JUNE 1, 2016

QUICK STUDY ON WASTE MANAGEMENT IN MYANMAR

CURRENT SITUATION AND KEY CHALLENGES

1. Introduction

Myanmar has been facing considerable challenges with the management of waste as a result of increasing income and consumption levels, urban population growth, and lack of effective waste treatment and disposal options. In this regard, the country's Environmental Conservation Law was established with the objective of enabling the implementation of the Myanmar National Environmental policy, which was enacted in 2012. Environmental Conservation Rules have also been developed for the implementation of the Law. Accordingly, Myanmar's environmental conservation law and rules emphasize that the development of national and local waste management strategies are urgently needed. Further to a request for support from Myanmar's Ministry of Environment Conservation and Forestry (MOECAF), the International Environmental Technology Centre (IETC) of the United Nations Environmental Programme (UNEP) has been actively working with national and local governments and other institutions to build capacity for waste management and promote the development of conducive policy framework and strategies. In this regard, the IGES – Centre Collaborating with UNEP on Environmental Technologies (CCET) was selected to provide technical assistance towards the development of waste management strategies at the national and city levels based on a holistic waste management approach: addressing waste in all the forms (solid waste, liquid waste / wastewater, and gaseous emissions), primarily focusing on solid waste but also covering other forms of waste in accordance with the intention and capacity of respective national and local governments.

1.1 Objectives

In line with the above, this quick study aims to review the scope and effectiveness of Myanmar's present waste management system, identify constraints and areas for improvement with a view to meet the country's desired level of performance, and analyse gaps in current waste management policy and practice. The subsequent findings will be used to provide appropriate data for drafting national/ city level waste management strategies aimed at addressing waste issues in a holistic and integrated manner.

1.2. Methodology

The quick study is based on a literature review, technical discussions and personal interviews with relevant staff of the Environmental Conservation Department (ECD) of the Ministry of Natural Resources and Environmental Conservation (MONREC), Yangon City Development Committee (YCDC), Mandalay City Development Committee (MCDC) and Nay Pyi Taw City Development Committee (NCDC), together with site visits to respective waste management facilities.

Figure 1: Inception meeting with relevant officials in Myanmar. Source: Authors, 2016

2. Country Context

Myanmar is the largest country in mainland Southeast Asia with a total land area of 677,000 sq.km[1]. It is strategically located as a potential land bridge between South and Southeast Asia and shares borders with Bangladesh, the People's Republic of China (PRC), India, the Lao People's Democratic Republic, and Thailand (See Fig 2). In addition to its strategic location, Myanmar has vast energy potential largely due to its abundance of natural resources. Myanmar's population is approximately 55 million, increasing at about 0.8% annually-- one of the lowest rates in Southeast Asia[2]. Approximately one-third of Myanmar's population is classified as living in urban areas, while rest of the population lives in rural areas and largely dependent on subsistence farming[3]. The official capital of the country is Nay Pyi Taw, located midway between Myanmar's two largest cities of Yangon, with a population of about 4.6 million, and Mandalay, with a population of about 1.0 million.

Figure 2: Location of Myanmar in South-East Asia.
Source: Government of Myanmar, 2010

The country is divided into seven states (Chin, Kachin, Kayah, Kayin, Mon, Rakhine, and Shan) that mainly encompass hilly and mountainous areas, and are predominantly populated by ethnic communities of the seven regions or divisions (Ayeyarwady, Bago, Magway, Mandalay, Sagaing, Tanintharyi, and Yangon). Similarly, Myanmar's plains region is predominantly populated by people of Bamar ethnic origin. The country's economy is predominantly agriculture based, with rice being the main crop and staple food. The agriculture sector accounts for 60%–70% of total employment and 38% of GDP, which has contracted from 57% in 2001. In contrast, the share of GDP accounted for by the industry sector more than doubled during the same period, to 25%. Liberalization of the economy and opening up to foreign direct investment has prompted rapid growth of the industrial sector, notably through exports of natural gas[4]. In addition, the services sector has been expanding strongly in recent years, and the opening of the economy offers great potential for the development of tourism and related services.

The government that assumed office in March 2011 introduced sweeping reforms, both to the administrative and political process as well as the economic system. In terms of the economic reforms, the country's new Land Law and Foreign Investment Law addresses issues fundamental to development, as does unification of the former multiple exchange rate system. However, underinvestment in urban infrastructure and services including water supply, sanitation, drainage, wastewater, and solid waste management has resulted in significantly deficient urban services throughout Myanmar especially in large urban areas of Yangon and Mandalay. Inadequate water, drainage, and sanitation services, coupled with insufficient investment in preventative health care, have resulted in severe health threats at many levels. The incidence of diarrhea among children under 5 years of age is considerably higher than elsewhere in Southeast Asia, contributing to a high child mortality rate. The high prevalence of debilitating water-related vector borne diseases, such as malaria, dengue, and Chikungunya fever are also directly related to the poor state of critical urban services[5].

[1] Country Presentation for 2nd Regional Meeting of the Regional 3R Forum, 4-6 October 2010, Government of Myanmar
[2] http://data.worldbank.org/indicator/SP.POP.GROW/countries/MM?display=graph
[3] ADB. 2011. *Key Indicators for Asia and the Pacific.* Manila
[4] http://www.themimu.info/sites/themimu.info/files/documents/Report_Urban_Water_Sector_Assessment_ADB_2013.pdf
[5] ADB. 2011. *Key Indicators for Asia and the Pacific.* Manila

2. Overview of Solid Waste Management

2.1. Waste Generation

The industrialization, rapid urbanization, economic growth and changes in consumption patterns have been accompanied by immense challenges in managing the country's solid waste. However, currently there is no accurate and reliable data on the total waste generation in the country. According to the estimation of the World Bank (2012), the current solid waste generation in Myanmar was 5,616 tonnes/day with the per capita waste generation of 0.44 kg/capita/day. This figure was expected to reach about 21,012 tonnes/day with 0.85 kg/capita/day by 2025[6]. Out of the total waste generation in the country, approximately 55% is generated by three major cities including Mandalay (955 tons/day), Yangon (1,981 tons/day), and Nay Pyi Taw (160 tons/day)[7]. Due to the rapid increase of waste generation (See Figure 3 & 4), both Mandalay and City Development Committees have prioritised solid waste management as issues of immediate concern, both in terms of the environment and public health.

