

Causal chain analysis

This section aims to identify the root causes of the environmental and socio-economic impacts resulting from those issues and concerns that were prioritised during the assessment, so that appropriate policy interventions can be developed and focused where they will yield the greatest benefits for the region. In order to achieve this aim, the analysis involves a step-by-step process that identifies the most important causal links between the environmental and socio-economic impacts, their immediate causes, the human activities and economic sectors responsible and, finally, the root causes that determine the behaviour of those sectors. The GIWA Causal chain analysis also recognises that, within each region, there is often enormous variation in capacity and great social, cultural, political and environmental diversity. In order to ensure that the final outcomes of the GIWA are viable options for future remediation, the Causal chain analyses of the GIWA adopt relatively simple and practical analytical models and focus on specific sites within the region. For further details, please refer to the chapter describing the GIWA methodology.

Introduction

The focus of the Causal Chain Analysis (CCA) is to determine the source, underlying constraints and the root causes of the solid waste issue in the Indian Ocean Islands region. Solid waste management and disposal is a major environmental concern in all the four island states. Besides a number of unmanaged dumping sites and uncontrolled landfilling in Comoros and Madagascar, the dumping of solid wastes in rivers, on beaches and in the sea is common practice. This also used to be the situation in Seychelles and Mauritius, but these activities have been discontinued through adoption of a national solid waste management plan and provision of the necessary infrastructure, where both countries have made considerable investments. For example, Seychelles has

invested over 6 to 8 million USD in solid waste management over the last 10 years. Solid waste management is indeed very complex; for example, setting up refundable deposit systems, variable taxes on collection and siting of landfills in a way that does not harm the environment or people. Developing the appropriate mechanisms and capacity to control the entire process from waste generation and collection through to appropriate disposal requires an integrated approach.

Many of the states in the region have undergone a profound shift in consumption patterns in the past decades. One of the main drivers of consumerism has been the flood of products from developed countries and newly industrialised countries, particularly in South East Asia. For example, plastic packed food, polystyrene plates and aluminium cans came into fashion as fast food became popular with an increase in the purchasing power of the people. Improvements in travel, tourism and access to foreign markets, coupled with the influence of television have also had a profound impact on the consumption patterns of members of the public. The results of these changes are multifaceted, ranging from increase in solid wastes generation to obesity which can be seen as precursors of an affluent society. On the other hand, increase in fisheries development has also brought about additional problems such as nets and buoys that are constantly being washed ashore on many of the small islands in the archipelago.

The reasoning behind the choice of focusing the causal chain analysis on solid waste can be argued against, but because the extent of the problem is not the same on each island and each island suffers from significant amounts of solid wastes found lying in the street, some of which get washed up daily on beaches, the imperative to address the issue becomes even stronger.

The assumptions concerning the nature of the solid waste problem based upon the review in the previous section, Assessment, is summarised below:

- There has been a general increase in the consumption of packaged goods and other waste-related products in all four island states;
- The human generation of solid wastes has increased;
- Poor solid waste collection service is in place;
- There is generally a lack of appropriate land for the location of disposal facilities;
- Explosion in vermin and mosquitoes, which are disease-vectors, is common in many parts of Madagascar and Comoros;
- Overall, solid wastes have been found to clog up drains leading to flooding;
- There is an overall lack of in-country capacity to deal with the disposal of the waste;
- Some solid wastes would degrade or leach chemicals over time with long-term effects.

Furthermore, the impacts of wastes are also transboundary, both as a function of human movement and dispersal through natural forces such as wind and ocean currents. Transboundary issues that are relevant in this analysis include:

- Waste such as marine debris which floats and affects wildlife;
- Waste that get carried by ocean current to other islands and countries;
- Disposal of solid waste at sea;
- Waste that is dumped by boats, especially fishing vessels;
- Discarded fishing gear, which cannot be recovered, often remains in the ocean affecting wildlife for many years;
- The leaching of wastes into the marine environment, including accumulation in the food web;
- The commercial transport of waste to be disposed or recycled in another island state can be dumped on the high seas to minimise costs of treatment.

