सफा अभियान
नेपाल

BASELINE ASSESSMENT WASTE MANAGEMENT IN NEPAL 2018-2019

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The strategy document has been developed basing on analyses carried out within the framework of the project titled "Strengthening the capacity of policymakers and practitioners in Nepal to reduce GHGs and SLCPs from the waste sector, based on the circular economy concept (Waste and Climate Change project)". The Leadership for Environment and Development (LEAD) Nepal is implementing the Waste and Climate Change Project (WCC) project on behalf of the Ministry of the Federal Affairs and General Administration (MoFAGA) from the funds of the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety International (BMUB) International Climate Initiative (IKI), with technical support from the United Nations Environment Programme International Environmental Technology Centre (UNEP IETC). Since 2017, UNEP IETC has been working on the waste and climate change project to reduce the impacts of waste sector on climate change, through capacity strengthening and policy support at the national and local level in Bhutan, Mongolia and Nepal.

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Foreword

Waste management is one of the prevailing urban governance challenges that have multi-fold implications on economic, environmental and social dimension. Like most of the cities in developing countries, urban centers in Nepal are also experiencing population growth and rampant urbanization leading to an increasing volume of waste generation, hence making it a challenge to provide an adequate and efficient waste management services.

Knowing the quantity and the composition of waste is one of the initial steps in designing and delivering a sound system for waste management. There is a need for high quality and reliable data in waste sector through conducting baseline assessments. In the past, the Solid Waste Management Technical Centre had conducted waste management assessment in 2004 and 2012 for 58 municipalities, and in 2017 for the 60 newly announced municipalities. Nepal has recently restructured its administrative boundaries with an addition of numerous municipalities, precisely, 6 metropolitan, 11 sub-metropolitan, 276 urban municipalities, and 460 rural municipalities. Therefore, another baseline study was required necessary to assess the waste management situation in this new administrative structure.

This baseline study provides a general overview of the municipal solid waste management situation from 35 selected municipalities across the seven provinces. In addition, the current baseline study establishes a linkage between waste management and climate change by quantifying short-lived climate pollutants emissions (SLCPs) from the waste sector.

I hope this report provides a clear, accurate and timely information to municipalities to understand the waste management issues. This report can also serve as a guiding document to develop waste management strategies on national and municipal level.

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Bishnu Dutta Gautam

Joint Secretary

Ministry of Federal Affairs General Administration

Acknowledgements

The Ministry of Federal Affairs and General Administration (MoFAGA) expresses its sincere appreciation to the team from Leadership for Environment and Development (LEAD) Nepal for their extensive work in designing and conducting the study and preparing the baseline report on the waste management situation in 35 municipalities across seven provinces of Nepal. We would like to thank the different sectors of the government and the society for their tremendous support for this study.

MoFAGA appreciates the former Solid Waste Management Technical Support Centre (SWMTSC) team for being instrumental in developing the baseline study approach and providing their valuable technical and coordination support. MoFAGA would like to extend its deep gratitude to the members of the technical committee for reviewing the report and providing valuable feedback for its improvement.

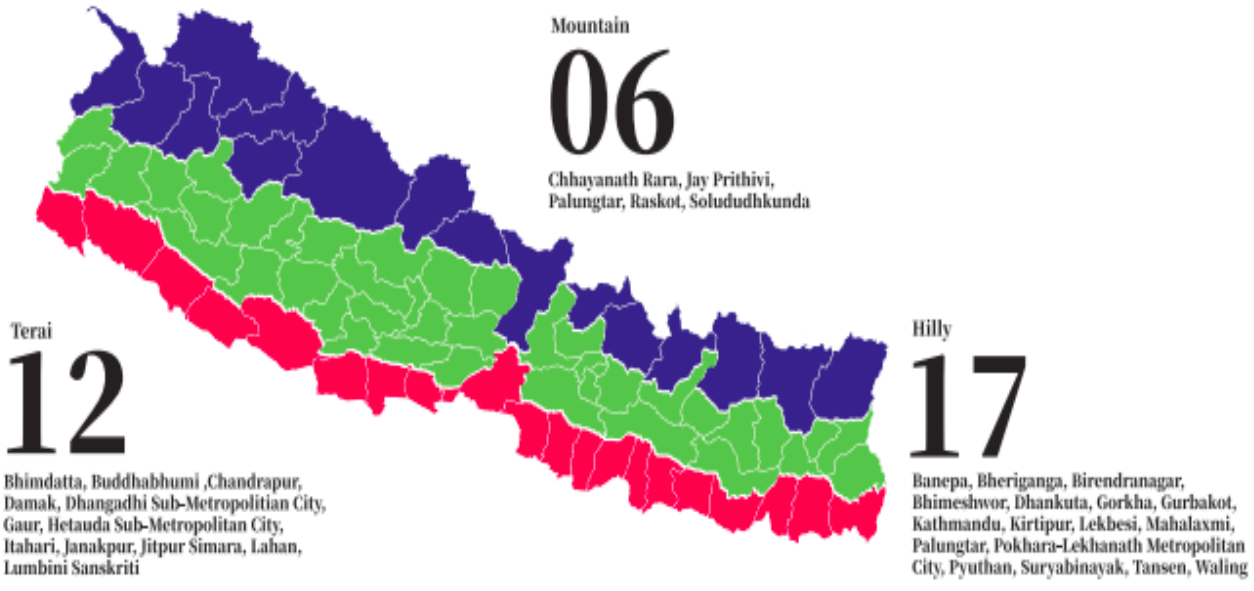
MoFAGA is grateful to the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) International Climate Initiative (IKI) and United Nations Environment Programme International Environmental Technology Centre (UNEP IETC) for their technical and financial support.

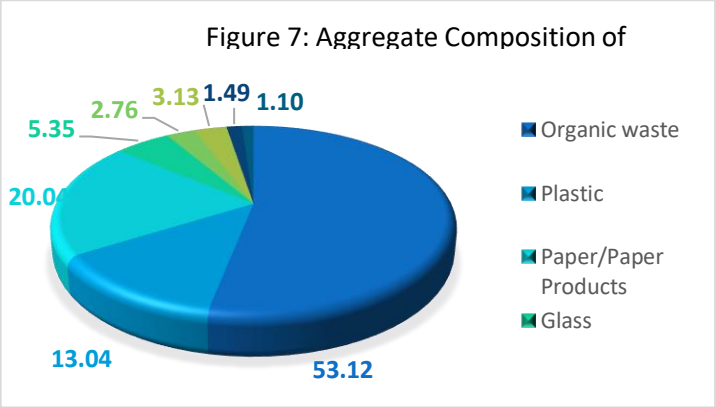
Finally, we thank all the field surveyors for their sheer dedication and diligence in collecting data from the 35 study municipalities.

Executive Summary

Waste is largely a local problem that city authorities struggle with for a better management. Nevertheless, waste management is also widely associated with global challenges like climate change. The waste sector contributes to nearly 3-5% of anthropogenic greenhouse gas (GHG) emissions. Landfills are the third largest source of anthropogenic methane emissions that account for approximately 11% of estimated global methane emissions. However, a holistic approach to waste management has positive consequences for the reduction of SLCP and GHG emissions. The United Nations Environment Programme commissioned Global Waste Management Outlook report suggests that holistic waste management can cut annual GHG emissions by up to 20%.

Recognizing such established connection of the waste sector with climate change, and availability of the opportunities to reduce these GHG emissions through sustainable waste management, the Leadership for Environment and Development (LEAD) Nepal is implementing the Waste and Climate Change (WCC) project. In this regard, it was necessary to assess the current situation of waste management, placing it within the context of climate change. The main objective of the baseline study was to derive a comprehensive information on both physical (technical) features of waste management flow, including waste generation, collection, transport, recycling, treatment, and final disposal, as well as the role of governance, such as policies, regulations, institutions, stakeholder participation, and finance. An assessment of solid waste management (SWM) practices was conducted in 35 selected municipalities across 7 provinces of Nepal as per the figure below.





When we consolidate all this data it is observed that the organic waste is at 53.12%, plastic at 13.04% and paper/paper products are at 20.04%. The pie chart depicts the different composition of waste from all sectors. It would be safe to assume that waste can be reduced by 95% if sound waste management is practiced.

This composition analysis reveals a higher potential for waste recycling and energy recovery. Despite the potential, waste recycling in Nepal is at a primitive level and at the hands of the informal sector. Recycling is mainly aided by the informal or small-scale formal private sector- the scrap dealers, and recycling factories. With thousands of scrap dealers and small-scale recycling companies operating in Nepal only hundreds are registered, hence the recycling efforts and revenue from recycling often go unrecorded and unnoticed. On a positive light, new recycling companies are being established in Nepal as opposed to earlier arrangements where the collected scrap materials used to be exported to the Indian recycling companies. Therefore, recycling practice in Nepal should be upscale and institutionalized with environmentally sound technologies and with a larger investment, while still making the recycling activities inclusive of the informal sector. Similarly, mainstreaming gender issues into waste management policy, development, research, advocacy, legislation, resource allocation and planning, designing, implementing and monitoring and evaluation of waste management programmes and projects.

In Nepal, waste management is a principal function of local municipalities including planning, financing and delivering the urban waste management services. The national institutions' role is limited to formulating waste management related policies and providing technical support. At present, waste management receives a low priority both at the national and local level. Lack of financial resources, human resources capacity, waste management technology, and infrastructure are often cited as the common barriers to waste management.

Looking at waste as a stand-alone issue is not enough. There is a need for a paradigm shift to consider waste as a resource and adopting a circular economy principle. Linking waste with various sustainable development goals (SDGs) and climate concerns help place waste at a national and local priority. This study calculated the SLCP emissions from the waste sector at the municipal and metropolitan cities to identify opportunities to reduce these emissions through various technology, policy and behavior solutions. The estimate of SLCPs was done by utilizing the Climate and Clean Air Coalition Municipal Solid Waste Initiative's (CCAC-MSWI) Solid Waste Emissions Estimation Tool (SWEET) in Kathmandu, Hetauda, Pokhara and Birendranagar.

In conclusion, the survey in 35 municipalities confirmed that waste management in Nepal is at a preliminary stage. The country is experiencing significant waste management challenges at both national and city levels due to a range of technical, social, economic and institutional constraints. However, it also shows the potential for improvements through identification of ESTs, informed policymaking, and design and deployment of bankable projects with significant opportunities to reduce SLCP emissions reduction from the waste sector. The realization of sustainable waste management in Nepal, however, requires some foundation work in place, such as; building a more reliable and comprehensive waste-related statistics at municipal and national level; improving compliance of waste related regulations, promoting investments in waste sector through public-private participation (PPP); encouraging innovation in waste sector, integrating informal waste sector, encouraging community participation promoting waste entrepreneurship, and exercising balanced efforts in harmonizing policy and institutional gaps and barriers through research, training and capacity building activities.

Acronyms and Abbreviations

3R	Reduce Reuse Recycle
ADB	Asian Development Bank
BC	Black Carbon
CBOs	Community Based Organizations
CCAC MSWI	Climate and Clean Air Coalition Municipal Solid Waste Initiative
CDM	Clean Development Mechanism
CH_4	Methane
CNG	Compressed Natural Gas
CO_2	Carbon dioxide
DDC	District Development Committee
EFLGF	Environmentally Friendly Local Governance Framework
EIA	Environmental Impact Assessment
EPA	Environmental Protection Act
EPR	Environmental protection Rules
CO_2e	Carbon dioxide equivalent
ESTs	Environmentally Sound Technologies
GHG	Greenhouse gas
GTZ	German Technical cooperation Agency
HH	Household
ICT	Information Communication and Technology
IEE	Initial Environmental Examination
IETC	International Environmental Technology Centre
IKI	International Climate Initiative
INDCs	Intended Nationally Determined Commitments
JICA	Japan International Cooperation Agency
KMC	Kathmandu Metropolitan City

LEAD Nepal	Leadership for Environment and Development Nepal
MEAs	Multilateral Environmental Agreements
MoALMC	Ministry of Agriculture, Land Management and Cooperative
MoFAGA	Ministry of Federal Affairs and General Administration
MoFALD	Ministry of Federal Affairs and Local Development
MoFE	Ministry of Forestry and Environment
MoHP	Ministry of Population and Health
MoICS	Ministry of Industry Commerce and Supplies
MoPE	Ministry of Environment and Population
MoUD	Ministry of Urban Development
MSW	Municipal Solid Waste
NAPA	National Adaptation Programme of Action
NatCom	National Communication
NDCs	Nationally Determined Commitments
NGOs	Non-Governmental organizations
NPC	National Planning Commission
OC	Organic Carbon
POPs	Persistent Organic Pollutants
PPP	Public Private Partnership
PSP	Private Sector Participation
Rs.	Rupees
SDGs	Sustainable Development Goals
SLCPs	Short Lived Climate Pollutants
SWEET	Solid Waste Emission Estimation Tool
SWM	Solid Waste Management
SWMA	Solid Waste Management Act
SWMRMC	Solid Waste Management Resource Mobilization Centre
SWMTSC	Solid Waste Management Technical Support Centre
SWOT	Strength Weakness Opportunity Threat

TA	Technical Assistance
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework on Climate Change Convention
USD	United States Dollars
VDC	Village Development Committee
WCC	Waste and Climate Change
WCF	Ward Citizen Forum
WTE	Waste to Energy

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CHAPTER 1: INTRODUCTION

Waste is a global issue and is everyone's responsibility. Improper management of waste affects not only our health but also our environment and climate overall. Waste management should be a necessity, but it is not a priority in many countries, as in Nepal, due to lack of awareness, knowledge and financial constraints. Waste generation per capita has risen markedly over the last 50 years. With its rapid urbanization, growth in population and economic development, Nepal has also become aware of its waste management issues and has ratified national Acts and local Declarations. The Solid Waste Management Act (SWMA) 2011 is one of the regulatory efforts. Nepal has also identified the reduction of GHG emissions and is on its way to adopt a low-carbon development pathway through its Climate Change Policy and (Intended) Nationally Determined Commitments (I/NDCs).

Nepal's current system of waste disposal consist of open dumping in landfill/dump sites and burning. This is no longer an optimum method of disposal as landfill/dump sites are overflowing and availability of land is limited. Dumping and burning garbage is also an environment hazard. These malpractices together with the poor condition of waste handling equipment and rundown transportation vehicles (carbon-based fuel used) lead to emissions of the greenhouse gases (GHGs) and short-lived climate pollutants (SLCPs) often linking the waste sector to the climate change phenomenon.

Nepal faces many challenges in managing its waste from governing policy and laws, technology, financial constraints to increasing public awareness and participation of the people. It was therefore necessary to strengthen the capacity of policy makers and practitioners to tap unused potential of mitigating GHGs and SLCP emissions generated from the waste sector by developing an evidence-based policy, enabling regulatory framework, innovative financing mechanisms and adoption of the environmentally sound technologies (ESTs) for pursuing sustainable waste management efforts in Nepal.

To manage waste effectively it is essential to know the current statistics. To this effect, LEAD Nepal conducted a comprehensive baseline study in 35 provinces in 2018-2019.

Support for this study:

This baseline was conducted as a part of the WCC project. The implementation of the project titled "Strengthening the capacity of policymakers and practitioners in Bhutan, Mongolia, and Nepal to reduce GHGs and SLCPs from the waste sector, based on the circular economy concept (the WCC project) is expected to make the linkages with waste and climate change and work towards achieving sustainable waste management while exuberating climate co-benefits. The WCC project is funded by the German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety, International Climate Initiative (IKI), and the United Nations Environment Programme International Environmental Technology Centre (UNEP IETC). The WCC is a four-year (Aug 2017 - Aug 2021) project with multiple partners involving government actors, non-governmental organization, the private sector, and civil society working towards sustainable waste management. In Nepal, the Ministry of Federal Affairs and General Administration (MoFAGA) is the government partner institution, and the Leadership for Environment and Development (LEAD) Nepal - a nongovernmental organization is the executing

partner that will oversee the overall project management activities and report to the UNEP IETC. The overarching goal, of the WCC project is to capacitate key actors (policymakers and key waste sector stakeholders) to implement enhanced legislative formworks, creating enabling conditions for the introduction and uptake of suitable environmentally sound technologies (ESTs) in the waste sector, while contributing to the achievement of the pledged (intended) nationally determined commitments (I/NDCs).

Purpose of the study

This report provides a snapshot of the waste management situation in the country, placing it within the context of climate change. It compiles information on MSW quantity, composition and characteristics, together with the assessment of the extent and effectiveness of the existing waste management systems, identification of the gaps and challenges as well as the opportunities to close those identified gaps in order to support the country in achieving its climate change commitments through improvements in the waste sector. This baseline report is the foundation for the next step where a national and city level strategies for waste management with explicit opportunities to mitigate SLCPs from the waste sector will be developed as one of the project outputs.

Overall approach

The baseline consists of both primary and secondary information. All past studies, reports, journal articles, and database were thoroughly reviewed and compiled. In addition, an empirical study was designed to gather first-hand information and data from the selected municipalities across seven provinces of Nepal. The data collection and analysis were done mainly to develop an inventory with waste generation, collection, treatment, recovery and recycling and disposal data. Together, a comprehensive assessment of the waste management practices and the contributions of the SLCP emissions from the waste sector in Nepal were conducted, and the findings have been compiled in the baseline report.

CHAPTER 2: APPROACH AND METHODOLOGY

Methodology for waste quantification and composition analysis

Empirical study design

A major part of the assessment was through field survey. For this, a scientific methodology was adopted, a survey questionnaire was developed, and a pilot test was carried out before actual data collection. The methodology involved:

I. Household, Commercial and Institution survey via questioner
II. A series of field observation and interviews conducted with relevant government actors/institutions, private recyclers, and informal waste sector representatives to assess the stakeholders' perception and participation towards waste management. The assessment also included waste and climate-related policy review, review of waste management technology in use, and institutional analysis for understanding the roles and responsibilities.

The field study included various techniques: a survey form, waste quantification and composition analysis, field observation and key informant interviews. The content included the level of

understanding of the current waste management and collection service, preferences for future services, waste disposal practices and opinions on environmental impacts.

Study area- country's new federal administrative structure

Recently, Nepal has entered a Federal system, redefining its administrative boundaries. The Federal Democratic Republic of Nepal (*Sanghiya Loktantrik Ganatartra Nepa*l) is administratively, divided into Provinces, Districts, and Municipalities as illustrated in **Figure 1** below.

