in the region should create conducive environments, such as economic incentives, to encourage private sector participation
- iii) Decision-makers should work to ensure that acceptable environmental standards are taken into consideration in determining the solution to wastewater problem solving. There is a general lack of sensitivity in management toward the receiving environment. Engineering outcomes are often a stronger driver for management than environmental outcomes, especially with regard to long-term environmental consequence and sustainability.

Re-Use of Sewage

Restricted use of treated domestic wastewater is taking place in a number of countries in southern Africa. According to SADC et. al., (1994), Windhoek, Namibia was recycling 13 per cent of its wastewater for domestic consumption in 1994, while Harare, Zimbabwe was recycling 10 per cent. Gaborone, in Botswana was planning to recycle 60 per cent of its urban flow by the year 2020.

Use of wastewater is an issue gaining importance throughout the developing world, as water sources become scarcer and competition for them increases. In Peru, research has shown the technical, economic and social feasibility of growing fish in wastewater. Such fish farms recover 100 % of the wastewater treatment costs (Prein, 1995).

Most tourist hotels in the coastal areas have extensive gardens which use large amounts of water for irrigation. Given the fact that the soils in some of these countries have poor storage capacity, high evaporation and species planted are not adapted to arid conditions, a lot of water is used for irrigation . Wastewater reuse in tourist hotels for irrigation purposes should be promoted, even though caution must be exercised to ensure its use does not cause any environmental or health hazards.

Recommendations

- i) Treated sewage water should be used in a number of ways. These include irrigation of farmlands, in watering gardens and in the industrial sector. A ‘no-discharge’ policy regarding sewage should be encouraged in the region.

REGIONAL INITIATIVES

The Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region (Nairobi Convention) and its related protocols concerning Protected Areas and Marine Pollution provides the legal basis for marine environmental action in the region.

Recommendations

- i) Need for a harmonised approach to the adoption and implementation of regional effluent standards at the national level. The approach to setting environmental standards is highly variable across the region and generally does not reflect the character of the receiving environment.
- ii) Initiation of the process of enacting a protocol on land-based sources and activities to help combat, prevent and reduce marine and coastal pollution in the Eastern African region. The protocol should have a detailed scientific and technical annexes, including an “Annex on municipal wastewater”
- iii) Facilitate the implementation of the Twining Arrangement between the Nairobi Convention and the Baltic Marine Environment Protection Commission (HELCOM)(Annex I)

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Annex I: Twinning arrangement between Nairobi Convention and HELCOM

Twinning Arrangement between the Baltic Marine Environment Protection Commission and UNEP's Regional Seas Programme for the Eastern African Region

NOTING that the Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1992, *inter alia*, provides for a legal regime for the prevention of pollution of the sea by land-based sources and for the protection of marine and coastal biological diversity (habitats and species);

NOTING ALSO that the Second Global Meeting of the Regional Seas Conventions and Action Plans held in the Hague, the Netherlands, from 5-8 July 1999 asked UNEP to strengthen horizontal co-operation and ties among regional seas conventions and action plans as well as other relevant organizations;

NOTING FURTHER that the Contracting Parties to the Nairobi Convention requested the Executive Director, UNEP, to explore the possibilities of developing twinning arrangements with the Helsinki Commission among other regional seas programmes and conventions (cf. Decision CP2/5 (d) from 2-4 November 1999);

RECALLING that the Global Programme of Action for the Protection of the Marine Environment from Land-based Sources under the United Nations Environment Programme (UNEP/GPA) aims at preventing the degradation of the marine environment from land-based activities by facilitating the realization of the duty of States to preserve and protect the marine environment,

RECALLING ALSO the decisions taken at the nineteenth and twentieth sessions of the UNEP Governing Council prioritizing measures to be taken to address pollution by sewage from land-based sources and to this end the development of the draft UNEP/GPA "Strategic Action Plan to Address Sewage as a Major Land-based Pollutant";