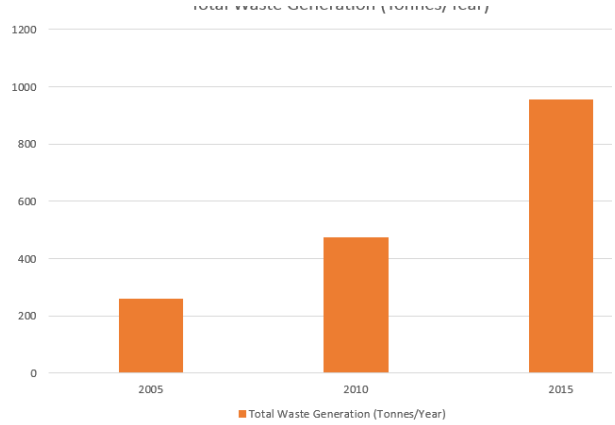

Figure 3: Increase of Waste Generation in Mandalay.
Source: MCDC, 2016

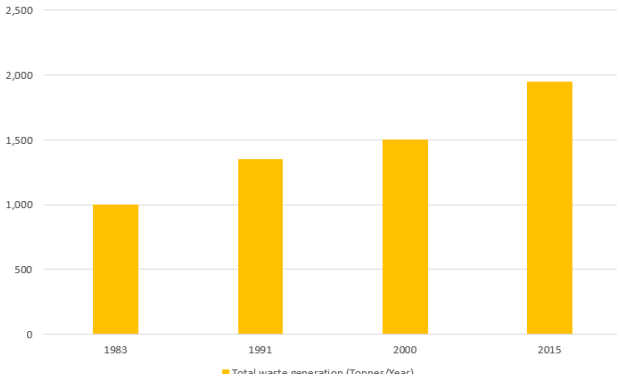

Figure 4: Increase of Waste Generation in Yangon.
Source: YCDC, 2016

Municipal solid waste is defined as the "non-gaseous and non-liquid waste" that results from the daily activities of community's residential and commercial sector within a given administrative urban area. Myanmar's municipal solid waste is generated from households (60%), markets (15%), commercial (10%), hotel (2%), garden (5%) and others (8%). The municipal solid waste is composed mainly of organic materials (77%) while the remainder comprises plastic (13%), paper (7%), and others (3%). This has been largely confirmed by observation and evaluation of the waste composition of Yangon and Mandalay.

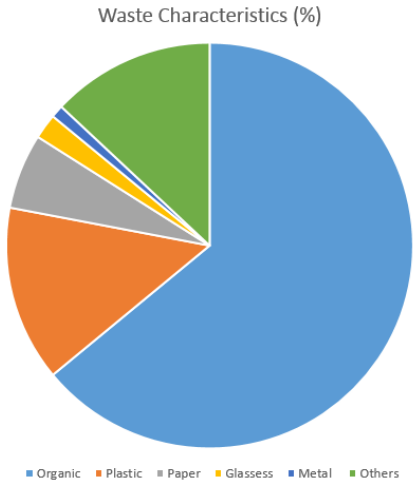

Figure 5: Waste Characteristics in Mandalay.
Source: MCDC, 2016

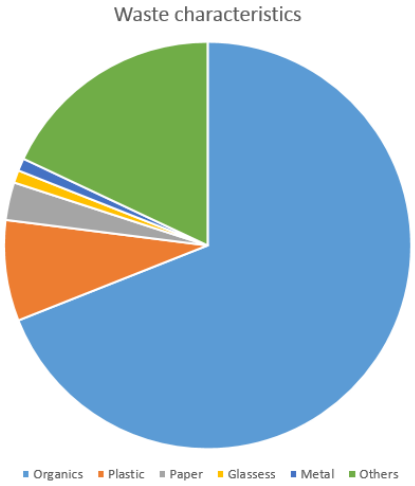

Figure 6: Waste Characteristics in Yangon.
Source: YCDC, 2016

[6] http://siteresources.worldbank.org/INTURBANDEVELOPMENT/Resources/336387-1334852610766/What_a_Waste2012_Final.pdf
[7] Data collected from the respective cities, 2016

2.2. Waste Collection

Traditionally, waste collection and disposal in Myanmar have been the responsibility of local municipal authorities. In Yangon, Mandalay and Nay Pyi Taw, autonomous City Development Committees and their Pollution Control and Cleansing Departments (PCCDs) with their network of administrative branches and sub-units are tasked with solid waste management in municipal areas. In other parts of the country the respective Township Development Committees under the Local Government, which manage municipal waste collection and disposal.

Figure 7: Waste Collection Ratio in Yangon. Source: YCDC, 2016

Figure 8: Waste Collection System in Yangon. Source: YCDC, 2016

Municipal solid waste collection systems in Myanmar cities can largely be characterized as labour intensive, relying on the use of both manual workers and non-specialised vehicles. Waste collection capacity, as measured by the ratio of solid waste collected to total waste generated, has been increasing for many major cities. In general, the current waste collection system includes primary and secondary collection. Primary collection takes place in different forms such as door-to-door (bell collection), block, and container collection methods. The primary waste collection system is carried out either or in combination of push carts and tri-bicycles while secondary collection system is performed mainly with tipper trucks (dumpers).

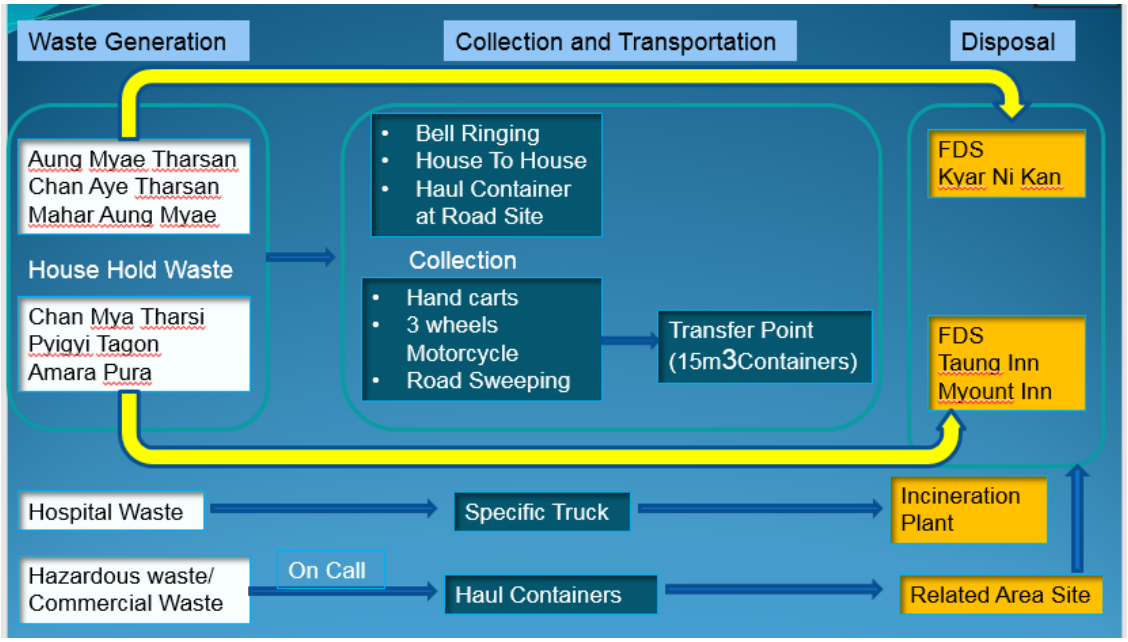

Figure 9: Waste Collection System in Mandalay. Source: MCDC, 2015

2.3. Promotion of 3R (reduce, reuse and recycle) activities

Most cities in Myanmar conduct public awareness raising campaigns and environmental education programmes for local residents to mobilize support for waste reduction and reuse activities. For example, the MCDC has prohibited the production, trading and using the thin plastic bags in its administrative area and use of alternative bags such as string bags, leaves boxes and baskets have been introduced since 2009. Similarly, public awareness programmes have also been implemented by MCDC to promote sustainable lifestyles. Recycling activities are carried out in many cities in Myanmar mostly by the informal sector, including scavengers, waste collectors, and waste dealers. The scavengers and waste collectors collect recyclable materials such as newspapers, metal, plastic bottles, tin and glass from households, communal depots, streets, commercial areas and final disposal sites and in turn sell these items to waste dealers who subsequently clean, sort, store and sell them in bulk to the recycling industry both locally and for export. Currently there is a lack of accurate and reliable data on recycling volumes, ratio and the number of recycling factories in the cities. However, a sample survey carried out in Yangon City identified that 86 tonnes of recyclable materials are directed to the waste dealers per day. Out of this total 57% was glass; cardboard and paper accounted 15% and 13%, respectively. In addition, plastic (7%), tin cans (7%) and other materials such as metal, iron and steel, (1%) are also collected.