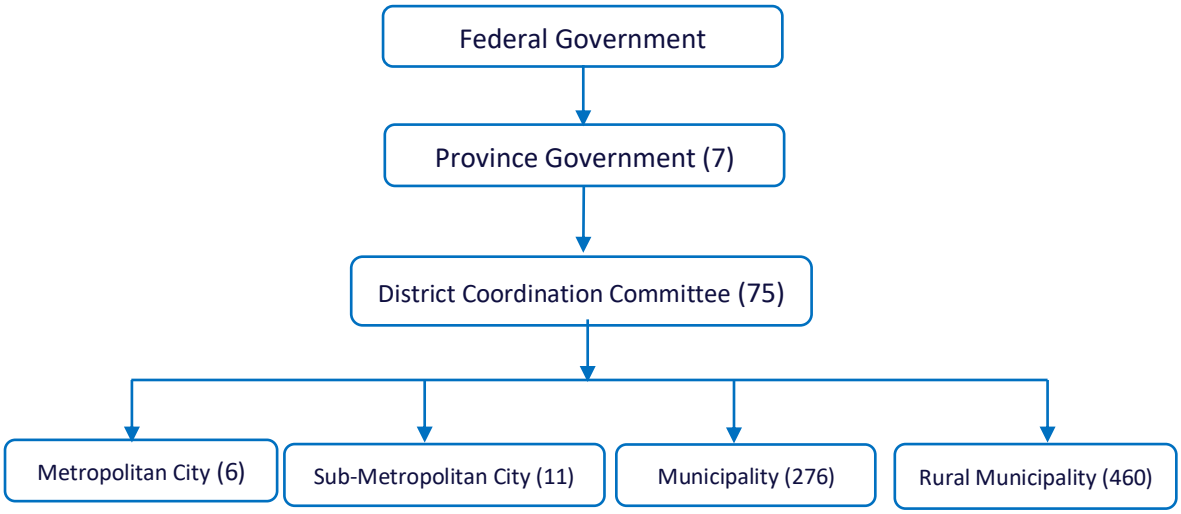


Figure 1. New administrative structure of the Federal Democratic Republic of Nepal

For the baseline assessment 35 municipalities from across 7 Provinces were selected as study area (**Figure 2**).

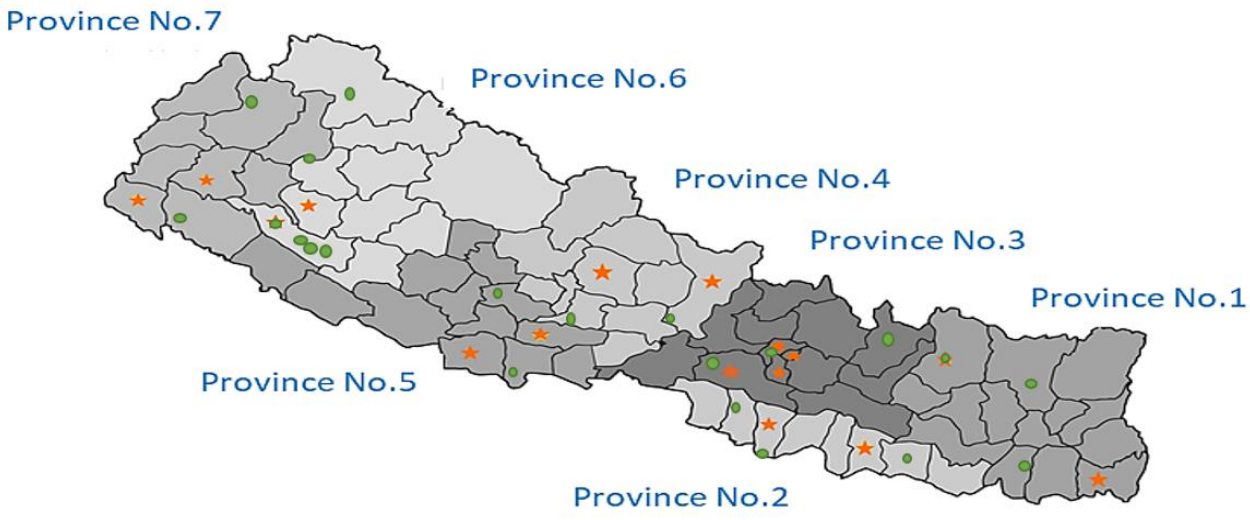


Figure 2. Location of the 35 municipalities

The topography (Terai, Hill, Mountain), population and economic development were considered as the important criteria in picking these 35 municipalities as the study area.

Table 1 below presents the classification of the municipalities based on its population coverage and geographical distribution. Further details of the 35 municipalities are presented in **Annex 1.**

S.No.	1	2	3	4	5	Total
Population range	<=25,000	25,000-50,000	50,000-75,000	75,000-100,000	>=100000	
No. of municipalities	5	9	3	7	11	35
Name of the Municipality	Chhayanath Rara, Jay Prithivi, Palungtar, Raskot, Solududhkunda	Bheriganga, Bhimeshwor, Dhankuta, Dullu, Gaur, Gurbakot, Lekbesi, Pyuthan, Sikhar	Gorkha, Lumbini Sanskriti, Waling	Banepa, Chandrapur, Kirtipur, Lahan, Mahalaxmi, Suryabinayak, Tansen	Bhimdatta, Birendranagar, Buddhabhumi, Damak, Dhangadhi Sub-Metropolitian City, Hetauda Sub-Metropolitan City, Itahari , Janakpur, Jitpur Simara, Kathmandu , Pokhara Metropolitan City	
Total Population	108,097	351,550	184,939	641,668	3,273,908	4,560,162

REGION	MUNCIPALITY
TERAI	Bhimdutta, Buddhabhumi, Chandrapur, Damak, Hetauda, Janakpur, Gaur, Itahari, Jitpur, Lahan, Lumbini and Dhangadhi Sub Metropolitian City,
MOUNTANIOUS	Raskot, Solududhkunda, Dullu, Chhayanath Rara, Jay Prithivi, Sikhar Municipality
HILLY	Gorkha, Pokhara-Lekhnath, Suryabinayak, Kathmandu, Mahalaxmi, Tansen, Banepa, Bheriganga, Bhimeshwor, Birendranagar. Dhankuta, Gurbakot, Kritipur, Lekbesi, Palungtar, Pyuthan Muncipality

Table 1. Demographic and geographical classification of the municipalities of 6 Mountain, 17 Hilly and 12 Terai municipalities

The selection of these 35 municipalities was made in close coordination with MoFAGA and the technical committee that comprised of line ministries, academician, municipality association and LEAD Nepal. MoFAGA is the coordinating focal ministry for the WCC project. The Technical Committee provided insights in designing the study approaches as well as facilitating the coordination among stakeholders. LEAD Nepal, the executing partner for the WCC project was in close consultation with MoFAGA and the Technical Committee throughout the survey process.

Waste composition analysis

The survey covered 35 municipalities comprising of 6 Mountain, 17 Hilly and 12 Terai municipalities. In these municipalities, a survey via structured questionnaire was conducted at three strata: at Household, Institutions and Commercial establishments including Healthcare Centers Temples and Slaughterhouses.

Since a municipality is dived into several wards[1], the team selected several wards bearing in mind the economy, geography and population of the wards. The number of wards selected varied on the size of the municipality. The field teams consulted with the Ward Citizen Forum (WCF) and Women's Groups to access socio-economic composition of the community and their waste management practices while selecting the wards. They survey covered 4000 HHs, 1175 commercial enterprises and 1100 institutions across 35 municipalities

After identifying these respondents from three strata, a survey form was filled. A data recorder sheet was designed and circulated to the enumerators. These respondents were provided with bags for the collection of waste generated in that household, institution, and commercial establishment within 24 hrs. These were weighed to calculate the total and per capita waste generation, as well as to determine the composition of the waste. The average per capita waste generation from these three sources was combined to calculate the overall per capita MSW generation in each municipality. For waste composition analysis, the collected waste was segregated into eight components, and each segregated component was weighed to calculate the percentage composition.

A partnership was built with the local Tribhuvan University and 68 students were selected, trained and recruited as the field enumerators. A four-day workshop was organized for the enumerators explaining the objective and framework of the empirical study. The survey forms were explained in detail, and the waste measurement and composition analysis steps were also taught through demo exercise. After the training, the enumerators were deployed to the field visit for 20 days. Each enumerator was equipped with safety gears and waste composition analysis tools. The baseline survey was conducted in the month of

[1] Ward is the smallest administrative unit in the municipality.

March–April 2018 and 2019 (summer dry season). No seasonal comparison was made due to limited time and budget constraints.

Waste characterization analysis

In addition to the waste composition analysis at the sources (HHs, institutions, and commercial establishments), the landfill in Kathmandu, Pokhara Lekhnath, Buddha Bhumi, and Birendranagar municipality were visited and a composition analysis was conducted using the quartering and coning method. The homogeneous mix of the landfill solid waste, as well as landfill leachate samples were brought to the Soil, Air, and Water Testing Laboratory in Kathmandu for waste characteristics analysis. Heavy metals in leachate samples were tested, while the solid waste was tested for various parameters such as moisture content, total solids content, total volatile solids content, total fixed solids, total organic Carbon, and total Nitrogen content. Based on the characteristics of the waste, a biomethane potential was also calculated.

Key informant interviews/stakeholder consultation

Key stakeholders from the government, non-government, private sector, civil society were consulted to understand their roles and responsibilities in waste management. These key actors were consulted specifically on how they can be engaged in formulating and implementing the province and municipal level policy and plans on waste management in the later stage of the WCC project implementation. A structured questionnaire was used for the interview. One of the outcomes of the key informant interview was the synthesis of the information into a Strength Weakness Opportunity and Threat (SWOT) analysis

The informal waste sector is an integral part of waste management. 185 individual itinerant buyers/scrap and 135 scrap dealers were interviewed through a structured questionnaire. The interview quantified the total quantity of recyclables collected and sold, and the environmental health and safety practiced while dealing with waste were also assessed. The gender roles in the informal waste picking and scrap dealing business were also analyzed.

In totality, structured questionnaire for the following seven respondent groups were developed and filled to arrive at assessment of the current status of waste management practices in the 35 municipalities; a)households, b) commercial & institutional establishments c) informal waste collector/pickers and scrap dealers d) farmers & fertilizer shops e) municipalities f) Landfill operators, g) slaughter house & Temples and h) medical institutions and the pharmacy.

Calculation of SLCP emissions from the waste sector

The contribution of SLCPs at various stages of waste management (from waste generation to collection to transportation, recovery, recycling and disposal) was quantified using the Solid Waste Emissions Estimation Tool (SWEET). The SWEET was developed by the U.S. Environmental Protection Agency (with assistance from Abt Associates and SCS Engineers) on behalf of the Climate and Clean Air Coalition Municipal Solid Waste Initiative (CCAC-MSWI)[2]. SWEET is an Excel-based tool that quantifies emissions of methane (CH_4), black carbon (BC), and other pollutants from the MSW sector. The tool provides emissions and emissions reduction estimates at the project, source, and municipality-level. The information is useful in establishing a baseline scenario, comparing a baseline scenario to as many as four alternative scenarios, analyzing specific projects for potential emissions reductions, estimating the contribution of activities in the waste sector to overall city emissions reduction goals, and tracking progress over time, among other things.

This is first of a kind attempt in Nepal to quantify SLCPs from the waste sector. The estimation of SLCPs from waste sector will be used for a comparison when the WCC project pilots the ESTs to reduce SLCP emissions from the waste sector, as a part of the project outcomes. A set of data on waste collection, transportation, waste handling equipment, composting, anaerobic digestion, waste burning, recycling facilities, landfills and dumpsites etc. were collected based on the SWEET template. Later, the data sets were computed using SWEET to generate the SLCP emissions scenarios at the municipal level.

Data analysis

The pre-coded field data sheets/survey questionnaires were carefully recorded using Microsoft Excel. Utmost care was given while recording the data in order to avoid mistakes, and several checks were done to assure the quality. After the data entry, a detailed analysis was performed and the results were inferred through calculation and were reflected as consolidated tables, as well as visual representation using graphs and charts.

Scope and limitations of the study

The baseline study is an extended effort to assess the current waste management practices in selected municipalities in a new federal administrative structure. However, the task was very challenging since the administrative restructuring is relatively new and local self-governance acts and regulations are yet to be in place.

One of the limitations of the study is the low coverage given the large size and population of the municipality. Due to time and budget constraints it was not possible to conduct the baseline in all 460 urban municipalities. The study, nonetheless, selected 35 municipalities from across the 7 Provinces while considering the socio-economic, demographic, geographical and ecological diversity. The study areas represent all 3 level of metropolitan governance: Metropolitan city, sub-metropolitan cities, and rest as (urban/rural) municipalities. The findings from these selected municipalities are expected to reflect and extrapolate the waste management system in urban population. The scope of the study encompasses mainly the MSW from domestic, commercial and institutional sources. In addition,

[2] http://www.waste.ccacoalition.org/document/solid-waste-emissions-estimation-tool-sweet-version-20

health care waste, agricultural waste, disaster waste, e-waste, slaughterhouse and e-waste were also studied in the study, but in a smaller sample size. Thus, the scale might not reflect the overall national situation but gives a glimpse of components and current management practices of these special waste streams other than MSW.

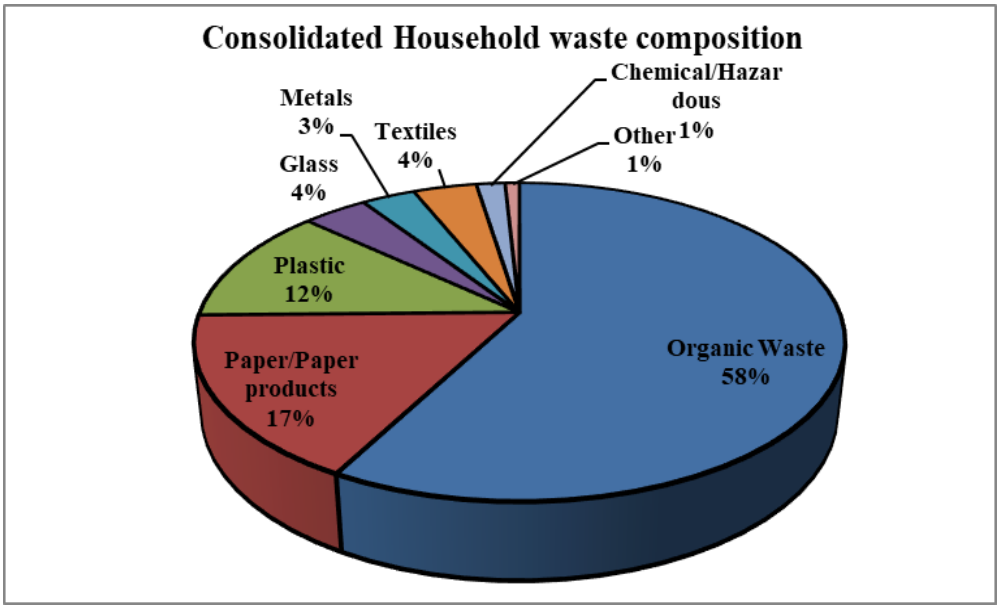
Estimation of the SLCP emissions from the waste sector encountered data constraints. It was observed that municipalities do not keep a detailed record of the waste management activities. It was, therefore, difficult to collect a reliable baseline data despite the comprehensive SWEET template. Many assumptions were made while quantifying the SLCP emissions from the waste sector in Nepal.

CHAPTER 3: FINDINGS OF THE BASELINE SURVEY

Composition of Solid Waste in 35 Municipalities

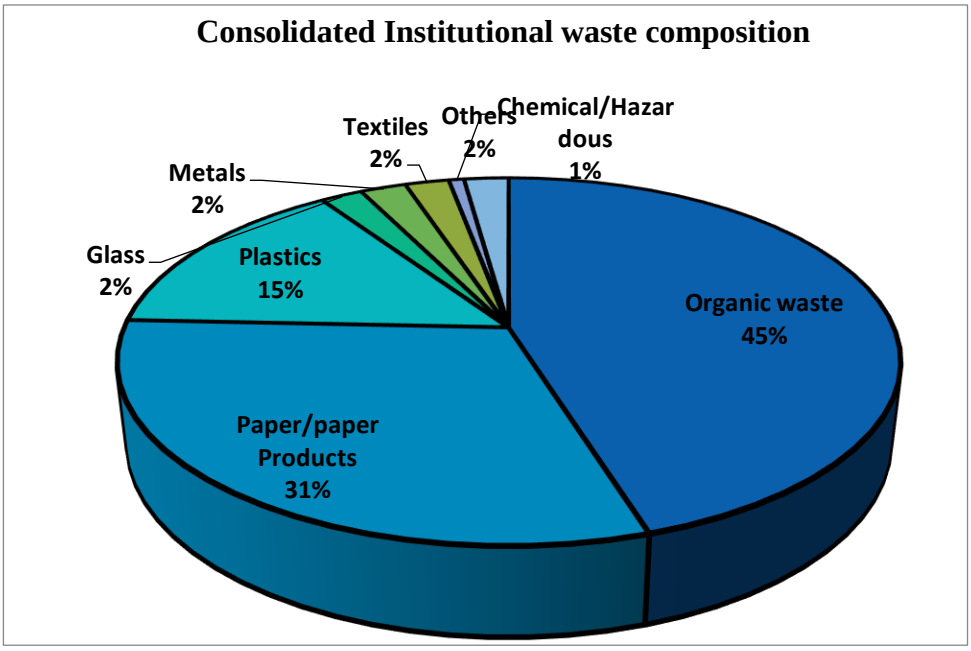
Primary data collected from 4000 households (HHs), 1175 commercial and 1100 institutions across 35 municipalities from different economic status and topography shows that organic waste is the major composition of waste generated at every level.

Household waste composition:



Data collected from 4000 HH shows that organic is the major waste generated at this level at 58%. Followed by paper and paper products at 17% and Plastic at 12 %. Paper and paper products can be composted or recycled while plastic can also be reused. Some glass, metal and textiles can also be recycled.

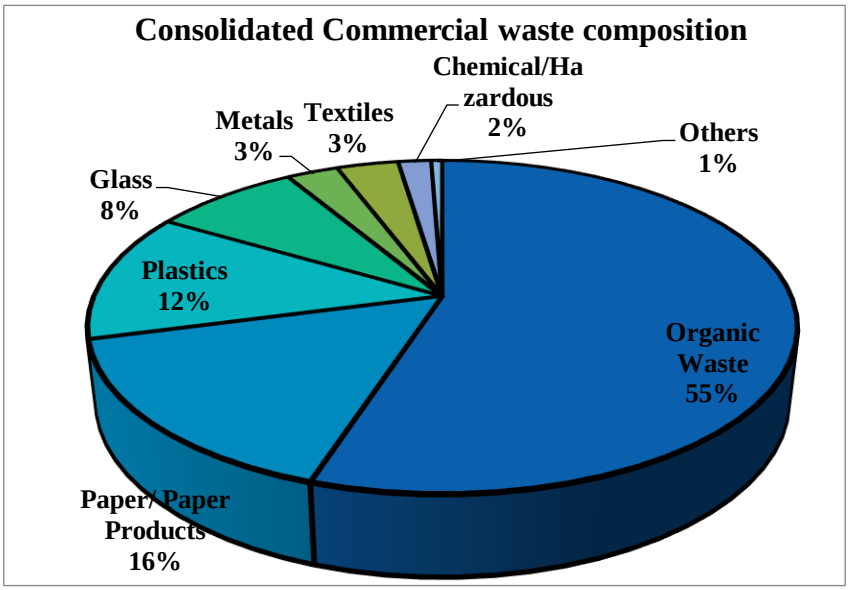
Institutional Waste Composition:



Data Collected from 1175 Institution shows organic waste as the major contributor of waste at 45 % closely followed by paper and paper products at 31%. Plastic waste generated is at 15 %.