Methodology

Clearly, there has been much work done in other countries on the issue of integrated solid waste management, but it is necessary that this report emphasises, where possible, the local conditions required for the development of a suitable policy model to address the identified root causes.

Based on the discussion in the previous section, Assessment, combined with current available knowledge on the issue, the causal chain for the problem of solid waste was constructed. To facilitate the assessment a

Table 19 Proxy indicators developed to facilitate and ensure comparability of the assessment in the region.

Indicators	Linkages					
	T	I	II	III	IV	V
E1	Habitat loss – the ratio of solid waste collected/not collected	✓			✓	
E2	Area used for solid waste disposal			✓	✓	
E3	Amount of solid waste removed from rivers and drains	✓	✓	✓	✓	✓
E4	Quantity collected during Clean-up-the-World Campaign	✓		✓		
E5	Number of wildlife affected by marine debris	✓	✓		✓	✓
E6	Quantity of solid wastes collected on beaches	✓		✓	✓	✓
C1	Cost of collection			✓		✓
C2	Cost of treatment and disposal			✓		
C3	Clean-up costs		✓	✓		
H1	Cost of pest eradication				✓	✓
H2	Number of cholera cases		✓			✓
S1	Cost of litigation (Not in my back yard)					✓
S2	Proportion of population affected by location of discharge			✓		
S3	Bins/collection sites per capita			✓		

Note: E = environmental indicator; C = economic indicator; H = health indicator; S = social indicator; T = transboundary relevance; I to V = the five GIWA concerns.

Table 20 Characteristics of sites selected for the Causal chain analysis

Country	Sites	Area (km ²)	Population
Comoros	Grande Comore Island	1 025	250 000
Madagascar	Antananarivo City (mainly)	30	1.5 million
Mauritius	Mauritius Island	1 865	1.2 million
Seychelles	Mahe Island	154	60 000

(Source: GIWA Task team calculations 2003)

series of proxy indicators were developed (see Table 19). The selection of those indicators was based upon an assessment of availability of data and adequacy of the data.

The choice of a definite geographical site for the CCA is problematic in view of the small size of some islands, e.g. Seychelles, where data is aggregated at national level, and large islands, e.g. Madagascar where data for some indicators are available in one area only. Secondly, the transboundary impacts can extend beyond several thousand miles. The final selection of sites for the CCA is given in Table 20.

The immediate causes of solid waste

The immediate causes of the problem of solid wastes are linked to the main sources generating these wastes, viz:

Municipal/industrial solid wastes – i.e. solid waste generated from urban and industrial centres. Such wastes are usually domestic, combined with industrial, which includes wastes from manufacturing industries as well as service industries, such as tourism establishments. Such wastes are mixed consisting of both organic, biodegradable and non-biodegradable components (ITW 1994).

Discards from beach users – includes solid wastes that are dumped on the beach by users, tourists, and so on. Such waste consists of plastics, cigarette butts, empty bottles (Payet 1996) and in some areas wastes similar to municipal wastes.

Sewage related debris – these are mainly originating from wastewater treatment outfalls in the major cities. This cannot be quantified but hypodermic needles, plastics, and other small items which have been observed.

Among those three listed immediate causes, the municipal and industrial wastes are the most significant in the region. As discussed in the previous section, at least 2.8 million tonnes of solid wastes are generated in the region, of which only 30% are collected routinely and beach deposited rubbish is estimated to be about 40 640 tonnes.

Sector activities that generate solid waste

Sector-based data on solid wastes is not available in the region, except for Seychelles (Figure 20). However, from the analysis in the previous section, and observations of the authors, the following sectors in order of priority are the highest generators of solid wastes in the region.

Urbanisation and consumption – As presented in the socio-economic characteristics of the region above, coastal urbanisation is likely to double in Comoros and Madagascar by year 2015, with moderate growth in Seychelles and Mauritius. An increase in human settlement will lead to an increase in solid waste generation.