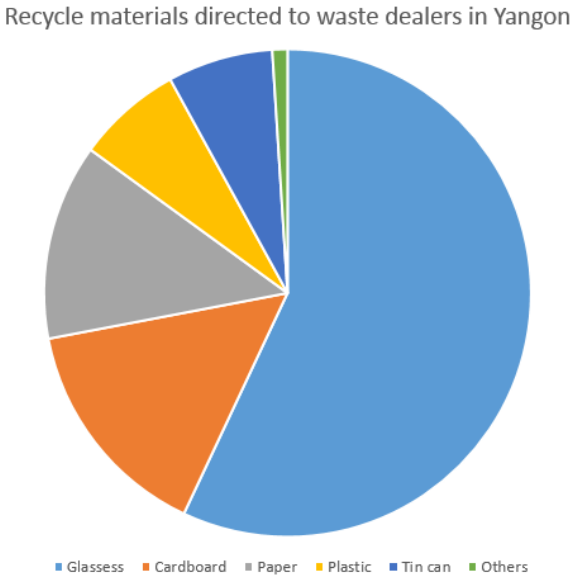

Figure 10: Recycle materials collected in Yangon. Source: YCDC, 2016

Figure 11: Traditional recycling collection and process in Myanmar. Source: Government of Myanmar, 2013

2.4. Treatment and final disposal

At present, waste collected by municipalities is transported to designated dumping sites located within city boundaries. A number of dumping sites that are used for waste dumping were identified in Yangon City and Mandalay City (See Table 1). These are often located about 10 to 25 km away from the city's CBD (central business district) area and were found to comprise approximately 1 hectare or so. The typical duration for dumping in line with onsite capacity was found to be one or two years to a maximum of five years at most. Most dump sites face challenges in terms of operations and management. Transported waste is unloaded on the ground or onto existing waste. Waste is subsequently sorted by waste pickers by hand and manual tools, such as rakes. Following manual sorting, unsorted waste is moved further inside the dumpsite by using mechanical equipment, such as bulldozers. Sorted waste is thereafter packed, stored and transported back to the city for resale. Landfill fires are common which generates dense smoke and noxious fumes. In addition to offensive odours, uncontrolled dumps pose a number of health hazards including from pathogenic organisms, insects, rodents as well as air pollution from dust, accidental burning, and ground and surface water pollution from issues of unaddressed leachate.

Table 1: Landfill Operation in Yangon and Mandalay. Source: YCDC/MCDC, 2016

Location	Capacity (t/d)	Condition	Remarks
Yangon City Development Committee (YCDC)			
Hteinpin	1,080	Open dumping	Operating
Dawai Chang	843	Open dumping	Operating
Shwepyithar	61	Open dumping	Operating
Mingalardon	43	Open dumping	Operating
Dala	33	Open dumping	Operating
Seikyi Khanaungato	4	Open dumping	Operating
Mandalay City Development Committee (MCDC)			
Kyar Ni Kan (North)	450	Open dumping	Operating
Thaung Inn Myount Inn (South)	300	Open dumping	Operating
New Breway factory	142	Open dumping	Closed in 2009
New Kandawgyi lake	80	Open dumping	Closed in 2009
New Zanngkalow pond	28	Open dumping	Closed in 2007
Corner of N/E Mandalay	450	Open dumping	Closed in 2013

It was found that composting was introduced by YCDC in 1999 with an aim to reduce the amount of organic waste sent to landfill with the additional benefit of generating natural fertiliser for farmers. However, the project has discontinued due to absence of technical know-how, lack of monitoring instrument and challenges associated with the sorting process. In addition, MCDC has operated an anaerobic digester (30 tons/day) in Pathein Gyi to treat organic waste collected from the rural part of the city. MCDC also installed an incinerator in Thaung Inn Myount Inn (South) landfill to treat municipal waste (30 tons/day). At present, these are not operational. This indicates that the introduction of waste treatment technologies is still in the early stages, and that measures should be taken to ensure a stepwise transition from pilot to full scale modification of existing MSWM practice.

Figure 12: Landfill operation in Mandalay. Source: Authors, 2016

2.5. Industrial Waste Management

Although Myanmar's economy is largely based on agricultural production, the government is placing increasing emphasis on industrialization. In this regard the government has made efforts to enhance the country's basic infrastructure including, bridges and communication systems to accelerate economic activities. Accordingly, Ministry of Industry is responsible for managing state-owned industries, 18 industrial zones, 3 special economic zones and coordinating with private industries to engage in the industrial sector. Moreover, seven industrial zones will be extended. Notably, the Government has made efforts to encourage the industrial sector to minimize impacts on the environment. For instance, in order to avoid unnecessary pollution and damage on the natural environment caused by industrial waste, the Water and Air Pollution Control Plan (Standing Order No.3) was issued in 1995. In this order, actions to control, reduce and eliminate wastes must be progressively developed and carried out. However, it was found that all major cities (Yangon, Mandalay and Nay Pyi Taw) are facing tremendous challenges with regard to managing industrial waste. Accordingly, all cities are responsible for collecting industrial waste from respective factories but only on-call basis. Consequently, collected waste is often transported to landfill sites without prior treatment. There is currently no reliable data on the generation and collection of industrial waste by the cities. According to YCDC, approximately 150 tons of industrial waste are daily collected by the city.

Figure 13: DOWA Factory in Yangon. Source: Authors, 2016

Table 2 provides common list of waste categories generated from the selected industrial process in Yangon. In Yangon, DOWA ECO-SYSTEM CO., LTD, a subsidiary of DOWA HOLDINGS CO., LTD of Japan has established and begun operating Myanmar's first controlled landfill facility at the Thilawa Special Economic Zone. This area is jointly developed by Myanmar and Japan, with the development of Phase 1 Area (211ha) completed in June 2015. It is planned this site will receive industrial waste not only from the Thilawa Special Economic Zone but across the country. In addition to tackling different discharge sources, and managing the controlled landfill, the new company will provide comprehensive waste management services to cover the collection, transportation, intermediate treatment and recycling of waste according to their different characteristics. In so doing, the company will work to address the waste management needs of different industries whilst helping to contribute to the sustainable industrial development of the country.

Table 2: Types of Industrial Waste Generation in Selected Industries in Yangon. Source: Authors, 2016

Type of Factory	Total no.	Types of Solid wastes		
		Common Types of Generated Solid Waste from Industrial Process		**Domestic Solid Waste from the Industry**
		Industrial Processing waste	**Packaging Processing Waste**	
Clothing Apparel and wearing	10	Textile, A Piece of Leather, Woven, Wool, Carpet, Fibber, Slick, Leftover Cotton, Buttons, Zippers, Elastic Fastener, Hangers, Rubber	Scrap Mental, Metal, Wood, Plastic, Cardboard, Plastic Bags, Plastic string	Kitchen waste (food waste, plastic, paper, glass, metal can, sanitary napkins, tissue paper), Garden Waste
Construction Materials	4	Iron, Steel Scrap, Fly Ash, Wood pieces, Ferruginous Waste- Mill Scale, Flue dust sludge, Non-Ferruginous Waste - Broken Brick, Clay Brick, Acetylene plant Sludge, Stone, Ceramics, Rubber, Gypsum	Plastic bags, Rubber bags, String, Cardboard, Paperboard	Kitchen waste (food waste, plastic, paper, glass, metal can, sanitary napkins, tissue paper), Garden Waste
Electrical Goods	3	Aluminium Products, Wire, Unwanted electrical device, Lithium, Lead Containing Battery, Light Bulbs, Mercury Containing Device, Cathode Ray Tube	Cardboard, Paperboard, Plastic Bags, Corrugated Box	Kitchen waste (food waste, plastic, paper, glass, metal can, sanitary napkins, tissue paper), Garden Waste
Food and Beverages	56	Grain, Yeast, oils and grease; food preparation waste; uneaten food, leftover portions of meals, Leftover Fruits	Cardboard, Paperboard, Steel cans, Aluminium cans, Plastic bottles and Jars, Clear, Amber and Green Glass Jars and Bottles	Kitchen waste (food waste, plastic, paper, glass, metal can, sanitary napkins, tissue paper), Garden Waste