So, we can safely assume that 90.54 % can be composted, recycled or reused.

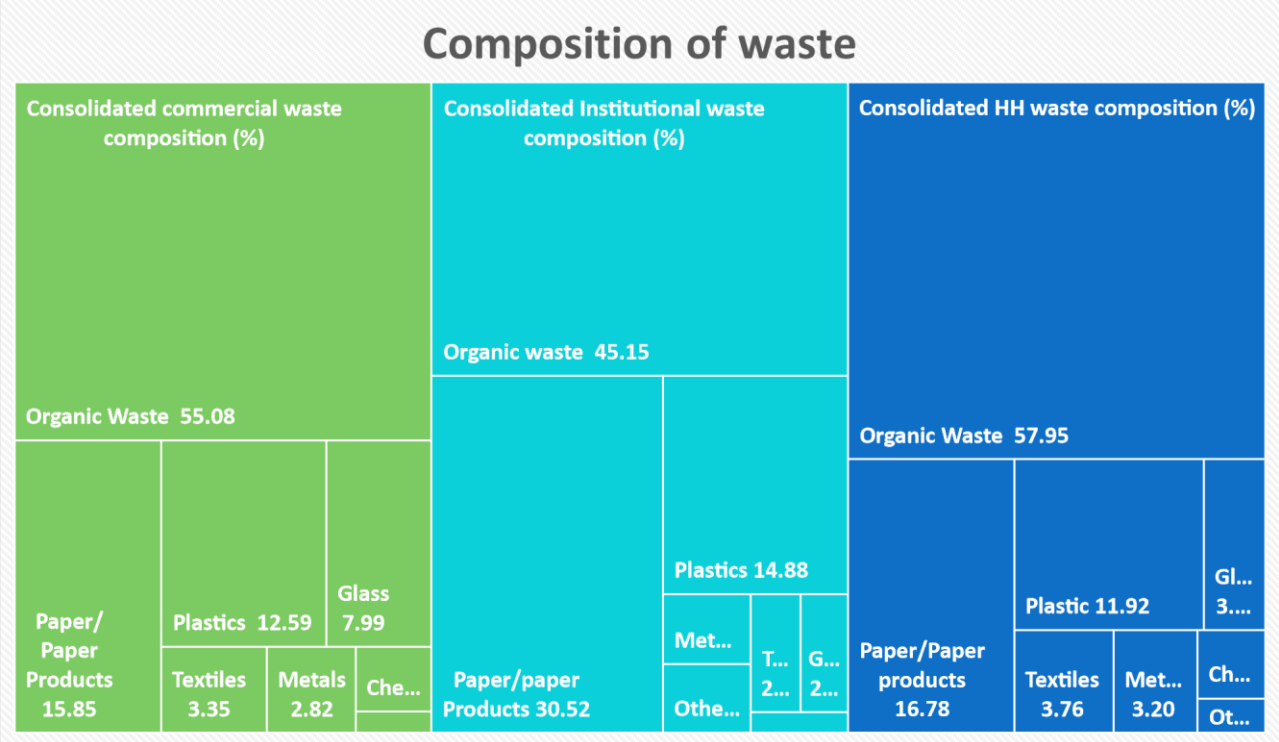
Commercial Waste Composition:



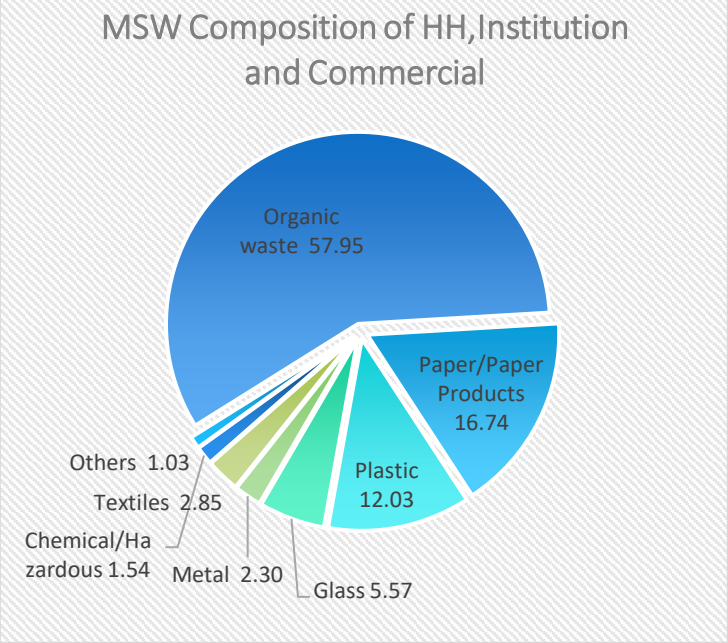
Data collected from 1100 commercial sector from all 35 municipalities show that organic waste is generated at 58% while paper and paper products at 16 %. Plastic waste generated is at 12 %. Most of these wastes can be recycled.

With proper education and facilities waste generated by this sector can be minimised by 83% or more.

Consolidated Waste Composition of Household, Institution and Commercial Sector



Waste %	Organic	Paper/Paper products	Plastic	Glass	Metals	Textiles	Chemical/ Hazardous	Other
Household	57.95	16.78	11.92	3.85	3.20	3.76	1.70	0.86
Institution	45.15	30.52	14.88	2.08	2.26	2.16	0.75	2.20
Commercial	55.08	15.85	12.59	7.99	2.82	3.35	1.80	0.60



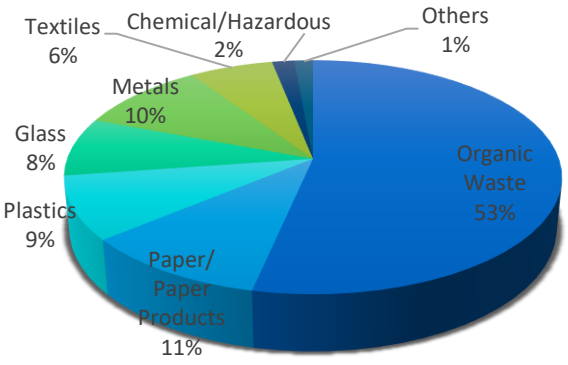
WASTE COMPOSITION COMPARISION

Organic waste is the major composition of waste generated in Household, Institution and Commercial Sector. They are at 57.95%, 45.15% 55.08% and 5.57%. Paper and paper products waste generated is highest in institutions at 30.52% followed by household at 16.78% amd commercial at 15.85%. Plastic waste is generated approximately at the similar rate at 11.92% in HH, 14.88% at institution and 12.59% at commercial sectors.

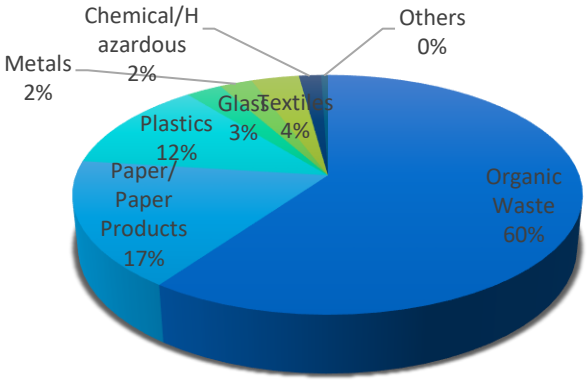
Organic waste from all sectors is at 57.95%. While paper and plastic follow at 16.74% and 12.03%. It would be safe to assume that waste can be reduced by 95%.

Composition of waste varied among different geographical locations

Household Waste Composition in Mountain, Hilly and Terai region:



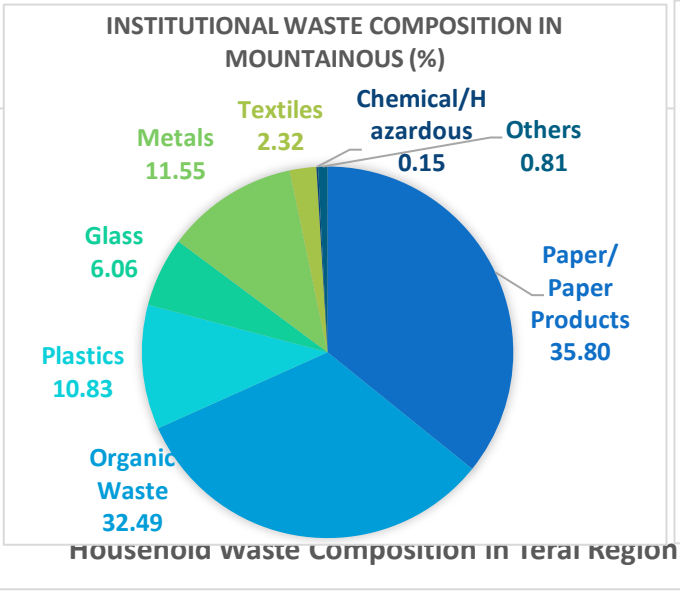
Household Waste Composition in Mountainous Region

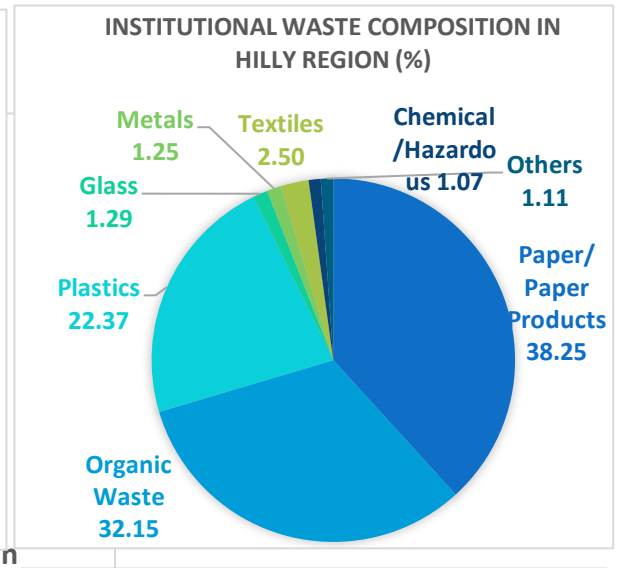


Household Waste Composition in Hilly Region

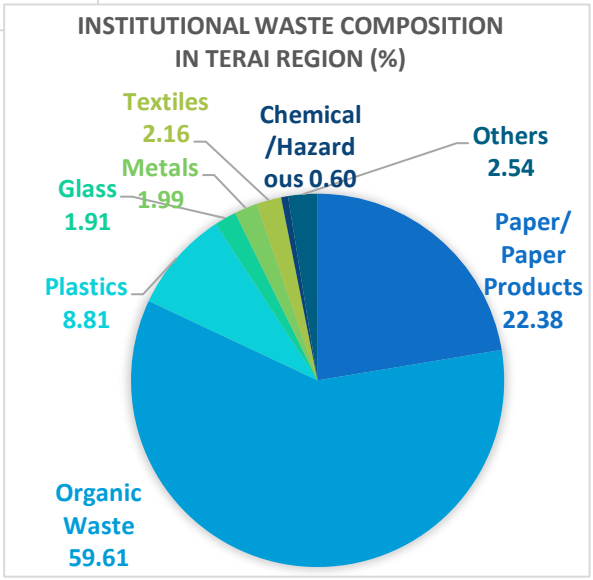
As you can see from the figures organic waste is still the major composition in all the regions followed by paper and plastic. However hilly regions are at 60% while terai is at 57% and mountain region is at 53 % for organic waste. While terai is leading in paper and paper products at 19% followed by hilly at 17% and then mountain at 11%. Waste composition of plastic in terai is at 13% followed closely by hilly at 12% and mountain regions is at 9%. Thus, you can see that the composition of waste is different in different regions. This should be considered while creating an effective solution for waste management.

Institutional Waste Composition in Mountain, Hilly and Terai region





Household Waste Composition in Terai Region

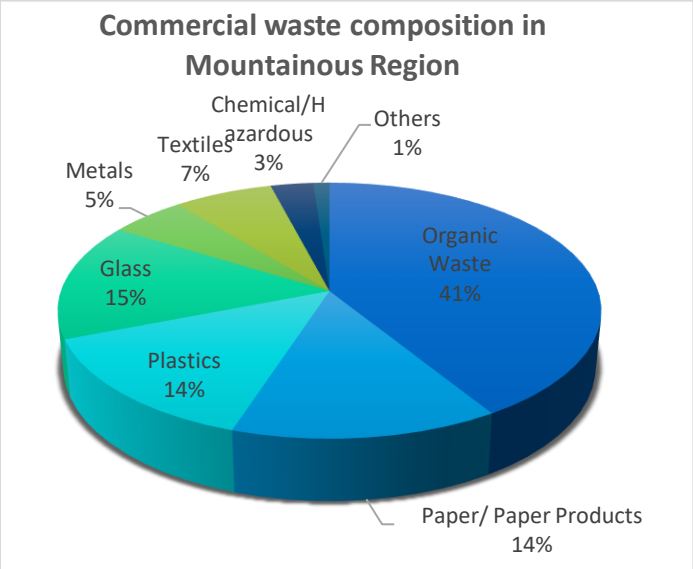


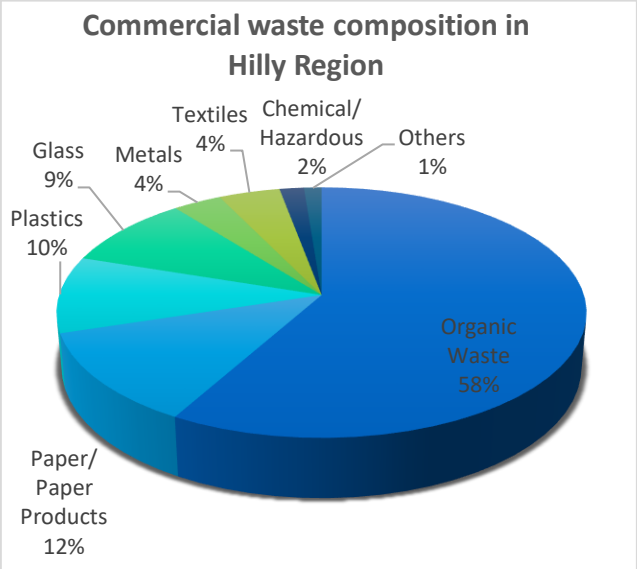
As shown in the figures a notable difference in the composition of waste in the 3 regions is

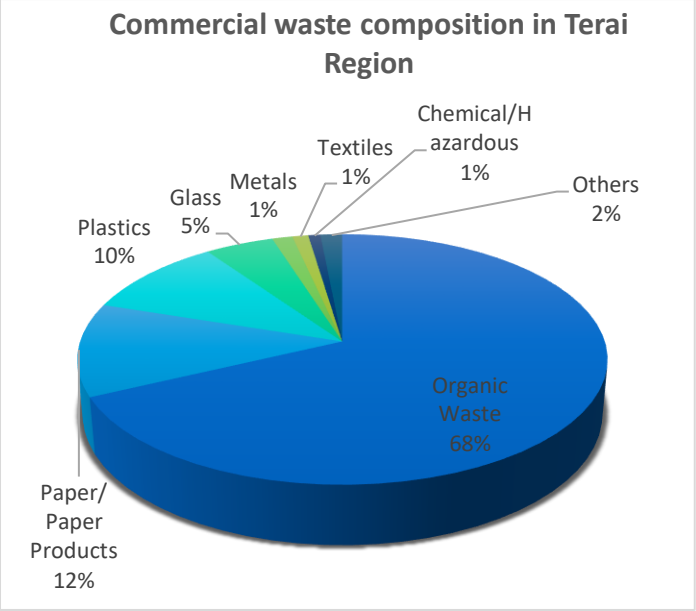
1. Major waste composition in hilly and mountain region is paper and paper products at 38.25% and 35.80%. While the major waste composition in terai is organic waste at 59.61% and then paper at 22.38%
2. Plastic waste is in hilly regions is also a high contributor at 22.37% when compared to mountain at 10.83% and in terai at 8.81 %

This clearly shows that the composition of waste varies in different regions. This should be considered while formulation an effective waste management solution.

Commercial Waste Composition in Mountain, Hilly and Terai region:







Organic waste is again the major component of waste in commercial waste. Organic waste in terai is the highest at 68% followed by Hilly at 58% then Mountain region at 41%.