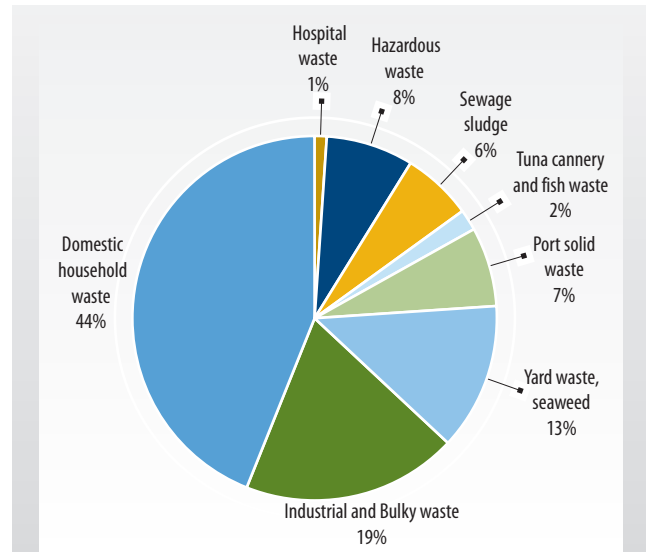


Figure 20 Solid waste sources in Seychelles.
(Source: ITW 1994)

Industry – Will not likely increase beyond what it is now, due to emerging trade opportunities, but will continue to generate significant amounts of wastes. For example, growth in the industrial base in Madagascar due to its low cost of labour, or growth of tourism in Seychelles and Mauritius, will all likely contribute to an increase in solid wastes generated.

Transport – Will likely increase to meet tourism and trade demands. Additional tourism opportunities will be explored which may create growth in the sector. Both Madagascar and Comoros are functioning well below normal tourism trends, implying there is great potential for growth.

Between 30-50% of all solid waste generated comes from domestic sources (Figure 20). The domestic sector is therefore the primary waste generator followed by industry. Due to relatively low levels of transport in the Indian Ocean Islands region compared with many other regions, such as the Caribbean, wastes generated by this sector are expected not to exceed 10% of total generated wastes.

Root cause analysis

The determination of root causes can be a complex task especially where the problem is linked to other social and economic issues. The main root causes identified are, in order of priority:

Root cause 1: Lack of investment planning and priorities.

Root cause 2: Lack of effective mechanisms, inadequate institutional structure, laws and capacity.

Root cause 3: Lack of adequate facilities, services for collection and management of wastes.

Root cause 4: Lack of education and awareness.

However, to undertake an in-depth analysis of these root causes, it is important that the following issues are also considered. The scope of each of these root causes is discussed in detail.

Root cause 1: Lack of investment planning and priorities

National development planning is a critical process whereby national priorities are defined, and in many countries the World Bank and various UN agencies provide support for the development and implementation of national development plans. In Seychelles, national development planning has existed since the early 1980s, but it was only at the beginning of the 1990s that sustainable development issues were specifically integrated as part of national planning.

The Environment Management Plan framework has been the primary driver for implementation of solid waste management policies within the national development process in all the countries in the region. In the case of Mauritius and Seychelles, the issue of solid waste management was clearly identified in the Environment Management Plan, and significant funding was dedicated to address the problem. Being ACP (African-Caribbean-Pacific) countries within the European Union Cooperation Programme, both countries benefited from European expertise to establish integrated solid waste management programmes. This included the identification and development of fully engineered landfills (disposal options), improvements in the waste collection service with participation from the private sector and exploring other aspects of solid waste management such as composting, recycling and recovery. However, both Madagascar and Comoros are still in the very early stages of developing integrated waste management approaches.

In spite of this progress, as indicated in the previous section, Assessment, a number of problems still exist such as lack of adequate land for solid waste disposal, reduction of littering, and most importantly putting in place a sustainable financing mechanism for finalising solid waste management in the long-term. In Seychelles, for example, people are not directly charged for solid waste collection, but instead the annual budget for solid waste management is sourced from the government

budget. One of the factors that cannot be addressed in the short-term is the problem of population growth and increasing purchasing power. Although it is a root cause in itself, the problem lies at the centre of national planning and therefore deserves some treatment to illustrate the linkages and how the population problem affects this root cause.