2.6. Medical Waste Management

Overall, health-care waste management practices in Myanmar are substandard although there is basic awareness at all levels about the importance of protecting health workers, visitors to health care facilities and communities living within the vicinity of health-care waste. Cities are responsible for collecting medical waste. Both YCDC and MCDC collect medical waste from large hospitals and special clinics on a daily basis while collection service is provided to smaller facilities once a week or on an on-call basis. Three different colour bags are used for separating the waste: (i) blue or green (YCDC)/ black (MCDC) for non-hazardous health care waste or domestic waste uncontaminated with infectious or pathogenic agents (food residues, paper, cardboard and plastic wrapping); (ii) yellow for pathological waste, infectious waste as well as items that have been used for medical care; and (iii) red for sharps, mainly, but not exclusively, auto-disable or disposal syringes with needles and pharmaceutical waste that consists of outdated drugs or expired unfinished medical solvents. Infectious waste is incinerated or burned in cemeteries while sharp wastes are buried underground in landfills. Other waste is treated as domestic waste. Though there is incomplete information on the current levels of medical waste generation in the country, YCDC and MCDC estimate that on average the medical waste that is generated comprises 280 and 779 tons per year, respectively. A significant portion of this (over 70%) is infectious waste.

Figure 14: Medical waste disposal in landfill site, Nay Pyi Taw. Source: Authors, 2016

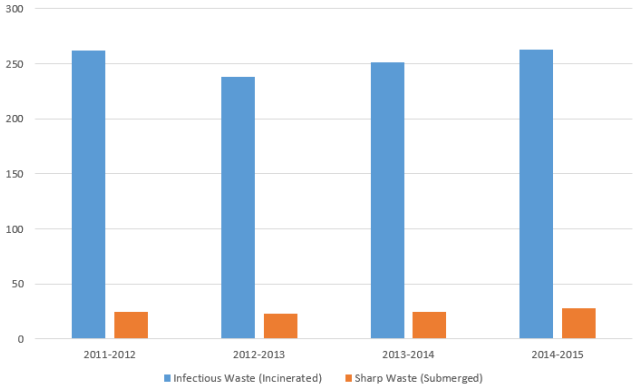

Figure 15: Medical waste generation in Yangon. Source: YCDC, 2016

Figure 16: Medical waste treatment process in Yangon. Source: Government of Myanmar, 2013

2.7. Liquid Waste (Waste Water and Sanitation) Management

Inadequate waste water and sanitation services, combined with underinvestment in preventative health care, have resulted in significant environmental and human health challenges. Research on solid waste management identified that large resettlement areas in Yangon, Mandalay and Nay Pyi Taw have urban sanitation services that are well below acceptable levels, with the situation worse in the other poor regions and areas of the country. With the exception of central business districts, there is no conventional central waste water and sewerage collection and treatment system in the three major cities. Domestic waste water is usually released into the storm water drainage and natural waterways. In Yangon, only six areas of the city (7% of total population) were observed to manage wastewater and sewage wastes with connection to the treatment plant drainage facilities whereby activated sludge is used as fertilizer and treated water is disposed to Yangon River. For other parts of the city, septic tank wastes are transported by vacuum trucks to the treatment pond. In Mandalay, septic tank sewage wastes are collected with a vacuum truck and disposed to Oxidation pond in the ground of Ayeyatenyein cemetery, Kyar Ni Kan village, Patheingyi township (old) and Patheingyi township (new). The remaining sludge after evaporation is utilized as fertilizer. Further, all industries generating wastewater have constructed individual temporary treatment systems to connect and dispose liquid waste via a (10) 10-inch drainage pipe line which is subsequently connected to the Dohte Hta Waddy River without any prior treatment. In Nayi Pyi Taw, there is a centralised waste water and sewerage treatment facility which is connected the premises in Wannatheikdeed Quarter comprising 110 units and a population of 10,000. The treatment plant makes use of an anaerobic microorganism system and chlorination processing before discharging treated water to the Bukwe Creek.

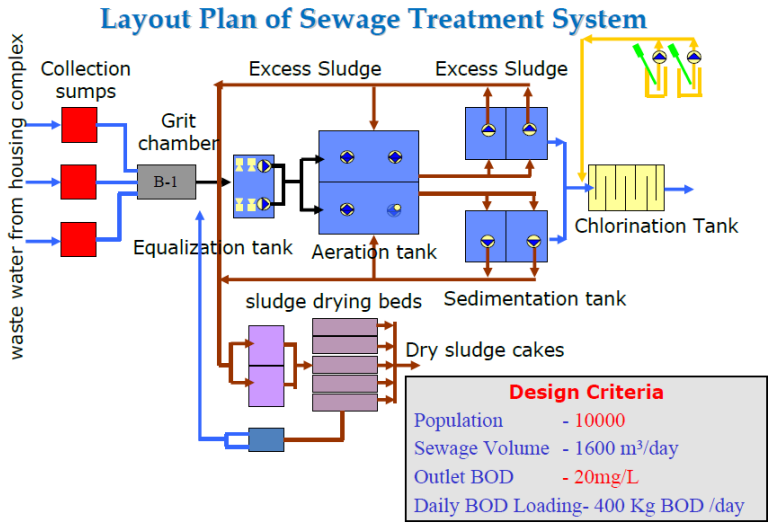

Figure 17: Centralised Waste Water Treatment Plant in Nay Pyi Taw. Source: YCDC, 2016

Figure 18: Waste Water Treatment Plants in Nay Pyi Taw (top), Yangon (below-right), and Mandalay (below-left). Source: Authors, 2016. YCDC/MCDC, 2016

3. Policies and Institutional Framework

3.1. National and Local Policies

The importance of environmental protection in Myanmar is recognized in national and local policy, which is in part due to the country being a signatory of various multilateral environmental treaties and agreements. Myanmar's National Environmental Policy of 1994 instituted environmental regulations on the utilization, conservation, and prevention of environmental degradation including water, land, forest, mineral, marine resources, and other natural resources. Following the development of this national policy, the country drafted its Agenda 21 commitment (1997) to implement integrated management of natural resources which provides a blueprint for achieving specific targets on environmentally sustainable development. In 2009, the country's National Sustainable Development Strategy (NSDS) was prepared, marking an important step for Myanmar as this guiding document aims to ensure development remains in harmony with the three main pillars of sustainability: environment, economy and society. The National Environmental Conservation Law and the Environmental Conservation Department (ECD) was established in 2012 as an enforcement mechanism to protect and conserve nature. In addition, City and Township Development Committees have promulgated a number of local policies and bylaws establishing a legal basis for action at local level. However, in practice actual implementation and proper enforcement of these environmental regulations has lagged behind general policy proclamations.