Waste composition here is slightly different from HH and Institution when comparing plastic and paper products. The values are similar to each other in all the regions:

Mountain: Paper at 14%, Plastic at 14%

Hilly: Paper at 12%, Plastic at 10%

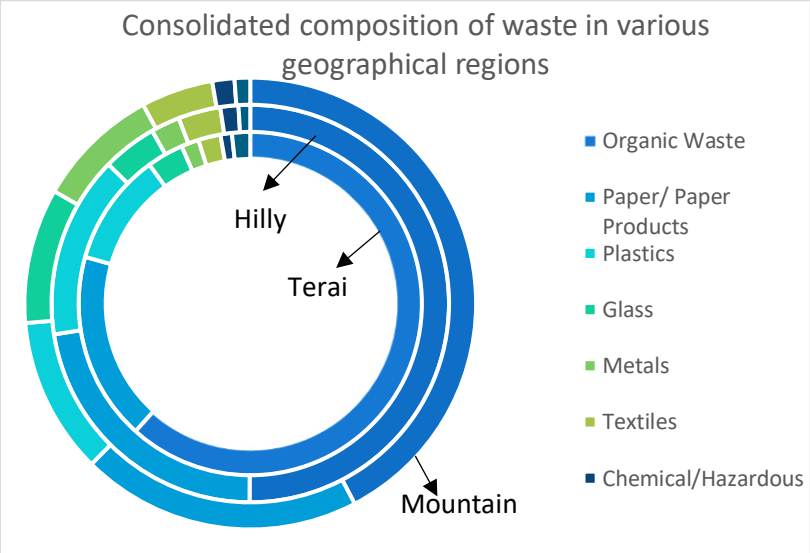
Terai: Paper at 12%, Plastic at 10%

Consolidate waste composition depending on topography (Mountainous, hilly and terai)

Consolidate waste composition varied among different geographical locations as depicted in the table and figure below:

Waste/ Region	Organic	Paper/ Paper Products	Plastics	Glass	Metals	Textiles	Chemical/ Hazardous	Others
Terai	61.66	17.73	10.61	3.45	1.66	2.10	1.07	1.71
Hilly	50.07	22.47	14.84	4.43	2.36	3.45	1.47	0.95

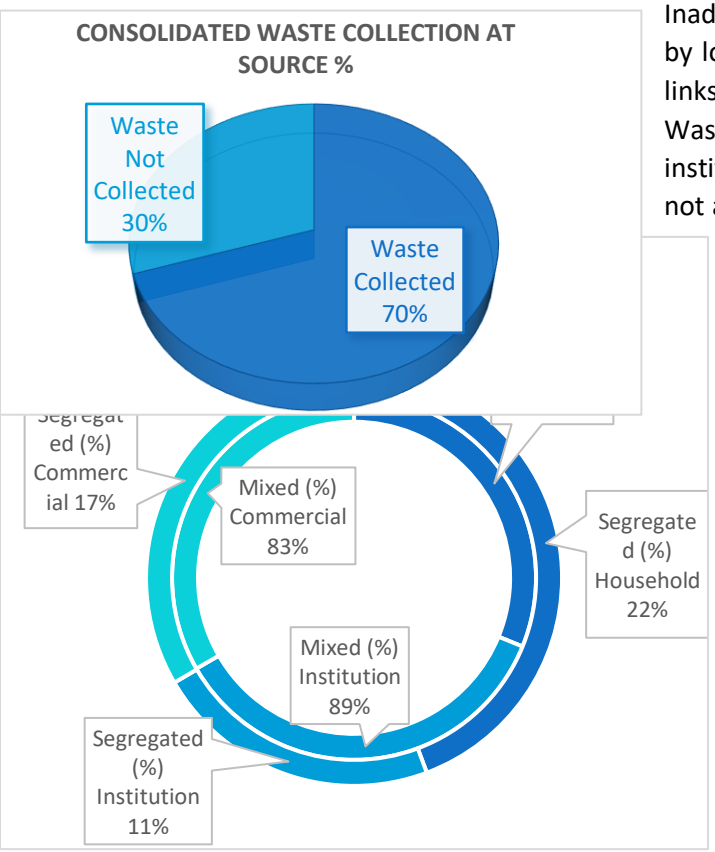
Mountain	42.35	20.07	11.21	9.66	8.85	5.16	1.59	1.11



Organic waste in the Mountainous region is approximately 20% less than the Terai region, which is at 61.66%. Paper and paper products show a difference of 4.5% between Terai and Hilly region. The mountains waste also show an 8.2% higher composition than the Terai. These differences clearly show that the composition of waste varies for each geographical location. Therefore, topography is a vital factor to consider when considering a strategy for waste management.

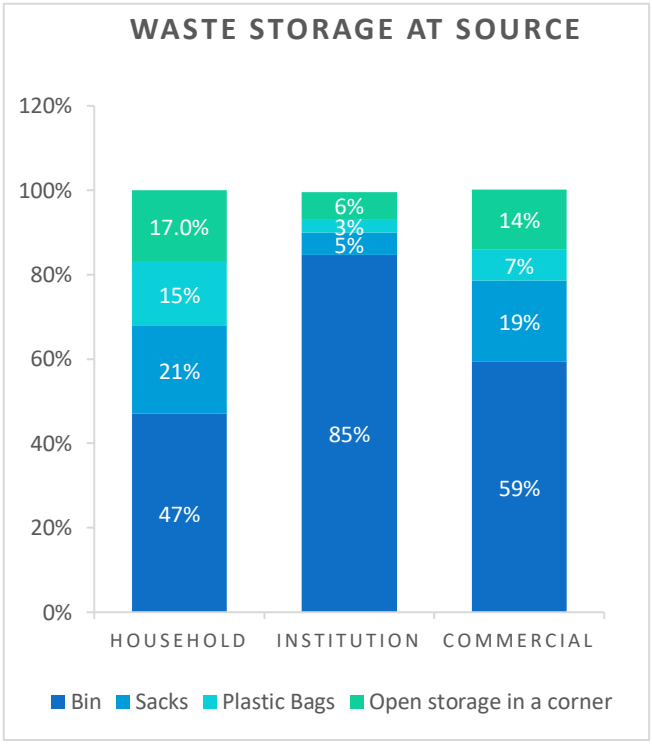
Existing MSW management system

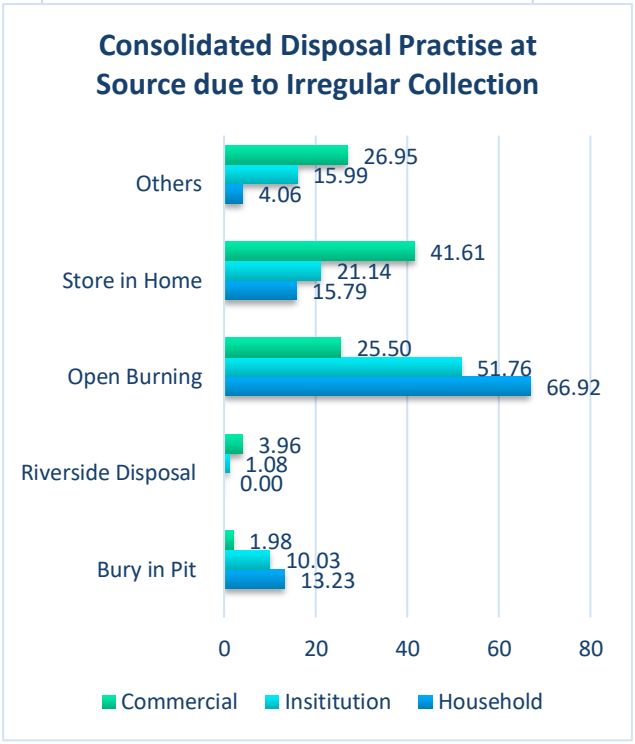
Collection and Segregation of waste:



Inadequate and ineffective waste collection by local municipalities is one of the weakest links in the MSW management in Nepal. Waste segregation at source by household, institutions and commercial establishments is not a common practice. However, few of the respondents were engaged in selling the high value dry recyclable items like metals, glass and plastic bottles. Only 17% of the total waste collected by the municipality is segregated.

Door to Door, Roadside pickup from open pile and Dumpster Collection are the three-prevailing system of waste collection. Solid waste collection system in many municipalities does not exist, if the system exists, it is not satisfactory. There was no collection service in several locations in the following municipality i.e. Dullu, Lekbesi, Mahalaxmi, Palungtar, Raskot and Sikhar, and Lakbasi. Due to irregular or no waste collection services, many respondents have taken up their own practices like burning, burying, composting and dumping their waste in rivers and roadside.





Is this ratio by number of respondents

Municipality Data on Waste Management System

Comprehensive and reliable data on various waste streams in the municipalities are currently missing. The difference in data received from the municipalities and the actual data from the baseline is indicated below:

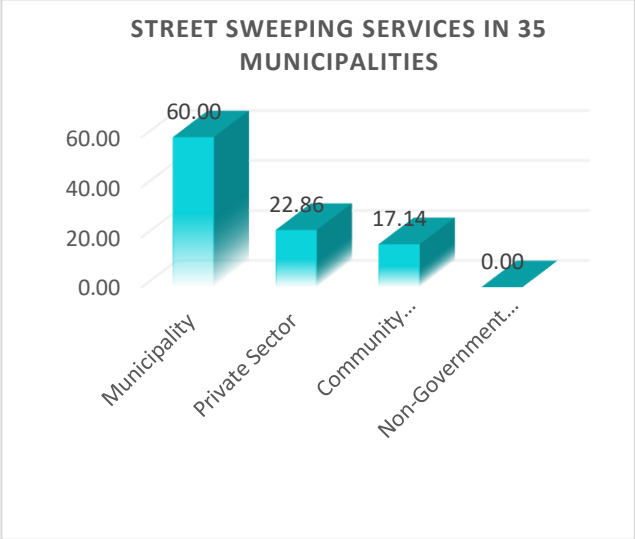
Waste Related Data	Data Point	Results	
		Municipality	Baseline
Waste per capita	capita/kg/day	0.25	0.37
Waste composition	Organic waste	0.21	57.95
	Plastic	0.07	12.03
	Paper/Paper Products	0.05	16.74
	Glass	0.03	5.57
	Metal	0.01	2.30

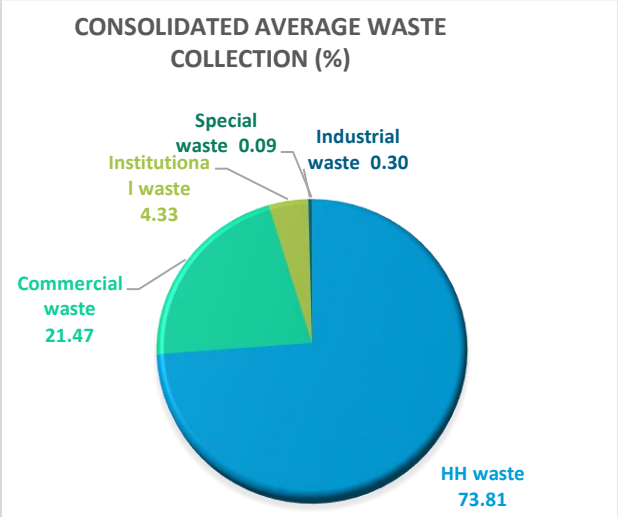
Glimpse of MSW System at work in the 35 municipalities:

Waste Collection:

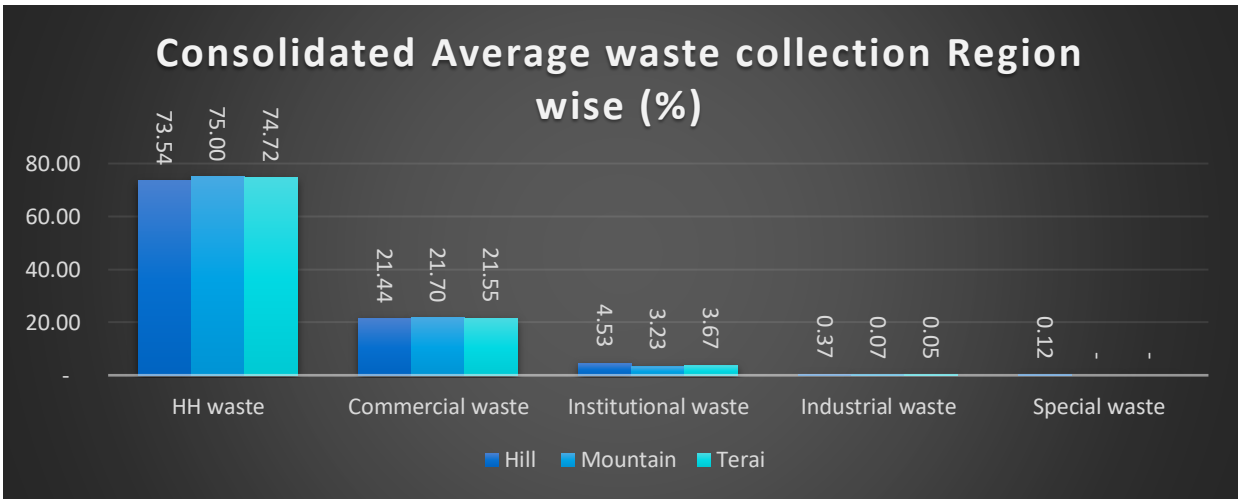
Waste Collection			
MSW collection (tons/day)	Waste collection coverage (access to a waste collection service in %)	Waste collection service	Frequency of cleaning streets and open spaces %
1706.66	70%	38% Door to Door 21% Roadside Pickup 41% Dumpster Collection	Daily: 5.71% thrice a week: 5.71% twice a week: 5.71% once a week:2.87% twice a year: 5.71% no sweeping system: 25.71%

The collection of waste is mostly handled by the municipality or given to contractors. 70 % of the 35 municipalities have access to waste collection either in the form of the collection at their door (38%), Roadside dumping then collected by the municipality (21%), in the public dustbins (41%). Cleaning open spaces and streets is mostly done by the municipality at 60%. In the case of 22.86% this contract has been given to the private sectors and 17.14% is handled by the community themselves. The baseline data indicate that in 35 municipalities the major service provided is street sweeping which constitutes of 74.29% followed by collection and final disposal site maintenance.





The pie chart below clearly shows that majority of the waste is collected from households at 73.81%. If the focus is given to segregation at the household level, the waste collected can be turned to resources by at least 95%. The bar chart on the below the waste collected from different regions. The chart indicates that the waste composition is different in different regions.

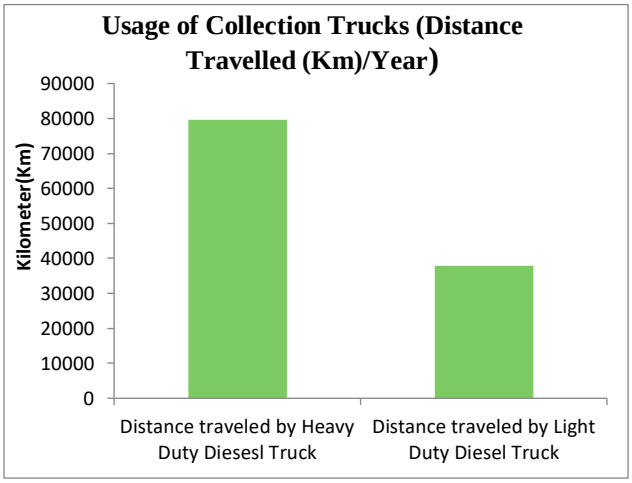


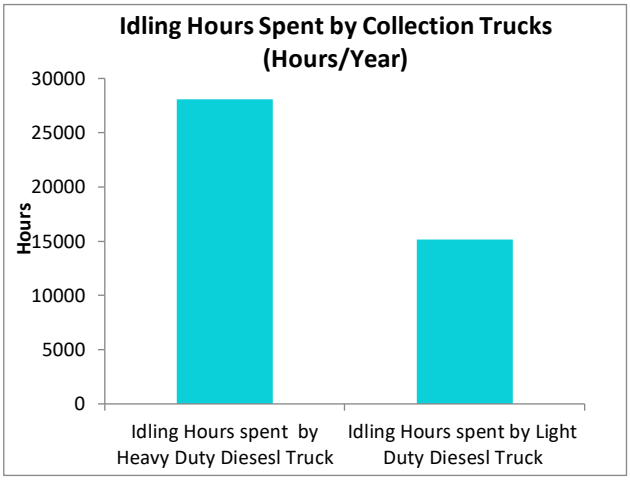
Equipment and Vehicles used in Waste Management

Type of Transport	*Total Number*	*Note*
Rickshaw / Cart	*98*	
Tractor / Power tiller	*90*	
Tipper / Dump trucks	*81*	
Heavy-duty diesel trucks	*66*	
Tractors/ backhoes	*42*	
Other	*31*	
Light-duty diesel trucks	*17*	
Excavators	*11*	*3 in Kathmandu and 2 in Jitpur Simara*
Loaders	*8*	
Hydraulic Campuster	*7*	*only in Pokhara*
Bulldozers	*6*	
Graders	*4*	*all 4 in Kathmandu*
Forklifts	*4*	*all 4 in Kathmandu*
Compacter	*3*	*one each in Kathmandu, Hetauda and Buddhabhum*

The number of technologies and equipment for transportation, collection and handling different streams of waste is insufficient for effective waste management. The existing machines are not run efficiently, and proper maintenance was also lacking as per baseline observations. Most of the machines were not environmentally friendly. All these factors contribute to the pollution of the environment and needs to be rectified as soon as possible. Lack of budgeting and improper planning is one of the reasons for this number.

<table>
<tr><th colspan="2">Waste Treatment and Disposal in 35 municipalities</th></tr>
<tr><td>MSW Disposal</td><td>7 do not have collection system so no disposal
35 practice open dumping.
25 have authorized dumpsites.
3 have sanitary landfill.
25 practice riverside dumping.
35 practice open burning
28 practice burying of waste
(Most of the municipalities waste are collected by either municipality and private sector.</td></tr>
<tr><td>Transfer Station</td><td>3 out of 35 municipalities Hetauda, Kathmandu and Kritipur</td></tr>
<tr><td>No. Composting Plants</td><td><table>
<tr><th>Composting Plants</th><th>Number</th><th>Total Capacity(tons/day)</th><th>Total Waste Received(tons/day)</th></tr>
<tr><td>Community Level</td><td>4</td><td>9</td><td>1.8</td></tr>
<tr><td>Municipality Level</td><td>3</td><td>11.8</td><td>3</td></tr>
</table></td></tr>
<tr><td>Quality of environmental protection in waste treatment and disposal</td><td>Low (< 5%) 2 out of 5 Anaerobic Digestion Plants is operational (Hetauda and Kathmandu), Only 1 out of 3 Sanitary landfills is well maintained.</td></tr>
<tr><td>Recycling rate (% of total MSW generated that is recycled as materials or as organic products</td><td>Low (<8%) Most of the scrap dealers are not registered therefore not included in this record.</td></tr>
</table>





Waste Treatment and Disposal

Governance in 35 Municipalities

Governance factors in 35 municipalities	
Municipality Budget 2075/76	15 municipalities did not allocate budget for SWM. Those that allocate budget were 2.96% of the total municipality budget.
SWM Budget Dispersal (NPR millions) 2075/76	Street Sweeping 8 Waste Collection 13 Landfill disposal 12 Others 18
Waste Collection Fee (NPRs)	HH Rs.50- Rs.200, Institutions Rs.100- Rs.3000, Hotels Rs.100- Rs.7000, Restaurants Rs.100- Rs.1000, Others(Hospital, Slaughter House, Industry) Rs.40 - Rs.8500
SWM Employees	Staff 1131, Male 704, Female 427, Lower Level Staff 1050
Sound institutions, proactive policies	Medium but policies are being amended to reflect the need of sound waste management practices
Enforcement	Low (< 5%)

Budget: As you can see in the table below the SWM budget for the year 2075/76 is only NPR. 681 million for the 35 municipalities. This amounts to 2.97% of the total municipal budget. The SWM budget is also not being fully utilized. The lack of planning, improper records and knowledge of the importance of proper waste management are factors that contribute to this situation.

Total Allocated Municipal Budget (NPR in million)-Consolidation				
Actual			Budgeted	Total
Actual (2072/73)	Actual (2073/74)	Actual (2074/75)	Budgeted (2075/76)	Total
3003.181	7,586	22,156	22,939	55,684

Allocated in SWM (NPR in million)- Consolidation				
Actual			Budgeted	Total
Actual (2072/73)	Actual (2073/74)	Actual (2074/75)	Budgeted (2075/76)	Total
71.325	416	3,003	681	4,171

Expenditure in SWM (NPR in Million)- Consolidation			
Actual		Budgeted	Total
2073/74	2074/75	2075/76	Total
33.37	924.99	29.94	988.31

Fees for waste collection are haphazard and vary widely from one ward to another. Some municipalities do not collect fees in while several wards do not have waste collection system.