Population changes

The population growth and projections to year 2015 for the region are given in Table 21. Madagascar, the largest country will have the largest population, with probably the largest impact in the region. Madagascar's population will effectively double by 2015, but growth rates are expected to decline from 3% to about 2.5 %. Population growth in both Seychelles and Mauritius will be low.

Table 21 Population growth.

Country/ Region	1975 (million)	1998 (million)	2015 (million)	Population growth rate % (1998-2015)
Comoros	0.3	0.7	1.0	2.5
Madagascar	7.8	15.1	23.4	2.6
Mauritius	0.9	1.1	1.3	0.8
Seychelles	0.06	0.08	0.10	0.87
Indian Ocean Islands	9.06	16.98	25.8	~2.5

(Source: UNDP 2000)

Solid waste generation is closely linked to the economic growth of the country and the purchasing power of its people. Considering the figures given on the GDP, it is likely that the amount of wastes currently generated will increase (Table 23). For example, in Mauritius, about 0.7 kg of solid waste per person per day is generated, which will likely increase to 0.9 kg by the year 2010. In Seychelles, solid waste generation is about 0.39 kg (1994 estimate) per person per day and it is estimated that this will likely increase to 0.53 by 2015 (UNDP 2000). For Comoros and Madagascar per capita data is estimated to be about 0.1-0.2 and 0.2-0.4 kg per person per day, respectively. Tourism development in the region will also increase solid waste generation.

Movement of the population within Comoros and Madagascar will be mainly influenced by better job opportunities and livelihood in the cities (Table 22). In Mauritius, the urbanisation rate has decreased due to government policies for providing good communication and services within the communities. In the case of Seychelles, urbanisation is strongly influenced by the lack of land for communities to expand in view of high conservation value of many areas, and therefore population centres will be planned development on the reclaimed areas around the city of Victoria.

Table 22 Changes in urban population.

Country/ Region	1975 (%)	1998 (%)	2015 (%)
Comoros	21.2	32.1	42.6
Madagascar	16.1	28.3	39.3
Mauritius	43.4	40.9	48.6
Seychelles	33.3	56.9	67.3
Indian Ocean Islands	28.5	40.0	50.0

(Source: UNDP 2000)

Solid waste is an issue that should remain a national priority, as it is closely related to the performance of the economy, especially if it depends upon tourism. Compared with other investments such as water and sewage, solid waste collection services entail huge costs every year, and policies aimed at reducing those costs whilst maximising the amount of waste collected would be the optimum approach. To achieve this optimum, a number of policy instruments will need to work together, as discussed in the next section. However, to implement any of these policy instruments consistent political will, national planning and a dedicated government budget is required every year.

Whilst the role of government in solid waste management is undoubtedly important, mechanisms should be put in place for private sector involvement and re-investment in the sector. These could then create the right investment environment for recycling, deposit-on-return, zero-packaging, green eco-labels and other schemes.

Root cause 2: Lack of effective mechanisms, inadequate institutional structure, laws and capacity

Mechanisms

The quantity of solid waste generated is closely linked with economic development. The states within the region can be conveniently divided into groups depending on the economic data presented in Table 23 and also in Table 8 and 9.

In Mauritius and Seychelles, it is envisaged that solid waste generation will continue to increase with increases in population, consumption and development activity being pushed towards the private sector (Table 24). However, Madagascar is expected to experience much more rapid growth, depending upon political stability and reform policies being implemented. In order to promote national unity and investments at community level, the government is likely to become increasingly involved to ensure better management at grass roots level and also

serve to tackle some of the ingrained problems related to ecosystem degradation in Madagascar. This kind of analysis is based upon expert views rather than an analysis of available data. Table 25 is a further extension of this analysis which considers the magnitude of changes in output between now and the year 2020.