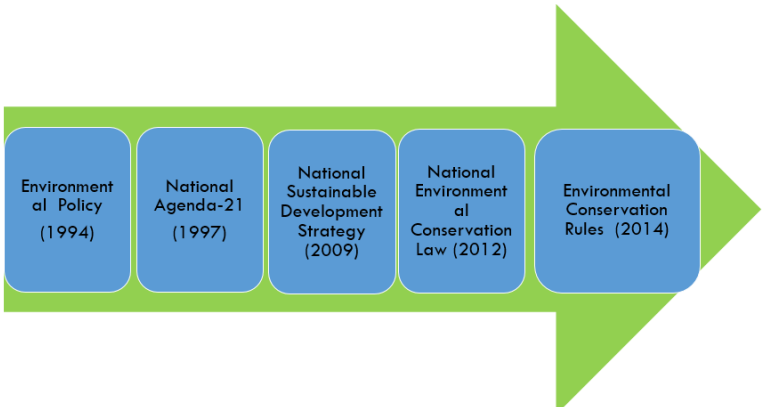

Figure 19: National policy development in Myanmar.
Source: Authors, 2016

Table 3: Related environmental laws, policies and enforcement system in major cities. Source: Authors, 2016

	Mandalay City Development Committee (MCDC)	Yangon City Development Committee (YCDC)	Nay Pyi Taw City Development Committee (NCDC)
Related Laws/ Acts	- MCDC Law 2015, Jan 12 - MCDC Environmental Conservation and Cleansing bylaws 2015, May 14 - The City of Mandalay Development Law (2002)	- The Yangon Water -work Act (1885) - The City of Yangon Municipal Act (1922) - The Water Power Act (1927) - The Underground Water Act (1930) - The City of Yangon Development Law (1990) - The Yangon Civil Development Law 2013	- NDC Pollution Control and Cleansing Department bylaws - NDC Water and Sanitation Department Bylaws - The Nay Pyi Taw Development Law (2009)
Enforcement methods	- Public awareness and training - Health impact training for waste handling workers - Public awareness training at school by different level - Informing the factories once three months to dispose waste water only in the defined time (between 6pm and 5am) and to regulate the temperature of waste water not more than 30·C - Inspecting the disposal together with checking main pipe line once a week - Having meeting with owners and instructing to follow the regulations	- Public awareness training has been done by distributing pamphlets in a small scale but not in large scale - Enforce to follow the instruction of separating waste types by sending instruction facts	- Just warning after first time not to do again

3.2. Institutional Framework

Solid waste management is a principal function of Township Development Committees designated within the cities. Each committee maintains a pollution control and cleansing department, which is responsible for overseeing household solid waste, industrial and hazardous waste management. On the other hand, the Department of Water and Sanitation is directly responsible for managing wastewater and sewerage waste. In addition, other departments such as Playground and Garden, City Planning, Inspection and Agriculture offices also play an important role in the planning and implementation of waste management activities.

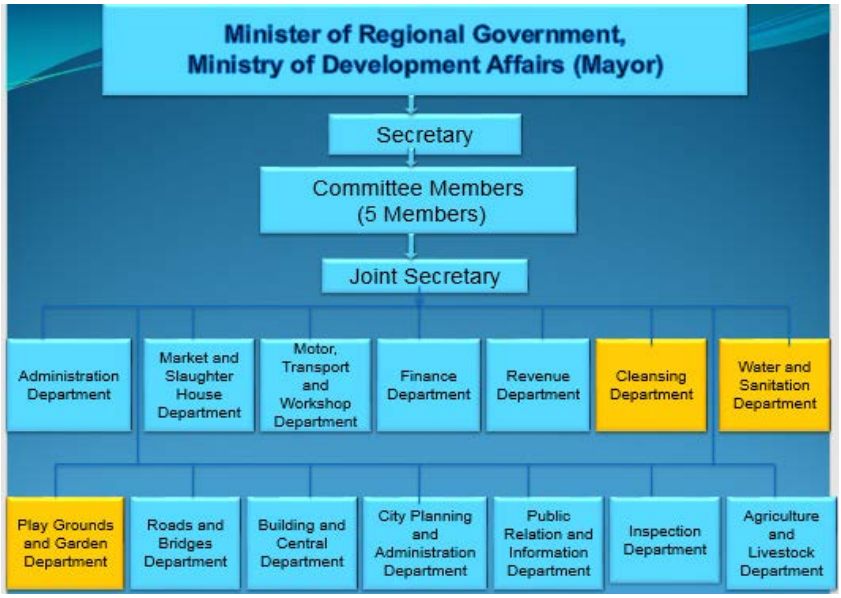

Figure 20: Institutional Framework in Mandalay. Source: MCDC, 2016

It was noted that the largest proportion of budget expenditures related to waste management are associated with labour and waste handling. As seen in Figure 19 below, a total of 4,220 workers were employed by YCDC for waste collection and disposal in 2015. In point of contrast, 1700 workers were employed for these tasks in the year 1983. This is very similar to the situation in MCDC where 2,000 workers were responsible for conducting waste management activities in 2016 compared to 900 workers in 2005. There has been a general increase in the allocation of capital expenditure for waste collection over time, including for purchasing new waste collection trucks and developing appropriate waste treatment infrastructure such as establishment of final disposal sites. This reflects the commitment and determination of Myanmar cities to enhance waste management systems and processes. However, collection and disposal are currently the main priorities of the municipalities and waste treatment (re-cycling) plays a minimal role at present.

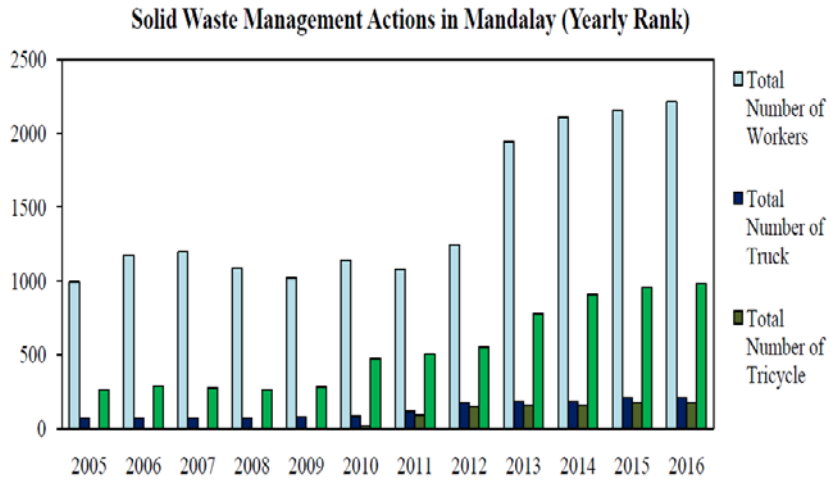

Figure 21: Resource allocation for waste management in Mandalay.
Source: MCDC, 2016

At the same time however, direct revenues are also generated through the collection of user charges for waste management services. Waste collection charges for household or domestic waste are based on the volume of waste disposed (MCDC) or the location (YCDC) and the fee ranges from 300-900 kyats/month. Other wastes are charged based on the waste volume and price for one truck (3 tons' capacity) comprising about 35,000 kyats per trip. This cost recovery policy helps to reduce waste disposal subsidies provided by the city and thus encourages more sound fiscal planning.