Waste collection charges and penalty can be a great source of income that could be put back to the community. The revenue from this sector is as follows:

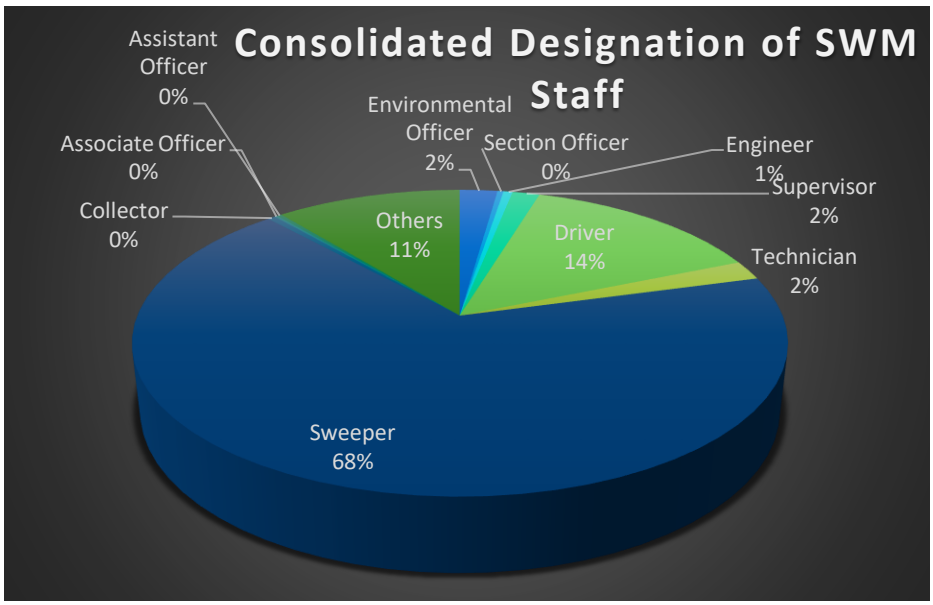
Fee collection			
Actual			Budgeted
2072/73	2073/74	2074/75	2075/76
14.54118012	12.879639	23.803	0

Other SWM fee (charges/penalties etc.)			
Actual			Budgeted
2072/73	2073/74	2074/75	2075/76
0	17.29	14.885	21.03

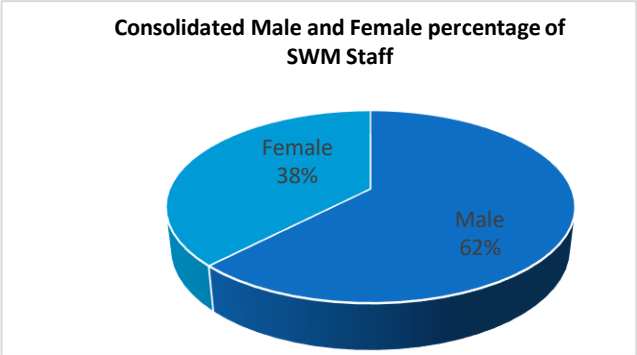
Total Revenue			
Actual			Budgeted
2072/73	2073/74	2074/75	2075/76
0	21.99	5.695	16.33

Gender and Waste Management

SWM Employees: The SWM staffs are a mix of ethnicity and gender. There are patterns to the staffing for example the sweepers, waste collectors, scrap collectors, sweepers and drivers mostly belong to the lower cast.



Male employees are at 62% whereas female employees are at 38%. Data also shows that there is gender subjective based on the job title and category. For example, 100% Ward heads, 100% of engineers, 100% of waste collectors and 99% of the drivers are male. SWM is a male dominated sector as per the baseline survey as shown in the bar graph below.



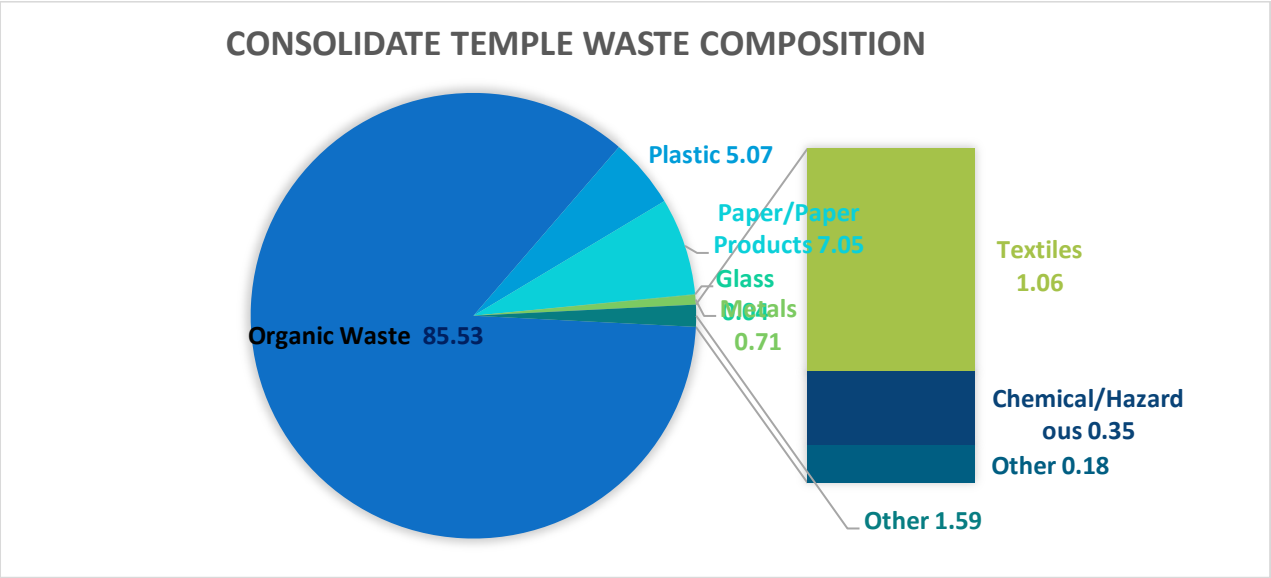
Special Waste

Temple and Slaughterhouse Waste

Assessment on slaughterhouse and temple waste was done specifically to showcase the idea that these sectors can be handled by the respective team/association at their place of work without outside intervention.

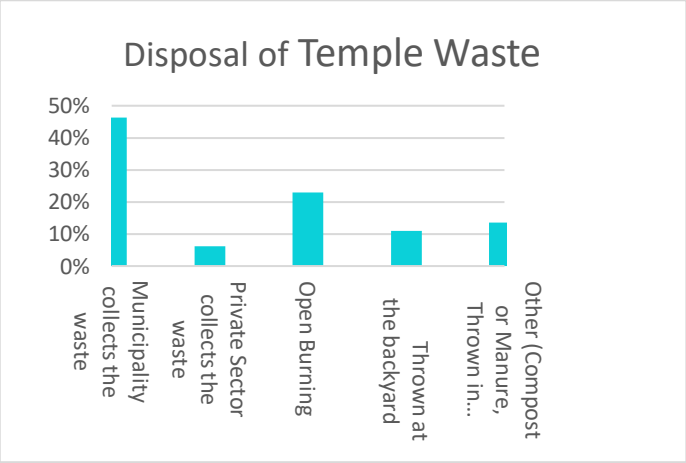
Temple Waste:

33 temples were surveyed to get a picture of waste generated and managed in this sector. 100.86 Kg waste was generated per day in 33 temples. The composition of waste are as follows:



Waste generated in this sector is mostly organic and can be converted into compost to reduce waste generation as well as to be used in their own little temple garden. Therefore, only the dry waste could be sent out of the temple for recycling.

Waste Management in the temples are as follows:



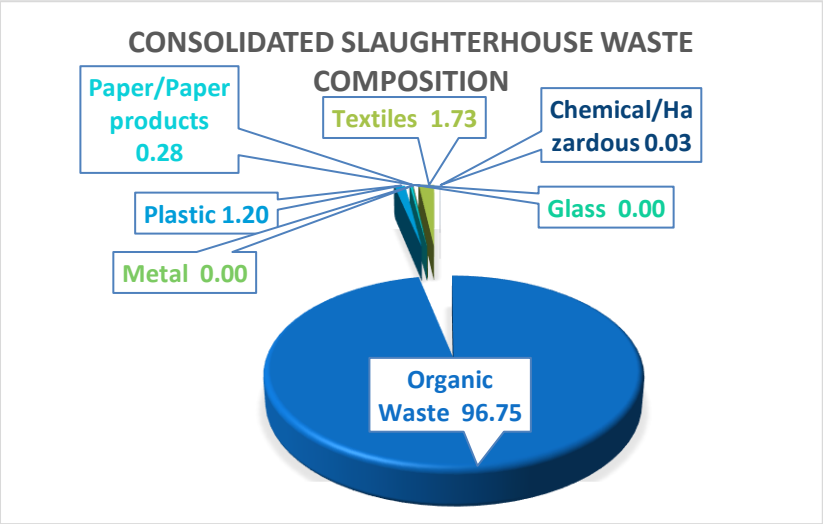
Only 1 (Dhangadhi Sub-Metropolitan City) out of the 35 municipalities segregate their temple waste. 11 municipalities collect waste daily while 6 municipalities get their temple waste collected twice a week. The rest either have a weekly collection or no municipality pick up at all. They either dump their waste on open land, rivers or burn them. Only 3 municipalities practice composting.

76% of the population has no knowledge of what happens to the waste after it is collected. Only 3 municipalities pay for waste collection. The survey showed that 8 municipalities are not willing to pay for waste collection. This could be the result of no education of the impact of improper waste disposal or the frustration of the current irregular waste collection practice.

Slaughterhouse Waste

The waste generated in this sector was mostly flesh, fur and bones which were mostly sold, and the only actual waste was that of animal discharges. This could be a great source for energy (biogas) for the slaughterhouse as they need to constantly boil water to separate the fur from the flesh.

However, millions of flees were seen feasting over animal discard. The average waste generated per day was 46.19 kg. The composition of waste is as follows:

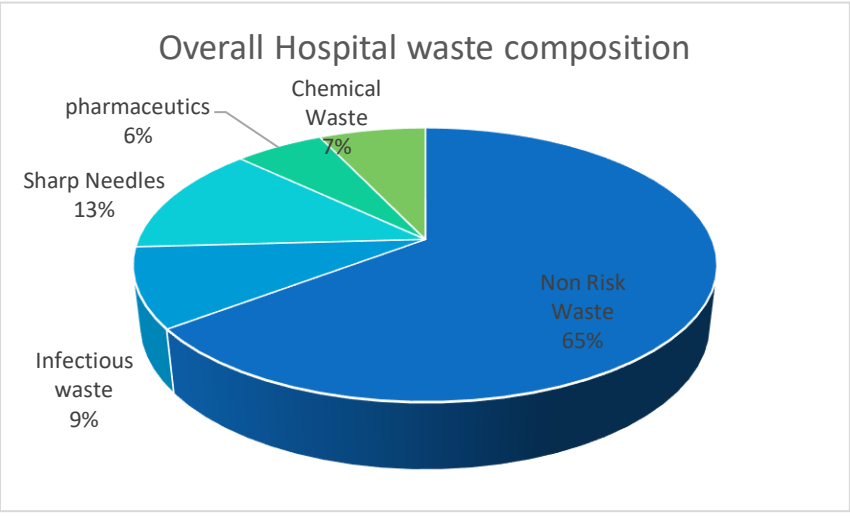


96.75 % of the waste can be recycled by converting organic waste to compost or biogas. Also, some paper, textiles and metal can be recycled. Thus, the realization of zero waste in this sector is also feasible.

The focus of the baseline study is on MSW, however a couple of other waste stream such as E waste, agricultural waste, healthcare waste, and disaster waste were also studied briefly.

Healthcare waste

Medical waste is the waste generated from various healthcare facilities including hospital, clinics, as well from pharmacy shops. During the survey it was observed that the participating hospitals practiced color coded bins for waste segregation. Red bins were for infectious waste such as blood and blood contaminated waste and sharps (syringes); blue bins collected non-hazardous inorganic wastes like paper, metal, and green bins were for non-risk and biodegradable waste.



Non risk waste made up to 65%, sharp needles to 13%, infectious waste to 9%, pharmaceutics waste to 6% and chemical waste to 7%.

Nearly 65% percent of the waste from healthcare institutions are non-infectious and non-risk waste, while remaining waste included pathological waste, sharp needles, and chemicals and expired medicines that require special disposal methods to avoid public health risks.

Survey results show that open dumping, burial and open burning of healthcare waste are the most common disposal practices.

Like hospitals, pharmacies also produce infectious and general waste. **Figure 3** represents the average composition of waste from pharmacy

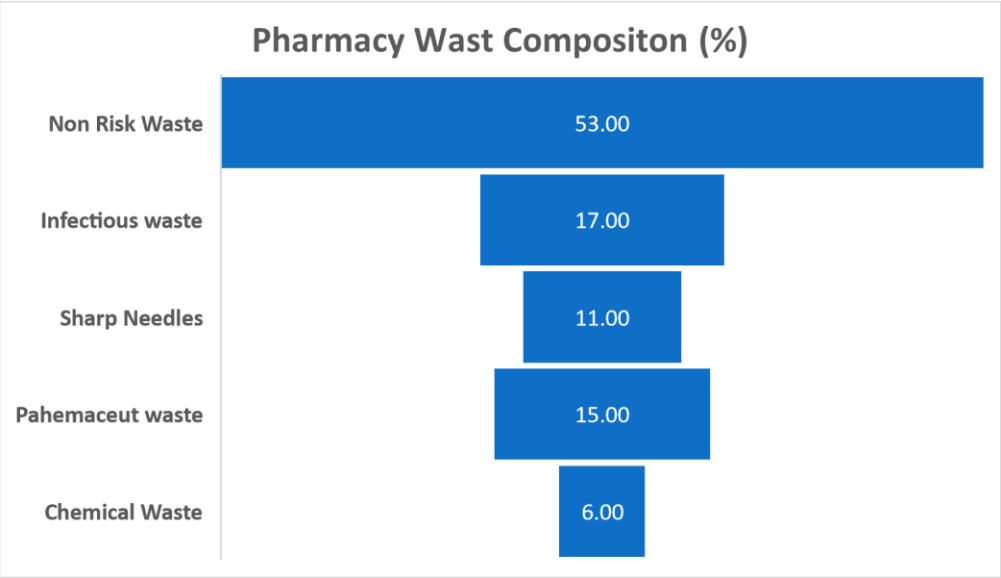


Figure 3. *Composition of waste at pharmacy shops*

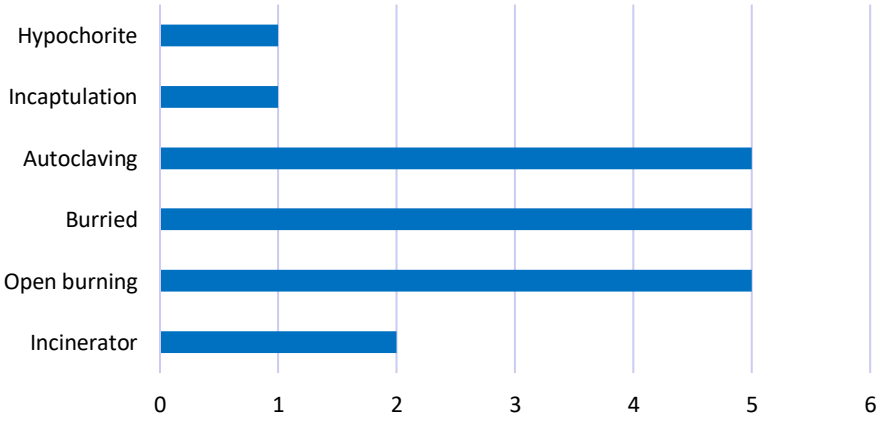
Of the 35 pharmacies surveyed, 70% of the pharmacies did not practice segregation of general and infectious waste. 50% of the waste from the surveyed pharmacy were collected by municipality and 10 percent by private company. Rest 40% were never collected and hence was managed by the pharmacy shop owners themselves. These wastes were managed by burning in the open or disposed in the backyard.

"....the municipality collects waste from our institution once a week, rest of the week we either dump or burn the waste in a nearby forest area..."

Open dumping of health care waste

Burning of health care waste, Doti

Very few hospitals have incineration facility. These Incineration facilities are a basic structure with a certain land area demarcated by concrete block to burn sharps. Some hospitals practiced scientific methods such as encapsulation and chlorination using hypochlorite to manage their wastes. **Figure 4** depicts the various waste



management practices adopted by the healthcare institutions that were surveyed.

Figure 4. *Waste disposal methods practiced in surveyed healthcare institutions*

Some of the healthcare institutions outsource the health care waste collection and management to a private company.

Healthcare waste management in Pokhara

Good Practice:

Waste Service Private Limited collects medical waste in Pokhara. The private company provides healthcare waste collection and management services to 70 healthcare institutions in and around Pokhara. The company has 18 staffs. Two diesel trucks with the capacity of 1.5 tons of infection waste (in white color truck) and 2-ton capacity non-infectious general waste (in green truck) is collected.

Organic waste is sold as animal feed to pig farms, and rest are sent to the MSW collection system. The company has a plan to build a compost plant of its own. Recyclables items are sold to scrap dealers. Infectious waste, pathological waste and sharp needles are autoclaved and disposed using deep burial method. The two autoclaves of 511 Liters and 420 liters capacity operate at 121 degree Celsius and 15 psi for 45 minutes. Medicines that have passed expiry date of 3 months are returned to the supplier, others are separated and encapsulated, autoclaved and is buried deep. The company owns a shredder machine but remains unused until the time of the baseline survey.

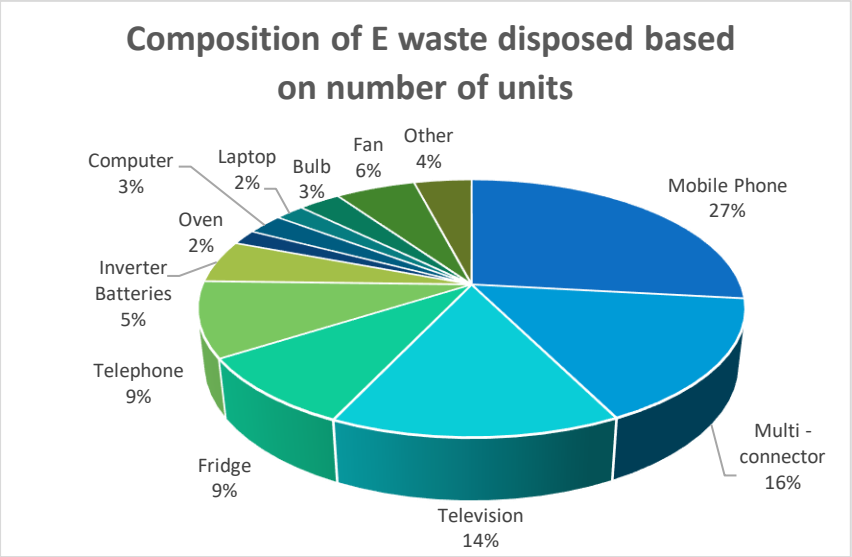
E-Waste

According to the Department of Customs report on Nepal Foreign trade Statistics, the electrical machinery and equipment and their parts and accessories, including television, computer, and mobile are increasing tremendously over the years. In the year 2012/2013, such import was worth Rs.38,744,588, which doubled in the year 2016/2017 with Rs. 70,061,617 worth of such imports. With changing lifestyles, access to electrical and electronic equipment have become easier. The more products used; the more E-waste is generated.