The size of change in output was difficult to determine due to lack of data and macro-economic scenarios for the region. Based upon past and historical data in economic growth, the proposals have been summarised in Table 25. Whilst it is expected that there will be increased industrialisation in Madagascar and Mauritius, Seychelles and Comoros will likely become more service oriented. Imports of goods are likely to generate more solid waste, and increased production will also increase

Table 23 Economic indicators.

	GDP 1995 (USD billion)	GDP annual growth rate 1980-1996 (%)
Comoros	0.2	2.0
Madagascar	3.2	-0.1
Mauritius	3.8	5.7
Seychelles	0.5	3.3

(Source: UNDP 2000)

Table 24 Likely changes in private and government consumption.

Country	Consumption 1998 (as % of GDP)		Consumption 2020	
	Private	Government	Private	Government
Comoros	93.8	11.6	+	++
Madagascar	88.6	6.1	+	+
Mauritius	65.0	11.0	+	-
Seychelles	65.7	17.0	+	-

Note: + = increase, - = decrease. (Source: UNDP 2000)

Table 25 Expected output change to the year 2020.

	Exports of goods & Services	Imports of Goods & Services	GDP
Comoros	+	+	+/-
Madagascar	++	+	+/-
Mauritius	++	+	+
Seychelles	+	+	+

Note: + = increase, - = decrease. (Source: GIWA task team calculations 2003)

solid waste as a by-product and as a product of consumption. The GDP of Madagascar and Comoros may or may not increase depending upon political stability and economic reform. The GDP of Mauritius and Seychelles will likely continue to increase.

Growth in the shipping industry is closely linked to the economic prosperity and consequently the trade input/output from the country. The countries in the region have considerable outputs in terms of both fisheries (Mauritius, Madagascar and Seychelles) and agriculture (Mauritius, Madagascar and Comoros). Marine transport being the cheapest and most favoured is thus the most important link between these islands and the world trade centres. However, with this increase in trade, an increase in marine wastes is highly probable. This is further exacerbated by ports in the region competing for the least cost. Competing on the basis of least cost foregoes the option of provision of waste reception facilities, as these can have a high cost associated with them.

Taxes and subsidies for solid waste management in the region are not well developed. There are taxes on consumer products, highest in the Seychelles, and this lowers customer purchasing power and has an effect on solid waste generation. Restrictions in availability of consumer products due to lack of convertible currencies in Seychelles, Madagascar and Comoros also results in less waste being generated.

In Mauritius, the government spends nearly 25 million USD per year (that is about 21 USD per person) for the collection, transportation and disposal of refuse waste. In Seychelles, spending is about 6 million USD per year or about 57 USD per person.

Legal

The institutional and legal framework for countries in the region is discussed in detail the first section of this report but the most salient points are worth emphasising here..

Mauritius addressed the issue of solid waste management by the creation of the Department of Environment in 1989 and the enactment of the Environment Protection Act (EPA) in 1991 (revised in 2002). Under Section 6 of the EPA 1991, it is the duty of the Minister of Environment to propose and develop policies on all aspects of environment protection and management pursuant to national objectives and goals set by the National Environment Commission. The Department of Environment of the Ministry of Environment functions as the Waste Regulation Authority and it formulates policies on waste management. The Environment Protection (Polyethylene Terephthalate (PET) Bottle

Permit) Regulations has been promulgated in 2001 under the EPA. The aim of these regulations is to develop "product responsibility" among bottlers for the proper management of the bottles after distribution. Bottlers, grouped in an association, have put up a system of collection of used PET bottles which are exported for recycling.

However, close monitoring is required and, to date, these regulations have not been enforced due to lack of staff. The polluter pays principle has been adopted where the 'Police de L'Environnement' issue fines if somebody is caught littering. This unit was created in December 2000 and is based at the Ministry of Environment. Its main functions are to enforce the laws (EPA, Local Government Act, Noise Prevention Act etc.). It comprises 26 policemen who work in a shift system to ensure that they are available round the clock. From 1st December 2000 to 2003, 5 897 contraventions have been established for illegal littering and 70 contraventions for illegal dumping under the 'Dumping and Waste Carrier's Regulations, 2003'. However, the number of Policemen of Environment is not enough for the 1.2 million people living in Mauritius. Still, some littering does occur, especially in rivers and other watercourses.