In addition, it was observed that the cities have entered into partnerships with both local and international partners aimed at improving waste collection in their respective cities. Local nongovernmental organisations (NGOs) support community awareness activities and implement initiatives to promote the 3Rs. Similarly, the private sector (both formal and informal) is involved in waste collection and recycling activities. Further, all three major cities (Yangon, Mandalay and Nay Pyi Taw) have received technical and financial support from international agencies (JICA, KOICA, ADB, EU, BORDA) and engaged with foreign partners' cities to establish new waste collection, recycling, treatment and final disposal facilities.

4. Identify Key Challenges and Gaps

The problems associated with waste management in the country can be categorized as follows:

(1) Waste Generation and Composition	• Rapid increase in volume of waste generation • Increase and emergence of a variety of wastes need a proper treatment • Shortage of landfill space and difficulties in finding suitable lands within city limits • Increase in waste management cost • Lack of basic data and information
(2) Policies, Regulations and Institutional Arrangements	• Lack of policy at both national and local levels • Weak enforcement of existing laws and regulations • Lack of policy to promote 3R • Lack of planning • Lack of know-how and capacity at national and local levels • Lack of coordination within and among different administrative layers
(3) Public Participation (Education, Promotion of 3Rs through awareness campaign & awareness raising)	• Lack of policies to promote 3Rs • Lack of awareness to promote 3Rs • Lack of awareness on health risks of the informal sector • Lack of participation and coordination among stakeholders e.g. inter-agency collaboration at national/local level
(4) Economic Aspects	• Revenue in the collection of waste is very low, so that it cannot cope with the total waste management expenditures • Penalties are not strictly enforced • Lack of measures for Public and Private Partnership
(5) Technological Aspects	• Limited know-how and capacity on suitable technologies adopted to the local condition • Limited resources including finance and expertise to invest for new technologies • Limited research and practical application on new technologies

Annexes

(1) Waste Generation

Waste category	Mandalay City Development Committee (MCDC)	Yangon City Development Committee (YCDC)	Nay Pyi Taw City Development Committee (NCDC)
(1) Solid Waste			
Municipal/ domestic waste (resident/ commercial)			
Total waste generation	955 tons/day	1,981 tons/day (0.4 kg/person/day) Landfill data, tons/day (Dawai Chaung 843, Hteinpin 1,080, Shwepyithar 61, Mingalardon 43, Dala 33, Seikyikhanaungato 4)	160 tons/day
Waste generation per capita	0.6 kg/person/day	0.4 kg/person/day	0.5 kg/person/day
Composition and characterisation	Organic waste: 64% Plastic: 14% Paper/cardboard: 6% Wood: 3% Textile: 4% Glasses: 2% Metal: 1% Others: 6%	Food waste: 69% Plastic: 8% Paper: 3% Green leaves: 8% Textile: 2% Glasses: 1% Metal: 1% Glue: 3% Others: 5%	Organic waste: 84% Non-combustible waste: 3% Combustible waste: 3% Plastic waste: 10%
Waste collection coverage	92%	92% (household waste 62%, market/commercial 35%, others 3%)	
If any projection and future trends	2005 – 259.93 tons/day 2010 – 473.61 tons/day 2015 – 955.30 tons/day 2020 – 1,020 tons/day		
Industrial		150 tonnes/day	No industrial zone
Hazardous (industrial/ medical)			
Total waste generation	Hospital waste: 2 tons/day	Hospital waste: 0.7 tons/day	
Composition	Infectious waste: 83% Sharps: 1% Miscellaneous: 16%	Infectious: 71% Sharp waste: 29%	
Construction and demolition			
Agricultural waste			No data available
(2) Liquid Waste			
Domestic waste water (residential/ commercial)			
Total waste generation	15,000 cu.meter/year		
Composition	Sludge: 95% - 97% Sanitary napkins: 5% - 3%		
Industrial waste water			
Total waste generation	-3 industrial zones are located in Pyigyitagun township (southern part of City) were established in 1991/1992 -About 1,500 industries are operation -Among them about 100 factories are generated industrial waste water amounted 1,500 – 2,000 cu. Meter/ day		
Composition	-For Distillery (Alcohol Factories) pH (scale): 4, D.O (mg/l): 0.01, BOD (mg/l): >25000, COD (mg/l): >15000 -For Tannery (Leather factories) pH (SCALE): 9.5, D.O (mg/l): 1.90, BOD (mg/l): >2500, COD (mg/l): >7000 For Sugar Mill pH (SCALE): 5-6.8, D.O (mg/l): 2.20, BOD (mg/l): <2000, COD (mg/l): <5000	-BOD ≤ 20mg/l -COD = 60mg/l -TSS = 30mg/l	From centralized waste water treatment system -Inflow composition (BOD: 250 – 300, COD: 416 – 500) -Effluent composition (BOD: 45, COD: 75)

	-For Recycle Paper Mill pH (SCALE): 7.5-9.5, D.O (mg/l): 3.10, BOD (mg/l): <1000, COD (mg/l): <3000		
(3) Waste Gases (GHG and Black Carbon) both solid and liquid sources			
Municipal (residential/ commercial)		-GHG emissions from waste collection/transport – 7.51 kg of CO2eq/tonnes - GHG emissions from open dumping (emissions of CH4 from open dumping – 22.88 kg of CH4/tonnes, direct GHG emission from mixed waste open dumping – 480.48 kg of CO2 eq/tonnes	
Industrial			

(2) Waste Management System

Waste category	Mandalay City Development Committee (MCDC)	Yangon City Development Committee (YCDC)	Nay Pyi Taw City Development Committee (NCDC)
(1) Solid Waste			
Municipal/ domestic waste (resident/ commercial)			
Waste separation, collection and transport	- Waste Collection Method (Door to Door Waste Collection, Bell Ringing Block Collection to the Household, Collect the waste from the Kerb site bins, Sweeping the waste on the road)	- Daily collection - Bell ringing collection system, collection at street dump yards, temporary storage system - Transport by trucks to the landfill	- Bell ringing collection system in the city - Carried with trucks and disposed to the open dumping site
Waste treatment and recycling	- 1 Incinerator (Stopped operation) – 30 tons/day at Thaung Inn Myout Inn (Southern Part of Mandalay) - 1 Anaerobic Digester – 30 tons/day (Pilot Project for Rural Areas) - 1 Incineration pit at Kyar Ni Kan (Northern Part of Mandalay for Medical Waste Only)	- Recycle materials (Plastic, Tin/Can, Bottle, Iron, Glass, Textile) - No correct data, assumption is that 86 tonnes/day generated waste is recycling	- No pre-treatment - No treatment - No recycle
Waste disposal	Final disposal - Landfill 1 (Engineering Landfill) - 450 ton/day at Kyar Ni Kan (Northern Part of Mandalay) - Landfill 2 (Engineering Landfill) -300 ton/day at Thaung Inn Myout Inn (Southern Part of Mandalay)	- Open dumping	- No defined dumping site area - 6 current dumping areas - Just open dumping
Waste management staff/vehicles	- Vehicles to collect in day time (Truck 211, Tricycle 179, Cart 322) - Vehicles to Collect Night time 77	- Staff (Officers 39, Permanent workers 180, daily workers 4000) - Vehicles 300 trucks (2ton/4ton/7ton/12ton)	- Officers and staffs: 56 - Vehicles: 33
Industrial (non-hazardous)	- Collect only on call		
Hazardous (industrial/ medical)	- Collect daily from large hospitals and clinics - Small clinics have to join large ones - All clinical wastes are incinerated in an incineration pit at Kyar Ni Kan except large body parts - Large body parts are incinerated at cemeteries - Only expired medicines are submerged as a special case in combining and classifying with Ministry of Health	- Collect waste (once a day for special clinic, once or twice per week for polyclinic) - Categorize into three types (Yellow colour for infectious waste, Red colour for sharpening and syringes, needles, etc, Blue & Green for domestic waste) - Infectious waste (incineration) - Sharp waste (submerged to concrete deep well)	- Collect only on call - Collect separately - Disposed to the same area of domestic waste dumping - No pre-treatment - No special incineration pit for hospital waste - Only the large body parts are incinerated in the cemeteries with the approval of doctors
Construction and demolition			-