E-waste are considered valuable recyclable items. After the items become irreparable it is sold to local itinerant buyers, which is then sold to larger dealers. The valuable components are usually extracted by scrap dealers in Nepal itself and end to India for recycling. During the baseline survey, it was found that a piece of mobile is sold at Rs. 10 per piece. Refrigerators are cut open to extract copper, aluminum, iron, plastic and motor to be sold separately, while the rest of the parts are discarded by burning or mixing it with MSW. Since the MSW collection service provider charges Rs. 100 to Rs. 500 for these non MSW components, the scrap dealers rather burn it than pay the fees. For television, only Copper is extracted, rest is either burnt or discarded in the municipal waste.

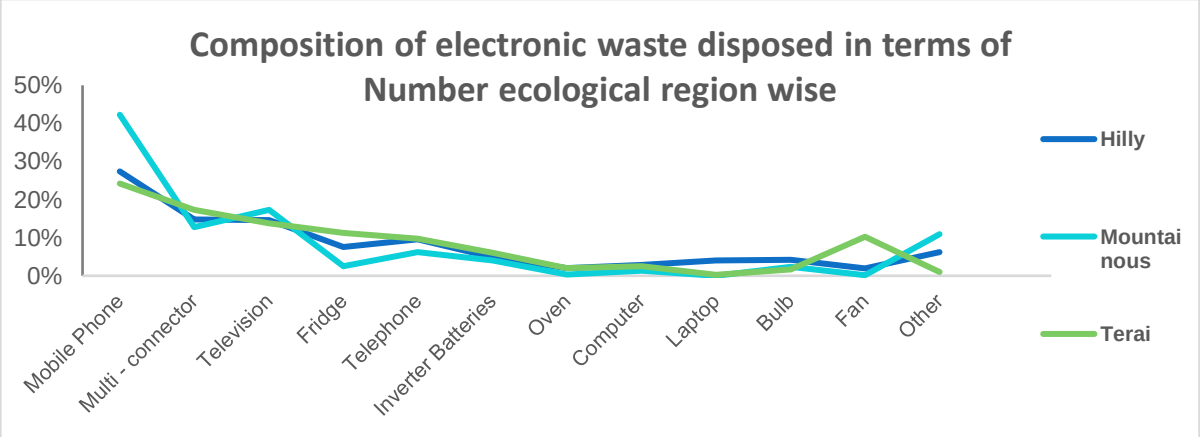
Composition of E-Waste:

Data was collected from 22 out of 35 municipalities. Several sources were referred before compiling this data. Also due to lack of concrete data in some cases a few calculations were made as mentioned below.



Based on the survey mobile phones contribute 27 % of the e-waste generated in 22 municipalities. It is followed by Multi-connectors and television at 16 % and 14 % as depicted in the figure.

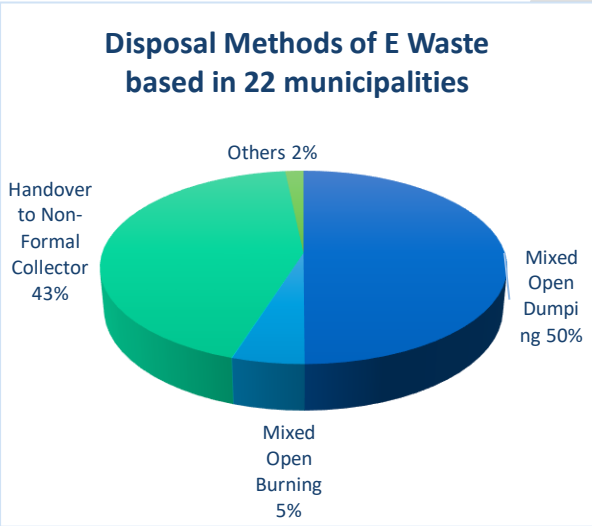
According to the analysis mountainous regions have a higher disposal of mobile phones at 42%

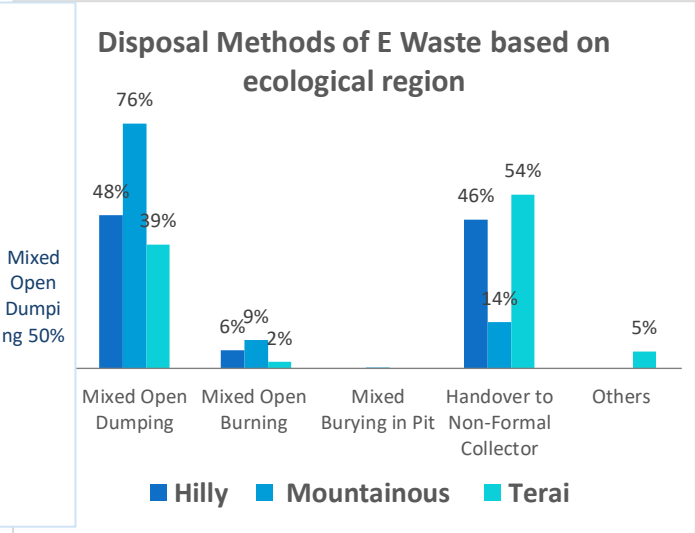


compared to terai(24%)and hilly (27%)regions. While terai is in the lead in the disposal of multi-connectors at 17% followed by hilly (15%) and mountainous (13%). There is a difference in the trend of disposal of fridge, where terai is at 11% followed by hilly (8%) then mountainous region at 2%. This trend shows that geographical locations impact the type and quantity of items disposed. This should be taken into consideration while formulation an effective waste management system.

Disposal of E-Waste:

According to the calculation and analysis of available data, 22 municipalities generates estimated 581 tons of electronic waste per year. The method of disposal of electronic waste is summarized as follows:



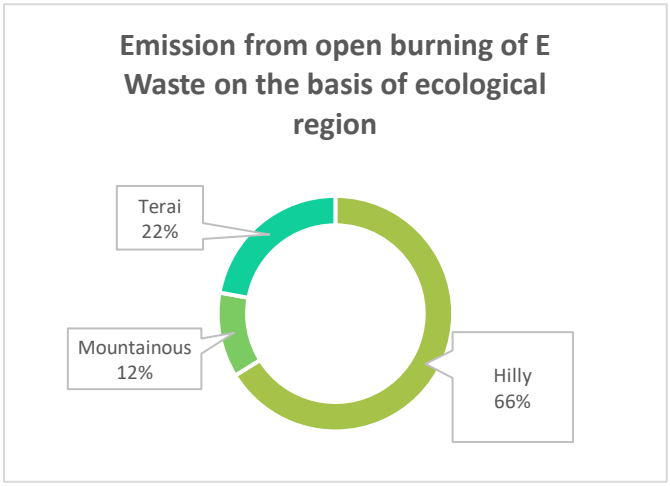


Please note due to limited number of survey questions, the analysis of electronic waste had to be derived through frequency of changing electronic devices or equipment of households, commercial and institutional establishments. It is based upon following assumptions:

- *The average weight of mobile phone, multi connector, television, fridge, telephone, bike batteries, oven and other items is assumed to be 0.155 kg, 0.63 kg, 5 kg, 100 kg, 0.3 kg, 3.5 kg, 3.5 kg and 5 kg respectively.*

- *The average frequency of changing of mobile phone, multi connector, television, fridge, telephone, bike batteries, oven and other item is assumed to be 3-year, 2-year, 7-year, - year, 5-year, 5-year, 5-year and 3-years respectively.*

Emission from E-Waste:



Analysis of Greenhouse gas emission in 22 municipalities was calculated to be approximately 36,364 kg of CO2 equivalent emission per year from the open burning of 13,827 kgs of electronic waste per year.

It should also be noted that there is no research-based data on rate of soil degradation caused by open dumping of e-waste.

The following measurement was taken to calculate Greenhouse gas emission: 1>The burning of 1 kg mixed electronic waste generates 2.63 kg of CO2 equivalent

Disaster waste

Nepal experienced a 7.8 Richter scale of earthquake in April 2015, which killed nearly 9,000 people, injured 30,000 and destroyed over 800,000 buildings. Nearly 14 million tons of waste was generated within a couple of days, 4 million tons of waste alone from Kathmandu, which is equal to waste generated over 11 years under normal conditions (NPC, 2015). Mixed with hazardous wastes, this large amount of disaster related waste resulted in adverse impact to public health and the environment (MoEST, 2015). This was a wakeup call at many levels as it was for realizing the need for documenting and managing disaster waste. Besides earthquake, disasters like landslides and flood are common in Nepal that results in disaster debris.

Drawn from the active dataset maintained by the MoHA, covering a period of 45 years (1971 to 2016) shows that a total of 21,856 disaster events have been recorded during this period. Annually, Nepal is exposed to approximately 500 events of disaster on average and fire is one of the most recurrent hazards. Number of fire incidences was recorded 8,721 times, followed by flood (3,950 times), epidemic (3,452 times) and landslide (3,246 times).

Table 2: Major Disasters in Nepal and the Damage and Loss, 1971-2016

Disaster type	No. of death	No. of persons missing	No. of persons injured	No. of houses damaged or destroyed	No of affected families	No. of incidents
Epidemic	16,583	-	43,111	-	512,989	3,452
Earthquake	9,771	-	29,142	982,855	890,995	175
Landslide	4980	174	1,871	33,617	558,264	3,246
Flood	4,445	42	544	216,190	3,710,065	3,950
Fire	1,605	-	1,619	86,261	259,935	8,721
Thunderbolt	1,620	129	2,684	963	7,140	1,711
Cold wave	515	-	83	-	2,393	390
Snow storm	87	7	-	-	-	5
Avalanche	16	3	7	-	-	2
Wind storm	2	-	11	215	191	44
Hailstones/ heavy rainfall	9	-	24	155	3,280	131
Others*	26	2	51	1	36	29
Total	**39,659**	**357**	**79,147**	**1,320,257**	**5,945,288**	**21,856**

* This data is recorded since 2016 only. It includes high altitude, boat capsized, snake bites, wild animal attack and others.

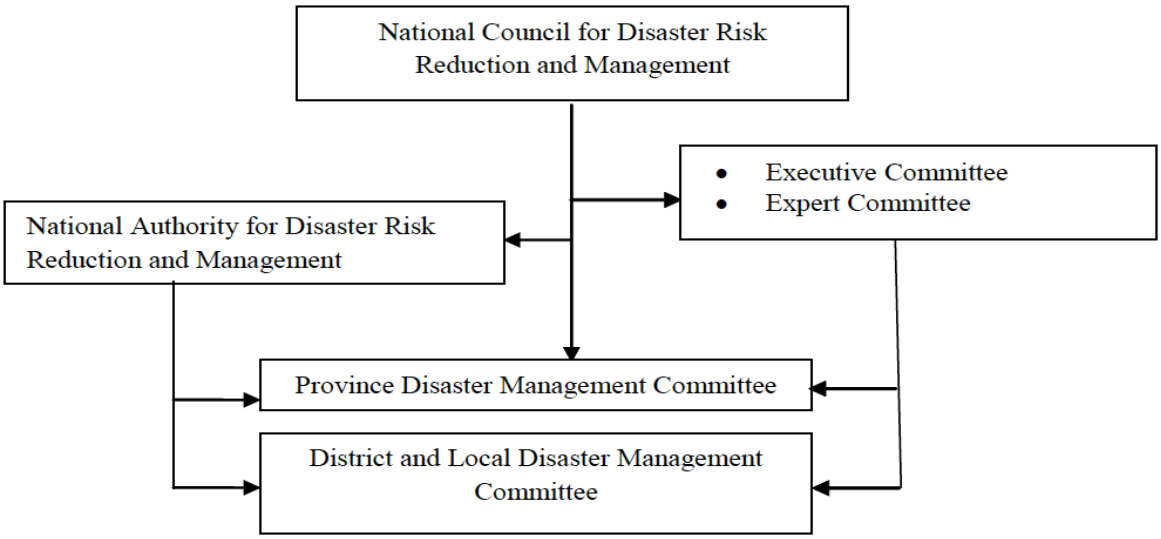


Figure 5*: Institutional structure according to the Disaster Risk Reduction and Management Act - 2017*

Both government and public lack awareness on disaster waste segregation and management, especially handling hazardous waste. Disasters also adds pressure to regular MSW management because these events interrupt regular municipal waste collection and disposal added with waste generation from temporary shelters and the disaster itself.

Majority of the respondents suggested that the local municipalities get itself prepared for the disaster waste management by preparing disaster waste management guidelines, temporary storage facility for collecting and segregating disaster debris, and promoting the sale of reusable components of disaster debris such as wood, iron, and bricks etc. **Table 3** outlines responses received by the surveyed households in 35 municipalities about their views on the challenges and opportunities for disaster waste management.

Table 2. Challenges and opportunities for managing disaster waste

Challenges	Opportunities
Lack of knowledge in Disaster waste management	Awareness program required on managing disaster waste
Lack of knowledge in segregating disaster waste	Training on handling different types of hazardous waste
No dumping site for disaster waste	Transfer or temporary dumping site to be allocated by the government demarking the types of DW
Smell from decomposed dead animals	Awareness on handling dead animals
No safe zones for temporary shelter	Temporary safe shelter should be allocated by the government
No collection system from the municipality	DW collection/transfer to allocated zones should be Responsibility of the municipality
No government counterpart responsible for DW	Transfer Facility to be established
No Transfer Facility	Recycling facility to be established
No recycling facility	Treatment facilities should be established

No treatment facility	
No proper equipment to manager DW while risqué process	Appropriate equipment to be stored for Disaster Events
No safety areas to take temporary shelter	
No rain gears or water food storage	Food Water and rain gears and other emergencies items to be stored based on municipality or wards
No government officials claimed responsible for DW	Law and policies for DWM to be adopted giving clear role and reasonability at the central, province and local level and also to the community

Public Awareness:

4000 HHs, 1071 commercial enterprises and 720 institutes were surveyed for this baseline and questioned whether they were aware of what happened to their waste after it was collected. An overwhelming 74 % of the respondents were not interested in this knowledge or was not responsive.

Public Awareness

Knowledge of SWM Disposal

	Yes	No
Household	1	70
Institution	150	164
Commercial	269	233

Knowledge of Impact of Dumping Waste on open land

	Yes	No
Household	118	1
Institution	277	10
Commercial	405	33

Knowledge of Impact of Dumping Waste in River/River Bed

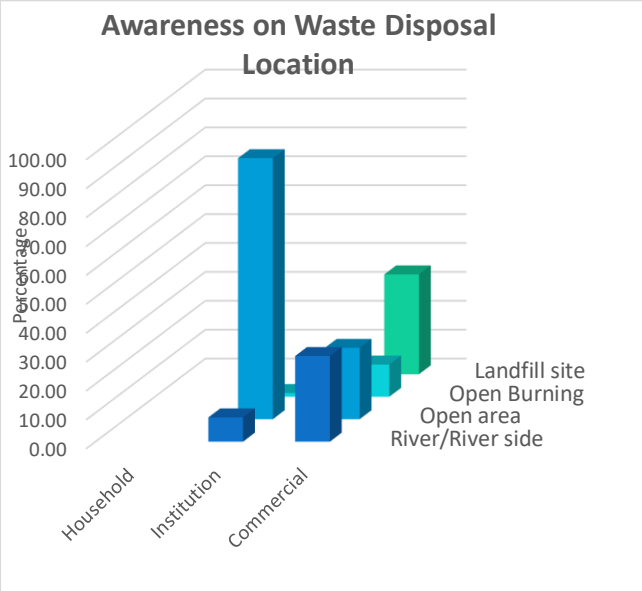
	Yes	No
Household	226	12
Institution	645	17
Commercial	733	59

Willing to pay for Waste Collection

	Yes	No
Household	119	0
Institution	230	62
Commercial	160	162

Respondents from institutes and commercial sector was more communicative in this regard. The response of remaining 26% is shown below:

Knowledge of where waste goes after collected by municipality / private sector (%)		
Sector	**Yes**	**No**
Household	1.41	98.59
Institution	47.77	52.23
Commercial	53.59	46.41



Perception of respondents regarding location				
	River/River side	Open area	Open Burning	Landfill site
Household	NR	NR	NR	NR
Institution	8.39	90.32	1.29	0.00
Commercial	29.63	24.69	11.11	34.57

Willing to pay for waste collection (%)		
	Yes	No
Household	100.00	0.00
institution	78.77	21.23
Commercial	50.91	49.09

Comparison of current baseline results on MSW quantity and composition with SWMRMC 2004, ADB 2012 and SWMTSC 2016 surveys

Year	2004 (SWMRMC)	2012 (ADB)	2016 (SWMTSC)	LEAD Nepal (2018-2019)
Municipalities surveyed	58	58	60	35
Population of surveyed Municipalities (In million)	3.48	4.5	2.07	4.56
Total surveyed Establishments				
Household	4,234	3,233	3,330	4000
Institution		627	600	1
Commercial		627	600	1071
Data Collection period				
Dry Season (March, April, May August)	2003-2004	2012	2016	2018-2019
Waste Generation				

Average MSW generation rate (Kg/Person/Day)	0.34	0.317	0.18	0.37
Total estimated MSW generation (Ton/Day)	1,369	1,435	419	1706.66
Total annual MSW generation (Ton/Year)	499,685	524,000	153,113	622,930.45
Source of waste				
Household waste (average of all studies municipalities- Kg/Capita/Day)	0.25 (75% of MSW)	0.176 (50-75% of MSW)	0.12 (60-75% of MSW)	0.180 Kg/Household/ day
Commercial waste	-	1.4 kg/shop 5.7 kg/hotel	1.1 kg/shop 3.1 kg/hotel	3.325Kg/Commercial/day
Institution	-	1.4 kg/office 4 kg/school	3.25 kg/school 0.95 kg/office	2.694 Kg/Institution/day
Average composition of MSW (in %)				
Organic	61.95	56	61	57.95
Plastic	7.34	16	12	12.03
Paper and paper products	8.21	16	11	16.74
Metals	1.18	2	2	2.30
Glass	2.38	3	6	5.57
Textile	1.91	2	1	2.85
Rubber	0.59			
Leather	0.32	1 (rubber & leather)	1 (rubber & leather)	
Medical	0.39	-	-	
Inert	9.32	-	-	
Chemical/Hazardous				1.54
Other	6.42	4	6	1.03

By summing up finding of 2019 baseline survey of 35 Municipalities, it is necessary to carry out the comparative analysis with previous waste surveys carried out in 2004, 2011 and 2017.The result indicated that in case of Household Survey the Organic waste seemed to be increase from 46.46% to 68% in 2004 to 2017 whilst slight decrement to 57.95% is observed in 2019. This could be due to increase of recycling activities. In 2011, the Plastic waste has

increased by 6.49% in compared to the 2004 survey and went through slight variations in between 2017 and 2019 but without exceeding 12% value made in 2011. This shows the change of consumer habits and also the steady value at 12% can be interpreted an increase in recycling activity. Paper and Paper Product contribution striking at 16.78% in 2019 is almost the double amount quantified in 2004, 2011 and 2019. This clearly depicts the population growth particularly at the school and college age groups.