In Seychelles, an authority was created to manage solid wastes. The authority, called the Solid Waste and Cleaning Agency (SWAC), is responsible for solid wastes and hazardous wastes management in the country. It operates through the management of contracts for collection and management of the landfills. The Environment Protection Act 1994, which makes specific provision for the management of solid wastes was utilised to develop subsidiary legislation to deal with solid wastes. To date, SWAC has over 30 staff members who are engaged in various enforcement and supervisory work that covers public collection points, maintaining certain public places, beaches and some drains. SWAC also undertakes several educational and sensitisation activities to promote waste reduction and recycling. Recycling fairs have also been organised to show how waste materials can be recycled into productive uses.

In Madagascar and Comoros, there are no dedicated solid waste management agencies. In Madagascar, management responsibility for solid waste is a function of the municipality, whereas in Comoros, the Ministry of Environment is responsible to issue contracts and ensure collection is done promptly. In both countries there are very few people who are involved in the management of solid wastes.

All the island states in the region are signatories to MARPOL (The International Convention for the Prevention of Pollution from Ships), and should comply to its requirements. However, due to problems linked to the root causes presented here, MARPOL is not at a high

level of implementation in the region. For example, the establishment of reception facilities can be a sound private sector investment but, due to a lack of regional harmonisation, no one is willing to put in the investment and risk those facilities not being used. A regional approach and timetable may be required to resolve the issue.

Root cause 3: Lack of adequate facilities, services for collection and management of wastes

The knowledge of treatment and management of wastes is most advanced in Mauritius and Seychelles. In Comoros and Madagascar, solid waste dumpsites dominate with no significant technology in the treatment of solid waste. Both Mauritius and Seychelles have one fully engineered landfill each, but another sanitary landfill is currently being used in Seychelles waiting for this fully engineered landfill to open.

In Seychelles, use of the fully engineered landfill will depend upon the performance of a solid waste sorting and composting facility, which is already operating, generating compost for local use and export. At this landfill at Anse Royale, only inert wastes, such as glass and certain types of plastics, will be deposited with the remainder being recycled (plastics, metal and waste oil) or converted into compost.

There are no large municipal solid waste incinerators in the region. A few small incinerators (e.g. in Seychelles and Mauritius) are used for special wastes such as hospital wastes.

In all the island states there are various levels of waste recycling, but nothing is done on a large commercial scale, except for a few factories in Mauritius that recycle plastics into other products and convert bagass (fibrous by-product of sugar refining) into energy. In Seychelles, recycling almost occurs at an artisanal scale, probably related to the small quantities produced. In Comoros and Madagascar, recycling is also artisanal but as an alternative livelihood to avoid poverty. Recycling is limited at national level due to the scale of economies, but at regional level there is large potential.

There are no proper reception facilities for ship-generated wastes in the region. It can be concluded that a huge proportion of the solid wastes generated by the shipping industry is dumped at sea, and the remainder in sanitary landfills on land.