RECALLING FURTHER the identification of the following priority issues for partnerships and cooperation in the Eastern African Region; a) strategic Action Plan on Sewage in the framework of the UNEP/GPA, b) development of a protocol on land-based sources of pollution to the Nairobi Convention; and/or c) development of Integrated Coastal Area Management policies and programmes;

BEING AWARE OF the decision of the Helsinki Commission (HELCOM) during HELCOM EXTRA 99 Meeting that HELCOM should take an active role in working with other organizations responsible for environmental management of major drainage basins, coastal areas and marine systems to identify lessons learned and transfer experience and to this end the decision of the First Meeting of HELCOM Heads of Delegation (HELCOM HOD 1/99) to authorize the Executive Secretary of the Commission to make necessary arrangements for the co-operation with UNEP/GPA;

MINDFUL of the potential in the transfer of experience and knowledge from more mature organizations and conventions with long experience to more recent organizations and conventions;

DECIDES to identify the lessons learned and transfer experience between HELCOM and UNEP's Regional Seas Programme for the Eastern African Region, in particular in relation to:

Monitoring and Assessment

- 1) the Pollution Load monitoring programme for monitoring of emissions and depositions as well as riverine load and discharges from point and non-point sources within the whole drainage area, leading to periodic assessments of both waterborne and airborne pollution loads entering the Baltic Sea Area;
- 2) the COMBINE programme for the coastal and marine environmental monitoring leading to periodic assessments of the environmental state of the marine environment of the Baltic Sea Area, including the programme for monitoring and assessment of the radioactive substances in the Baltic Sea Area;

Prevention of Pollution from Land-based Sources

- 3) the work related to the development of HELCOM Recommendations to reduce pollution from land-based sources, including the development of more specific targets for the reduction of discharges of nutrients and hazardous substances from point and non-point sources in order to reach a 50 % reduction in the pollution load entering the Baltic Sea Area (cf. the 1988 Ministerial Declaration);

Nature Conservation and Coastal Zone Management

- 4) the work related to the development of a publication describing, classifying and assessing the status of all Baltic marine and coastal biotopes (the "Red List of Marine and Coastal Biotopes and Biotope Complexes of the Baltic Sea, Belt Sea and Kattegat", BSEP No. 75);
- 5) the work related to the preparation of Integrated Coastal Zone Management Plans for five specified areas on the Baltic Sea coast and the initiation of the implementation thereof, as well as preparation of guidelines for coastal zone management in the Baltic Sea Area;

The Baltic Sea Joint Comprehensive Environmental Action Programme and the involvement of International Financial Institutions

- 6) the work related to the elaboration and implementation of the Baltic Sea Joint Comprehensive Environmental Action Programme (JCP) and the role of the International Financial Institutions in financing the investments needed for implementing the Programme;

DECIDES FURTHER that activities under this twinning arrangement will include:

- 7) participation in relevant meetings and workshops under the frame of the Helsinki Convention, such as meetings within the Land-based Pollution Group, the Monitoring and Assessment Group, the Nature Conservation and Coastal Zone Management Group and the Programme Implementation Task Force as well as their sub-groups and project groups;
- 8) participation in work carried out under the frame of the Helsinki Convention related to facilitating involvement and support from the business and financial communities and specifically participation in an extended meeting of the Programme Implementation Task Force (PITF) in the Autumn 2000 dedicated to identifying new ways of co-operation between PITF, the PITF member countries, the International Financial Institutions and other business and financial communities in the field of investments;

- 9) participation in training and research programmes carried out by the Contracting Parties and related to water and environmental management; and
- 10) identification of the possible involvement of individual Contracting Parties.

Signed on behalf of
the Helsinki Commission

Signed on behalf of UNEP's
Regional Seas Programme
for the Eastern African Region

Mieczysław S. Ostojski
Executive Secretary
Helsinki Commission

Klaus Töpfer
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