In case of Institutional waste, it can be observed that the Organic waste of 45.14% in 2019 is almost the doubled amount with respect to 2011 and 2017. Increase number of populations. In contrast to this, the plastic volume of 2011 and 2017 survey has declined drastically to the half amount of 14.88% in 2019. In addition, the Paper and Paper product has followed continuous declining trend from 45% in 2011 to 30.52% in 2019. In average 45.14% constitute wet waste and 54.86% dry waste which also demonstrated that there is about 95% opportunity for recycling.

In case of Commercial waste, the Organic waste amount has continuously followed the inclining pattern from 44% in 2011 to 55.08% in 2019. Conversely, the plastic amount seemed too decreased from 2011 to 2019 standing at 12.59%. The paper and Paper product have dropped from 23% in 2011 to 15.85% in 2019. Here too we can see that a clear window of opportunities for recycling of nearly 95%.

This result could be supported by increasing population, change in consumer habits, low awareness level, insufficient services from municipalities and private sectors, non-effective enforcement of the SWM act 2011 could equally obtain such results.

Gender mainstreaming in waste management

Gender Mainstreaming

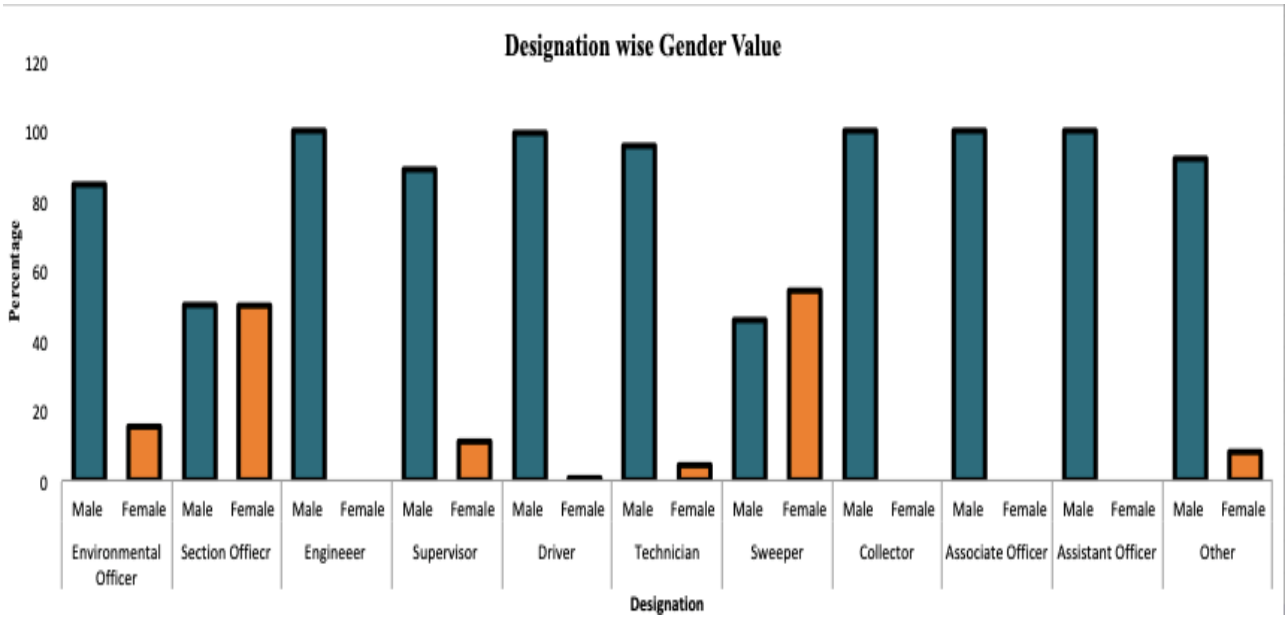
The Constitution of Nepal provides the rights against discrimination, the right to reproductive health, the right against physical, mental and other forms of violence and equal right to property. The Constitution and the Election Act (2007) provide substantive quota for women (33%) to be represented in Constituent Assembly (CA). Further Nepal was the first country in Asia to develop National Action Plan on Women, Peace and Security in 2011 and women's and girls' right are protected in the Comprehensive Peace Accord. In addition, Nepal is signatory to 23 human rights treaties and International human rights instruments with legal framework in Nepal largely supporting women's right and equality including the Convention on the Elimination of All Forms of Discrimination Against Women, Beijing Platform for Action, the Millennium Development Goals, UN Security Council Resolutions 1325 and 1820.

The country has adopted several policies, programmes and plans of action to promote gender equality and the empowerment of women. It has made some notable progress on legal and policy reforms concerning discrimination against women and gender equality, with many

discriminatory laws recently being amended and gender equality laws being adopted. However, 65 remaining laws have been identified that adversely impact on gender equality and women's empowerment. As many civil society organizations have noted, gender equality is often limited to laws and policy and is not translated into reality for women.

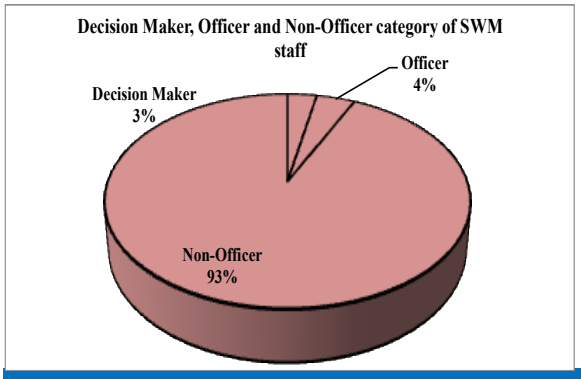
Gender and waste

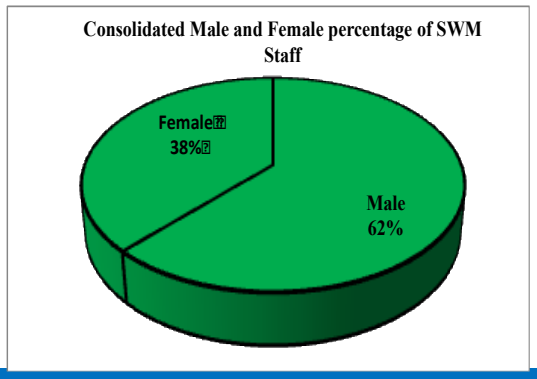
Waste is not necessarily a gender-neutral concept. Given women's primary household responsibility such as cooking, cleaning, laundry, it seems natural for women to handle garbage. Women are more exposed to waste than men. Women see waste differently than men. Recycling and reusing of wastes have critical gender dimensions. Women may have different needs and preferences on waste management services. Not only the gender roles in waste management, are women often left out in economic activities of recycling. For instance, in the informal sector, men usually take control over waste materials with higher value for recycling. It is also common to find that men mainly collect waste and sell the segregated materials, while women segregate the collected waste items at home and are responsible for disposing of those with no value. Such a division of labour makes women's work invisible or less valued, resulting in a lack of recognition of the economic contributions by women and inclusion in public policies. Women are also left out in decisions making in waste management program design and technology selection for waste treatment and recycling[3].



Gender Role is Waste Management:

[3] http://web.unep.org/ietc/sites/unep.org.ietc/files/Did%20You%20Know%20Sheet%20%28Gender%20%26%20WM%29%20v.1.1.pdf



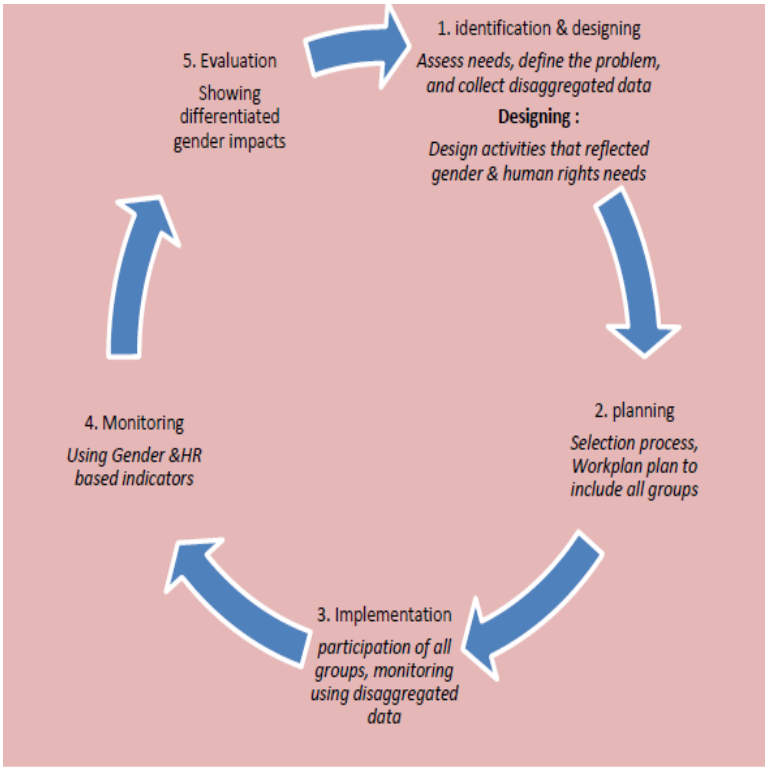


Issues of concern to women in waste management

- Equitable access to waste management
- Involvement, participation and equity
- Affordable cost of services
- Reliable services
- Appropriateness of technology
- Security and safety of the infrastructure
- Privacy
- Health and Hygiene
- High social, economic and opportunity costs

In Nepal waste management is predominantly the responsibility of the women at the household level and men at the commercial, institute and informal sectors. This reveals that the men are engaged in productive role and women in reproductive and community management role as an extension of their reproductive role both considered as voluntary or unpaid thus creating economic in-equalities and setting the boundaries of control.

Looking at the organizational/institute hierarchy very few women is placed in the decision-making or resource management position, thus demonstrating in-balance in gender equity. Therefore, from the perspective of the gender framework women and men, irrespective of their status, must participate as equals in decision-making, priority setting and resource allocation process. These principals are realized by ensuring that sex-disaggregated data is used as the basis for planning a service delivery which means gender equality are central to all activates be it policy development, research, advocacy, legislation, resource allocation and planning, designing, implementing and monitoring and evaluation stages of waste management programmes and projects.



Integrating gender into waste management from theory to action:

There is still a lack of understanding on the gender dynamics of waste management. Therefore, adopting a gendered approach to waste management to address the multiple dimensions is necessary. Including a gender perspective is the best possible way to solve operational problems of the waste collection services. Including a gender perspective in recycling sector will also enhance equality in access to and control over the benefits from (waste) resources.

Gendering waste management programmes

Women as care takers of a household are involved in waste collection, sorting, reusing and disposal of waste. Therefore, as a waste handler, women's decision on what is considered as waste and what not, what to re-use, what time is suitable for waste collection, how to dispose and where to dispose etc. are important aspects and should not conflict with the waste management program or activity designed by the local authorities or private sector. Consultation with women groups while designing a waste management program is thus useful.

Mainstreaming gender into institutes

Gender mainstreaming is never automatic. It calls for institutional reforms by revisiting and reviewing the organizational culture and ensuring gender is mainstreamed into the waste management institutes (governments, private, public partnership, NGOs or CBOs). Generally, the design and operation of the waste management systems, social and gender issues are often not recognised and considered by the largely male engineers and local government leaders. Similarly, at times, women employed by the municipalities for street sweeping and other cleaning activities are paid less than male staffs. Correction of such gender bias requires for a waste management strategy at the institutional level changing the unequal relations of men and women to resources, decision-making and rights with a gender perspective.

Gender Budgets

Commitment to gender mainstreaming in waste management can only be realized with adequate budgetary allocations. Budgets are one of the most influential tools for organizations because without funds, policies or programmes cannot be implemented. They influence the overall objectives of a project and reflect the strategic priorities by any organization.

The failure to allocate human and financial resources to gender in waste management activities can reduce the efficiency of the programs and policy implementation. Because project implementation is largely determined by the source of funding, budgets can either promote gender equality or exacerbate inequalities. A holistic waste management programme calls for including equity in budget planning and examining impact of budget decisions about both men and women. Budgeting for gender equity is a step forward.

Integration of gender in waste management

At the household level

1. Collecting of gender disaggregated data on waste management practices, needs and demands at the household level on issues like:
    - Selection, re-use, control and ownership
    - Practices and division of tasks with collection, storing and disposal
    - Practices, needs and demands concerning formal and informal/illegal waste disposal
    - and collection points
    - Perceptions, knowledge and information needs on health and hygiene related to waste
    - handling, health and safety risks

- Willingness and affordability to pay

2. Design and production of information and education materials that are gender sensitive and not sustaining or promoting specific/traditional gender roles and divisions.
3. Design and production of low-cost, hygienic and women friendly waste storage and disposal
   equipment and materials.
4. Set-up of low threshold communication lines with the waste collection services esp. for women to provide suggestions or to be consulted on the functioning and improvement of the system.

<u>At community level</u>

1. Collecting of gender disaggregated data on waste management practices at community level:
   - Management structure and power relations in community based formal and informal organizations.
   - Division of tasks with collection, disposal and recycling
   - Practices, needs and demands concerning formal and informal/illegal waste disposal and
     collection points
   - Perceptions, knowledge and information needs on health and hygiene related to waste
     handling, health and safety risks
   - Labour conditions in waste management organizations.
2. Formation of stakeholder groups, where women will have access to meetings and can take part in decision making.
3. Training sessions for men and women stakeholders on waste management and environmental issues as well as gender sensitization.
4. Set-up of low threshold communication lines with community leaders, esp. for women
5. Provision of opportunities for women to get paid employment in community based waste management services.
6. Involvement of schools, through gender sensitized education and information on health and hygiene related to waste management.

<u>At local government and private enterprise level</u>

1. Collection of gender disaggregated data in waste management services at local government level.
   - Management structure and hierarchy
   - Payment conditions

- Health and safety risks, labour conditions
- Communication flows within the departments
- Communication and information exchange with citizens
- Social and gender awareness/consciousness of staff

2. Training of staff on gender issues in waste management, participatory and gender disaggregated data collection and communication and information strategies.
3. Setting up of formal structures with involvement/representation of women on management and labour conditions.
4. Setting up of department for direct communications and information with citizens, with special attention to female stakeholders.
5. Training possibilities for female staff to upgrade their positions within the organization.
6. Representation of women into labour organizations and unions.

Source: Gender and Waste Alliance (GWA). No capacity to waste- training module gender and waste. http://www.waste.nl/sites/waste.nl/files/product/files/genderwastemodule_final100831.pdf

Collection of gender disaggregated data in waste management at HH, community, and local government and private enterprise level is a prerequisite to understand the gender aspects of waste and hence plan mainstreaming gender in the waste sector. The current baseline study attempted to look waste from gendered eye, however, it was not an in-depth study. It is hence suggested to conduct a detailed study on gender and waste aspect in future.

Resource Recovery

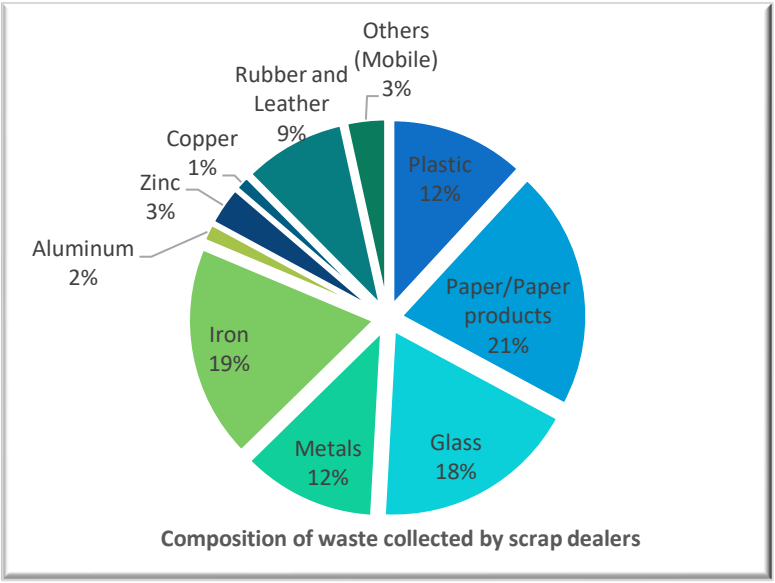
The Informal waste sector has always been an integral part of Nepal's waste management system that accelerates recycling activities. The recycling occurs in a value chain of door to door itinerant buying, scavenging of recyclable items in landfill, and bulk trading in scrap shop, and sending the recyclable items to recycling factories in Nepal and India

Individual itinerant buyer/scrap collector

The recycling value chain involving scrap dealers a series of steps, wherein an individual itinerant buyer (commonly known as *kabadiwala*) visits houses and purchases recyclable items, who then sells it to a mid or large scrap dealers (operated as junk shops). Then these scrap dealers trade the recyclables to a large company or to a recycling company directly or to a middleman. Once the scrap materials are traded, they are recycled into new products. 5% of the collected materials are reused by the scrap dealers, while rest is sold for recycling. Earlier, the scrap collected in Nepal was sent to Indian recycling companies, as there were no local recycling factories. However, there is a noticeable positive change in the recycling sector in Nepal, wherein there are at least 25 local recycling factories operating inside Nepal. These shows that if waste is properly segregated, there is a potential opportunity for recycling inside the country. The recycling companies operating in Nepal are listed in **Annex 5**.

Scrap dealers

There are 152 scrap dealers registered with the Office of Company Register. These dealers are spread across 7 provinces: Besides these registered businesses, it is estimated that the unregistered small scrap shops are 10 folds in number.



Composition of waste collected by scrap dealers

Scrap dealers usually buy almost all dry recyclable items. Of these traded items, Iron (Fe), Paper, Plastic, Glass, and Aluminum are the top five items that are preferred in scrap business as indicated by respondents.

Scraps like battery and Zinc are more in demand all over Nepal than compared to paper and paper products. The table below depicts the priority of the scrap based on the different regions. There is a difference in priority for copper; copper is highly sort after in the Mountain and Terai regions while it is only at priority 5 in Hilly areas. These differences can be observed in the table and should be considered while creating an effective solution for waste management.