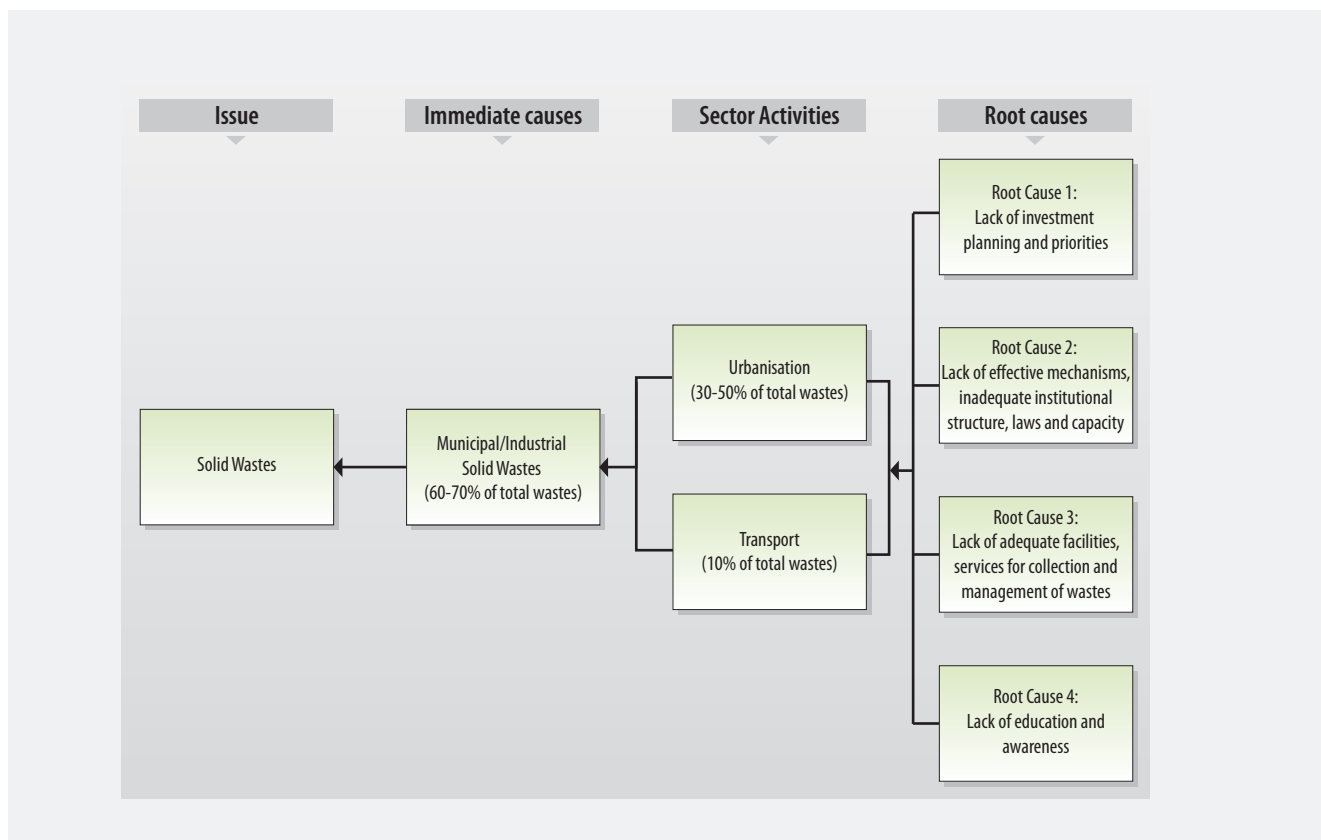


Figure 21 Causal chain diagram for solid waste.

Root cause 4: Lack of education and awareness

Lack of education and awareness is a root cause that transcends all levels of a society. Solid waste education is a specialised field but several activities or initiatives can be launched at national and local level to encourage reduction in waste generation, littering, illegal waste dumping, proper use of the receptacles, recycling, etc.

In the region, some education programmes have been conducted, and the “Clean-up the World Campaign” is held in each country every year. Other initiatives include short programmes on national TV, exhibitions and tips through the eco-home programme in Seychelles.

Despite all these efforts, public education is not easy and it takes years (in some cases as long as a generation) to change habits and tendencies. However, education programmes are done in a haphazard manner and not linked to public responses and a measurement of the improvements achieved is lacking. Solid waste management programmes in the region are therefore fragmented and opportunistic.

An effective combination of mechanisms ranging from enforcement to education and awareness can provide the tools to address this root cause in the short- and long-term.

Conclusions

The root causes elaborated in this section include a consideration of forces that are beyond the immediate control of governments (population growth and urbanisation) and those that can be addressed using a series of policy measures, such as altering consumer patterns and generation of wastes. The conceptual model showing the root causes in the context of the solid waste issue is depicted in Figure 21.

The root causes are closely linked to one another, and to the issues of population growth and economic development, both of which are rather long-term issues.