Agricultural waste			
(2) Liquid Waste			
Domestic waste water (residential/ commercial)	- No need to collect domestic waste water separately - All domestic waste water except sewage waste are disposed along the drainage pipe line to the nearest water body (Mandalay Kandawgyi and Ayeyarwaddy river) - No pre-treatment - Septic tank sewage wastes are collected with a vacuum truck and disposed to Oxidation pond - The old oxidation pond is in the ground of Ayeyatenyein cemetery, Kyar Ni Kan village, Patheingyi township - The new oxidation pond is in the ground of no.2 integrated farming, Patheingyi township - Sludge remained after evaporation is used as fertilizer	- Domestic waste water is being released into the YCDC drainage and then to the nearest water body - In 6 downtowns, sewage wastes are connected with the drains to the Than lhet sun pond - YCDC can serve only 4.3% of Yangon City people for sewage waste - For other towns, septic tank wastes are carried by vacuum trucks - Domestic waste water treatment (WWTP), Activated Sludge Process - Sludge is used as fertilizer - 3.25mg per day are disposed to Yangon River as treated water	In Wannatheikdeed Quarter (110 households and 10,000 people) - There is a centralized waste management treatment plant - Waste water is drained to the plant and treated and disposed to the Bukwe creek - Anaerobic microorganism system and Chlorination - About 75,000gal/day can be treated and disposed In other areas of the city - Decentralization system - Waste water is drained to along the drainage to the nearest water body except sewage waste - No pre-treatment - No treatment - Septic tank sewage wastes are carried with vacuum truck and
Industrial waste water	- All industries generating wastewater constructed their own temporary treatment system to connect and dispose to (10) inches disposal main pipe line - When they dispose their effluent to (10) inches main pipe Line, they don`t do any pre treatment - The main pipe line is disposed to Dohte Hta Waddy River		
(3) Waste Gases (GHG and Black Carbon) both solid and liquid sources			
Municipal (residential/ commercial)			
Industrial			

(3) National/local Policies

Waste category	Mandalay City Development Committee (MCDC)	Yangon City Development Committee (YCDC)	Nay Pyi Taw City Development Committee (NCDC)
(1) Solid Waste			
Municipal/ domestic waste (resident/ commercial)	Laws/Acts: - MCDC Law 2015, Jan 12 - MCDC Environmental Conservation and Cleansing bylaws 2015, May 14 Enforcement - Public awareness and training - Health impact training for waste handling workers - Public awareness training at school by different level	Laws/Acts: - The Yangon Water -work Act (1885) - The City of Yangon Municipal Act (1922) - The Water Power Act (1927) - The Underground Water Act (1930) - The City of Yangon Development Law (1990) - The Development Law (1993) - The City of Mandalay Development Law (2002) - The Nay Pyi Taw Development Law (2009) - Beside these, the City and Township Development Committees promulgated the solid waste disposal and collection by -law as its measure for legal basis at local level - The Yangon Civil Development Law 2013	Laws/Acts: - NDC Pollution Control and Cleansing Department bylaws Enforcement: - Public awareness training has been done by distributing pamphlets in a small scale but not in large scale - Enforce to follow the instruction of separating waste types by sending instruction facts
Industrial (non-hazardous)			
Hazardous (industrial/ medical)			
Construction and demolition			
Agricultural waste			
(2) Liquid Waste			
Domestic waste water (residential/ commercial)	Laws/Acts: - MCDC Law 2015, Jan 12 - MCDC Environmental Conservation and Cleansing bylaws 2015, May 14	Laws/Acts: - The Yangon Water -work Act (1885) - The Water Power Act (1927) - The Underground Water Act (1930) Standards/Guidelines: - EPA (United States) Guideline Standard (Reference) - Draft Standards are preparing	Laws/Acts: - NDC Water and Sanitation Department Bylaws Enforcement: - Just warning after first time not to do again
Industrial waste water	Laws/Acts: - MCDC Law 2015, Jan 12 - MCDC Environmental Conservation and Cleansing bylaws 2015, May 14 Enforcement: - Informing the factories once three months to dispose waste water only in the defined time (between 6pm and 5am) and to regulate the temperature of waste water not more than 30◦C - Inspecting the disposal together with checking main pipe line once a week - Having meeting with owners and instructing to follow the regulations		
(3) Waste Gases (GHG and Black Carbon) both solid and liquid sources			

Municipal (residential/ commercial)			
Industrial			

(4) Institutional Framework

Waste category	Mandalay City Development Committee (MCDC)	Yangon City Development Committee (YCDC)	Nay Pyi Taw City Development Committee (NCDC)
(1) Solid Waste			
Municipal/ domestic waste (resident/ commercial)	MCDC (Cleansing Department) More than 100 small scale recycling productions such as Myint Htay and Family ➢ Weekly Donation Groups ➢ Youth Volunteers Groups ➢ Health and Social Service Groups	YCDC ECD	NDC (Pollution Control and Cleansing Department)
Industrial (non-hazardous)			
Hazardous (industrial/ medical)		DOWA(Only in special Economic Zone and only hazardous)	
Construction and demolition			
Agricultural waste			
(2) Liquid Waste			
Domestic waste water (residential/ commercial)	MCDC (Water and Sanitation Department)	• Kubota • Mitsubishi Rayon Co.,ltd and Myanmar Water Engineering Product Co.,ltd • BORDA • Osaka ADB (Australia	NDC (Water and Sanitation Department)
Industrial waste water			
(3) Waste Gases (GHG and Black Carbon) both solid and liquid sources			
Municipal (residential/ commercial)			
Industrial			

(5) Financial Mechanisms

Waste Category	Mandalay City Development Committee (MCDC)	Yangon City Development Committee (YCDC)	Nay Pyi Taw City Development Committee (NCDC)
(1) Solid Waste			
Municipal/ domestic waste (resident)	Direct revenue - Collection fee is depending on amount of wastes disposed (60-900kyats per household per month) National/International support - Technical assistance from (Asian Development Bank , JICA, KOICA, ASEAN Working Group on Environmental Sustainable Cities under the ASEAN Socio-Cultural Community, Institute for Global Environmental Strategies, Kitakyushu City)	Direct revenue - Different depending on location (one household per day) (Downtown -20ks/day, Sub-urban - 15ks/day, uptown - 10ks/day) National/International support - Funding by EU for 3 components (3 years' project) (Law, Rules and Regulations development, Technical support, Public awareness)	Direct revenue - Free of charge
Commercial/Industrial (non-hazardous)	Direct revenue - For a room (Hotels, Motels, Inns 20000ks/month)	Direct revenues - For Clinics per day (lowest - 5000ks, highest - 1500000ks) - Free of charge for Government hospitals	Direct revenues - For shops – 2,000-4,000 Ks/ month - On call price for 1 truck (without the cost for labour and diesel used) (Government department 15,000 Ks, Private 25,000 Ks)
Hazardous (industrial/ medical)	Direct revenue - 3tons truck – 35000ks - Government Hospitals – free of charge - A private laboratory – 10000ks/month - A private operation room – 10000ks/month - A private clinical bedstead – 1500ks/month	Direct revenues - Go, collect and dispose only on call (35000ks/3 tons Loaded truck National/International - DOWA (Only in special Economic Zone and only hazardous)	Direct revenues - For government hospitals - free of charge - For private hospitals and clinics (Large – 35,000ks/ month, Medium – 2,000ks/ month, Small – 10,000ks/ month)
Construction and demolition			- On call for 1 truck 25,000Ks
Agricultural waste			
(2) Liquid Waste			
Domestic waste water (residential/ commercial)	Direct revenues - For a vacuum truck, collection fees vary depending on location. - For 5 townships except Amarapura Township, collection fee for a vacuum truck is 29100ks. - For Amarapura Township, collection fee for a vacuum truck is 31000ks. National/International support - With the support of JICA (NIPPON KOEI Co.,ltd) for four outputs (Inspection procedure for standardizing, Water Quality Survey of Doke Hta Waddy river (four times), Pollution source database development, Interpretation for report) - Proposed ADB loan project for household waste water management in Mandalay (To reduce BOD level about 70% for house hold wastewater in the city before disposing to Ayeyarwaddy river, To remove the sludge coming out from wastewater treatment plant by using electrical power, To clean the water from Thingazar Creek, To separate and dispose Shwe Ta Chaung main drain, Ngwe Ta Chaung drain's wastewater disposal system and storm water, To use sewerage system for downtown area, To	Direct revenue - Collection fee for domestic waste water – free of charge - For carrying septic tank (sewage) waste by vacuum truck, fees depend on location and are calculated on the amount of diesel used National/International Support; - BORDA - Capacity building - Osaka - Capacity Building, Funding, Donation of equipment - ADB (Australia) – Capacity building - Mitsubishi Rayon Co.,ltd and Myanmar Water Engineering Product Co.,ltd - Donation of equipment - Kubota- Donation of equipment	Direct revenue - For septic waste (1 vacuum truck – 40,000 Ks)

	control and decrease flooding during the raining season in the low land area, Proposed loan – USD 600 million) - For treatment of domestic waste to Taung Thaman Pond by the Chinese Company named Kumin Ditachi		
Industrial waste water	Direct revenue - 4.5 USD/m^3 National/international support - Establishment of central waste water treatment plant and collection system by the Thailand Company named Hydrotek Public Co. Ltd. - Method of Project Implementation - BOT (Built, Operate, Transfer) - Contract Period of BOT - 30 Years - Type of Process - Up flow Anaerobic Sludge Blanket and activated sludge system - Extension of Contract Period - 10 Years + 10 Years - Area of Service - Mandalay Industrial Zone (93 factories) - Effluent BOD5 after treatment - ≤ 20 mg/l - Main Power Supply to Central Waste Water Treatment Plant and Collection System Are - By MCDC - Land Required for Construction of Central Waste Water Treatment Plant (Approx. (5 Acres), by paying rental fee of fixed rate - Investment Cost (USD$ (12) million		
(3) Waste Gases (GHG and Black Carbon) both solid and liquid sources			
Municipal (residential/ commercial)			
Industrial			

(6) Stakeholder Involvement

Waste category	Mandalay City Development Committee (MCDC)	Yangon City Development Committee (YCDC)	Nay Pyi Taw City Development Committee (NCDC)
(1) Solid Waste			
Municipal/ domestic waste (resident/ commercial)	MCDC (Cleansing Department) - Defining where and how to dispose various wastes - Putting sufficient waste bags - Managing collection of wastes in defined places in appropriate ways - Managing final temporary and disposal of wastes - Managing systematic collecting, moving and disposing of wastes by taking cleansing service fees - Preparing emergency plans for wastes disposal in case of natural disasters	YCDC - Collect, transport, recycle, open dumping - Direct revenue for service	NDC (Pollution Control and Cleansing Department) - Collecting, carrying with trucks and disposing to the open dumping site - Cleansing waste thrown out along the roads and others as well as cleansing when informed by public - Putting the waste bins at the junctions and collecting - Get collection fees for service
Industrial (non-hazardous)			
Hazardous (industrial/ medical)		YCDC, DOWA (Only in Special Economic Zone and only hazardous) - Collect, transport, recycle, open dumping - Direct revenue for service	NDC (Pollution Control and Cleansing Department) - Collect on call - Get collection fees for service - Collect, carrying with trucks and disposing to the open dumping site - Get collection fees for service - Enforcing to separate the wastes as instructed
Construction and demolition			
Agricultural waste			
(2) Liquid Waste			
Domestic waste water (residential/ commercial)	MCDC (Water and Sanitation Department) - Supervision of sewerage collecting, systematic construction of sewerage tanks not to pollute the environment in accordance with the instruction - Negotiation of the complaints regarding the septic waste from the city - Planning to implement a Central waste water treatment plant for the treatment of domestic waste water in corporation with local and international organizations	YCDC - Collect, transport, treat - No revenue except for septic waste carrying and dumping	NDC (Pollution Control and Cleansing Department) - For Centralized area (Treatment of waste water and disposal of treated water, to maintain water quality) - For Decentralized areas (Supervision and maintenance of drainage systems, Supporting advices and designs in requesting) - For septic tank waste water, joining with the relevant department for carrying with vacuum truck
Industrial waste water	MCDC (Water and Sanitation Department) - Supervision of industrial waste disposal not to pollute the environment - There is no specific inspection Team for Industrial Zones - Usually inspect with other relevant departments when Some complaints and Abnormal conditions occur in industrial wastewater impact effected area - Relevant departments are local environmental conservation department, industrial supervision and inspection department, workers department, health department and township administration department and MCDC - At that time, LOCAL GOVERNMENT organized a joint inspection team with relevant departments and gave instructions to inspect the industrial zones - During inspection period, the joint inspection team gave and instructed many environmental knowledge, some pre-treatment technique (low cost and to get		

	suitable result) and not to dispose any untreated effluent directly to water body - And then take water sample from plants and factories and send to the water laboratory - According to the result of water laboratory, the cleansing department give a running permit to the factory and plant owners - After completion of inspection, the team report their findings to LOCAL GOVERNMENT AUTHORITIES		
(3) Waste Gases (GHG and Black Carbon) both solid and liquid sources			
Municipal (residential/ commercial)	MCDC (Cleansing Department) - Negotiation with relevant Government departments and organizations for the factory authorities to have plans to avoid from air pollution due to smoke, smell or other substances and noise emitted from a factory		
Industrial			

(7) Identify Gaps and Key challenges

Mandalay City Development Committee (MCDC)	Yangon City Development Committee (YCDC)	Nay Pyi Taw City Development Committee (NCDC)
- Need to promote public awareness on waste disposal and management - Although waste to energy technology is planned, negotiation for buying and selling of by-products (electricity)is a problem - Need strong policy effectiveness - Need close and strong relationships among ECD, MCDC and relevant departments - Need more financial support from both local and international institutions - Need active participation of all stakeholders in waste disposal and management - Difficult to get accurate data - Due to high cost of technology and insufficient land, most plants can't afford - Need to follow as instructed by ECD (law enforcement) - Need to have close relationship between ECD and General Administrative department - Need to enforce plant and factory owners to follow laws and regulations	- For all processes, budget is the main problem. - Need higher technology support - Need to have strong policy	- Difficult to get accurate waste data, classification and composition because of having to use large amount of human force, money and time - Need technical support as well as equipment - Need strong policy enforcement - Need to have the courses in the primary school levels - Need all stakeholder involvement - Need financial support for treatment of decentralized areas