Consolidated ranking of bestselling items based on ecological region

Items	Hilly Region	Mountain Region	Terai Region
Paper/ paper product	9	6	8
Plastic	8	4	6
Glass Bottles	3	9	7
Plastic Bottles	4	8	5
Beer Bottles	7	10	9
Iron	10	5	10
Aluminum	6	7	4
Zinc	2	3	1
Copper	5	2	3
Batteries	1	1	2

Human resources engaged in scrap dealing businesses include men, women and children. In 84 scrap dealer shops, a total of 614 personnel was found to be working. Out of which male staffs represented 83% of the total workforce as compared to 17% female workers. The workforce shows a distinct gender role, wherein men controls over by engaging primarily in all level of business activities including scrap collection, transportation segregation, trading (buy/sale) of the collected and segregated items, and overall management of the scrap shop. Women are engaged in collection and segregation (**Figure 6**). It is to be noted that the women worker is generally excluded from the managerial and trading roles. Such a division of roles makes women's work invisible or less valued, resulting in a lack of recognition of the economic contributions by women in recycling business.

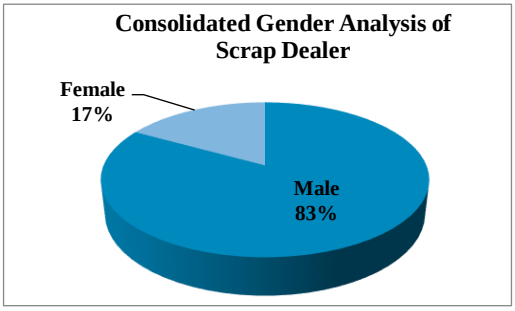
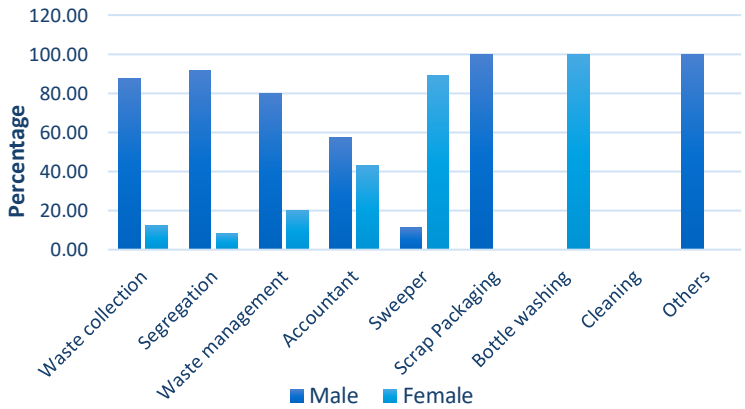
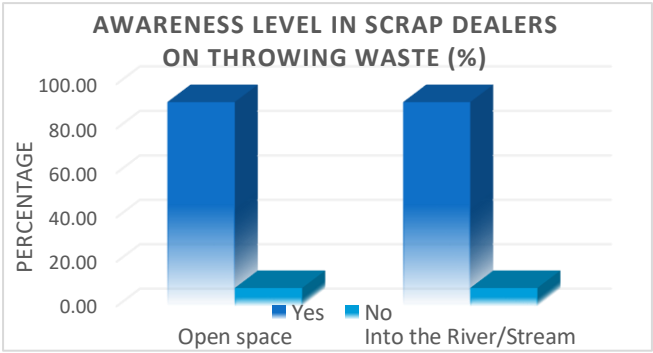


Fig. 6 **Taskwise Gender Role**

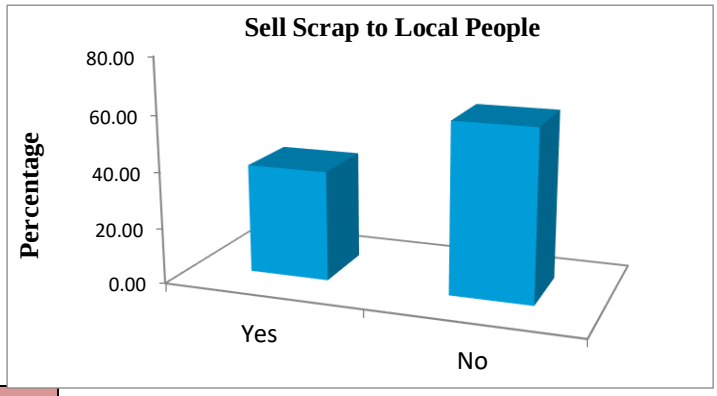


The scrap dealers were asked if they were aware of the impact of throwing waste in the riverbanks and open plan. The response is shown in the chart.

Response	Open space	Into the River/Stream
Yes	91.80	91.80
No	8.20	8.20



Most of the scrap is transported to bigger cities or across to India. Recycling industries are very few in Nepal. Only a small amount is sold to the locals, about 39%.



All Municipality Total	(Kg/Day)

Total Scrap received by All Municipality	**165668**
Average Scrap received per Scrap Dealer	**100**

In the peak season, an average a scrap dealer's daily business generates an income of Rs. 313,225 per day (equivalent to USD), which is the income without deducting the expenses including staff's

Scrap Types	Average Quantity of items bought per day (Kg)	Average Quantity of Items sold per day (kg)	Buying Cost (NRs.)/Kg	Selling Cost (NRs.)/Kg	Average Profit/day
Paper	18488.00	18130.67	835.00	1297.50	96274.58
Plastic	11634.50	11452.50	1368.00	1693.00	41346.27
Glass	15549.50	14915.00	549.92	811.48	42288.61
Iron	23176.75	22912.75	1544.00	1853.75	79638.19
Alumunium	6089.30	6036.30	3389.00	3994.45	41369.77
Zinc	3487.00	3521.00	126.00	193.00	2859.42
Copper	942.67	930.20	5720.00	6427.00	6980.24
Rubber	288.50	277.50	347.00	430.00	228.76
Battery	615.00	624.00	550.00	840.00	2213.21
Steel	18.00	18.00	100.00	135.00	7.50
Dolls	1.00	1.00	40.00	50.00	0.12
Textile	10.00	10.00	11.00	15.00	0.48
Tin	95.00	88.00	23.00	30.00	5.42
Old Bikes	100.00	80.00	30.00	50.00	11.90
Others	11.00	9.00	50.00	70.00	0.95
Total					313225.41

Table 4. Income from trading scrap materials

salary, transportation cost, waste cleaning, washing, sorting, bailing/and packaging cost, tax, bribe and other office management costs. **Table 4** displays the buying and selling cost of selected recyclable items.

Though the scrap dealing business seems profitable, it is not free from challenges ranging from issues of social stigma attached to the profession, occupational health and safety risks, and fluctuating or low prices of the recycled items. Of these, lack of social acceptance is one of the major challenges faced by the scrap dealers, followed by congested workspace as the second major challenge. Following are the measures suggested by the respondents in the scrap collection and trading business to break the barriers:

- Increasing social acceptance to scrap dealing occupation,
- Identification of scrap dealers as a stakeholder by local municipality,
- Provision of occupation health and safety insurance,
- Provision of loan facility for setting up a workspace for scrap collection, sorting and bailing,
- Designation of a specified area for scrap shops operation,
- Establishment of local recycling facilities hence avoiding the transportation and other operational cost to trade recyclable items to other cities in Nepal or to India,

- Uniformity in the price of scrap/recyclable materials, and
- Inclusion of the scrap management businesses in the waste management legislative framework.

Recently the scrap collection activities are taking a shape of a social entrepreneurship, giving the much-needed recognition to the scrap collectors. Use of Information, Communication and Technology (ICT) and involvement of youth is a refreshing change that is breaking the social stigma attached to the occupation of scrap collection and recycling in general.

Khalisisi.com: Innovation and waste-entrepreneurship

Youths in Nepal are eyeing waste and ICT as an innovative entrepreneurship opportunity. Khalisisi.com is a household name at least in Kathmandu. A start-up founded by Ayushi KC as aspirant entrepreneur who left her job at USAID Nepal uses ICT into its recyclable collection venture. Her company collects only dry recyclable items such as paper, plastic, metal, E-waste, glass and others. Residents who have segregated these waste contact Khalisis.com via electronic media website, Facebook, email or even telephone. The itinerant pickers are given an ID card from the Khalisis.com, who then reach the destination and collect recyclables. People either donate or sell their trash for cash. If the trash is donated, the company sets aside 10 percent of the money for the welfare of the informal waste collectors who are the Khalisisi members. The collected recyclable items are labelled and folded and are sent to the scrap collectors i.e. wholesalers and retailers.

Municipality goes smart waste app way

Lalitpur Metropolitan in collaboration with Blue Technology and Blue waste to value Pvt. Ltd. is launching a waste collection app named 'kawadi.' People can download the kawadi app which shows the list of scrap collectors within the radius of 2 Km. The resident can then choose the scrap buyer and upload information about the type and quantity of the recyclable item he/she wants to sell. If the user has a doubt in identifying the type of the waste, he/she can upload the photo of the waste for the classification of that particular waste type. As the price of each items are already mentioned in the app, it avoids the bargaining process. Once the user presses 'ok' the selected scrap buyer will reach the given address and purchases the recyclable items. The Lalitpur Metropolitan has already identified and training local scrap dealers into its network.

Source: Annapurna Post, 22 Baishak 2075. Mobilebata Phohr Byabasthapan.

Landfill Operators & Final Disposal

Two landfill operators from each of the municipalities that has landfill sites or authorized dump sites were interviewed. The quartering and coning method was applied to estimate the waste composition. In addition, solid waste and leachate samples were sent to laboratory for their characteristic's analysis.

Figure 7 represent the composition of waste at the final disposal stage. Landfill workers also contribute to recycling efforts as they too scavenge recyclable items such as paper and paperboards, glass, plastic, metals, battery and shoes.

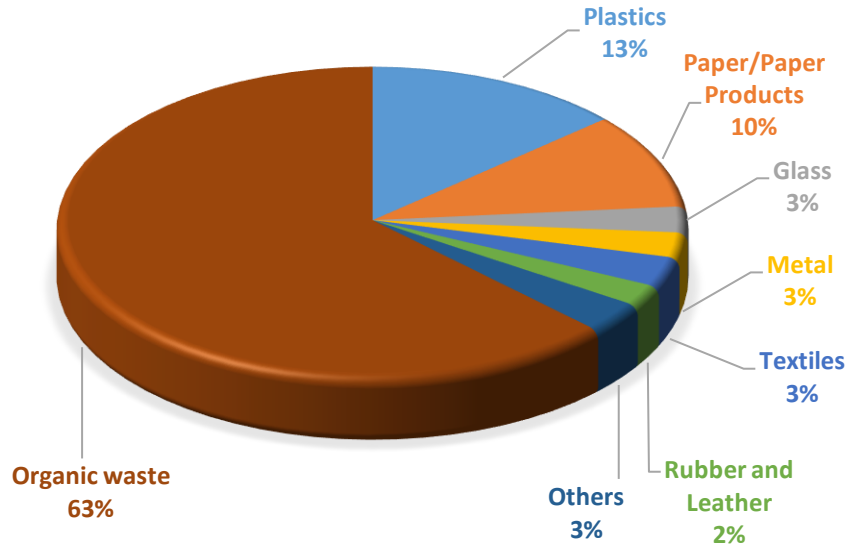
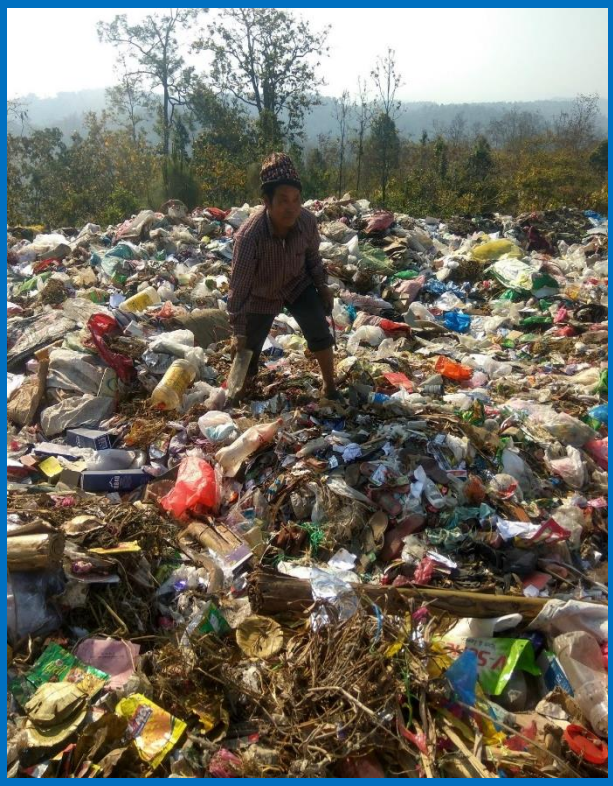


***Figure 3**. Waste composition at landfill site*

The surveyed landfills receive waste from the municipality in both covered and uncovered vehicles. These days majority of municipality have covered vehicles for waste transportation to the landfills, nonetheless, waste is also transported in uncovered vehicles such as rickshaw/cart, tractor/power tiller, tipper/dump trucks etc.

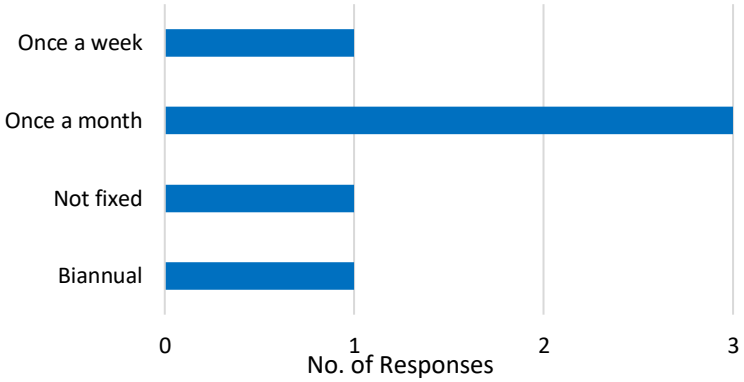
In terms of workforce for landfill site operation and management, majority (76%) is male staffs, 20% female staffs and even 2% of workforce were children.



A 71% of landfill workers use safety equipment like gloves and masks while handling waste, rest do not use. In the survey, a majority of the respondents denied participating in any of such awareness training/programmes on landfill operation, because there is hardly any awareness program targeted to landfill workers. When asked about the challenges the landfill workers face, the respondents listed various factors such as lack of adequate manpower, unhygienic working conditions and no social recognition of their profession.

Figure 4. *Frequency of monitoring visits to landfill site*

On a question about the frequency of the monitoring of the landfill sites by the municipal officers, it was encouraging to see that there are such M&E visits ranging from once a week to biannual visits depending on the municipality. **Figure 8** explains the frequency of such visits.



Landfill operators suggested a list of activities that could improve the current state of landfill sites. Landfill site planning by the municipality, including the design as well as operation guidelines,

provision of training for the landfill site operating staffs, and landfill gas extraction were the suggestions listed.

Scavenging of recyclable items are also done at the landfill site. In case of Kathmandu municipality, the recyclable items from Sisdol landfill site are segregated by waste scavenger. One person collects about 3-4 bags of recyclable items (each bag weighs about 30-40 kg), and temporarily store for 1-2 weeks at the landfill site. Within 7-15 days, a truckload of such bags is then transported to Teku or Golphutar to be sold to scrap dealers. The scrap dealers make one-time payment in every three months. The other way of recyclable items trading from landfill occurs when the scrap dealers themselves visit the landfill site and collect recyclables items by paying Rs. 300 per bag. Since these activities happen through an informal channel, no data is available in the municipality about the recycling rate and/or the informal recyclers.

Scrap collectors at Sidol landfill

Truckload of recyclable items ready to be transported from Sidol landfill to the scrap dealers in Kathmandu

Scaling up the recycling

In Nepal, recycling is showing a positive trend. Informal waste scavengers and small scrap dealers are formalizing their businesses by registering as a company, youth are engaging in social enterprises dealing with recycling, and formal private sector are establishing recycling businesses in Nepal. NGOs/CBOs especially women's groups are engaging into converting waste into upcycled products (such as bags and decorative items from plastic) and gaining an additional income. Few of the municipalities, for instance, Hetauda is investing in transfer station which segregates recycling

materials and sales to the recycling factories. The strong presence of these actors and their contributions in waste management system in Nepal is in fact a strength to grow recycling activities big and make it a profitable industry by transitioning towards a circular economy while still focusing of climate change mitigation.

A circular economy is a restorative and regenerative by design, in which resource (material and energy) input and waste, emission, and energy leakage are minimized by closing the loop through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling. Adopting a circular economy principle can accelerate transformational change in solid waste management by leading an increase in establishing infrastructure for recycling and reuse of waste and hence reducing the amount of disposed waste. This, however, is possible when all relevant stakeholders contribute. Manufacturers will have to step up their efforts towards more eco-friendly designs and promote the reuse of products; government needs to make efforts on a legislative and administrative level to establish a stable, ambitious and economically viable regulatory framework, and promote recycled products through green procurement policies; private sector to invest more on recycling businesses/infrastructure; and finally the citizens need to make environment friendly consumer choices and show efforts to separate waste, which will ultimately increase subsequent recycling.

Final disposal

Landfill is still a prevalent method of final waste disposal by municipalities. Most of the municipalities do not have an engineered sanitary landfill hence practices conventional dumping. Out of 35 municipalities, 19 municipalities do not have a dumping site, i.e., municipality has not allocated any land for waste dumping purposes, hence they practice open dumping, which is equivalent to illegal dumping. Old landfill site for Janakpur municipality has reached its end of life and is currently closed, while new landfill site has not been established until the time of baseline survey. Currently, only Pokhara Lekhnath metropolitan city operates a sanitary landfill site. Kathmandu's Sisdol landfill though started as a sanitary landfill in its initial operation stage but is not running as a sanitary landfill site. In fact the landfill has already met its end of life back in 2008, but is still being used for landfilling approximately 1,000 tons of waste per day (750 tons of waste per day from Kathmandu metropolitan and rest from Suryavinayak and other municipalities in Kathmandu valley), as the construction of the second landfill site at Banchare dada near to the existing landfill site has delayed by many years now. Rest of the municipalities have open dumpsites, few of which (as in case of Hetauda) runs as a controlled dumping which is an in-between dump site that is neither a sanitary landfill nor an open dump, some activities like covering the dumped waste with soil is practiced. Details of landfill and dumpsite of 35 municipalities is presented in **Annex 6.**

Compared with municipalities in three different ecological regions, only one Terai municipality, i.e., Damak municipality has a sanitary landfill site, but 62% of waste is not segregated at household level. Another Terai municipality Hetauda practices-controlled dumping where waste piles are merely covered with soil. Some level of open burning of waste at the dumpsite was also observed during the survey. Mountain municipalities do not have a

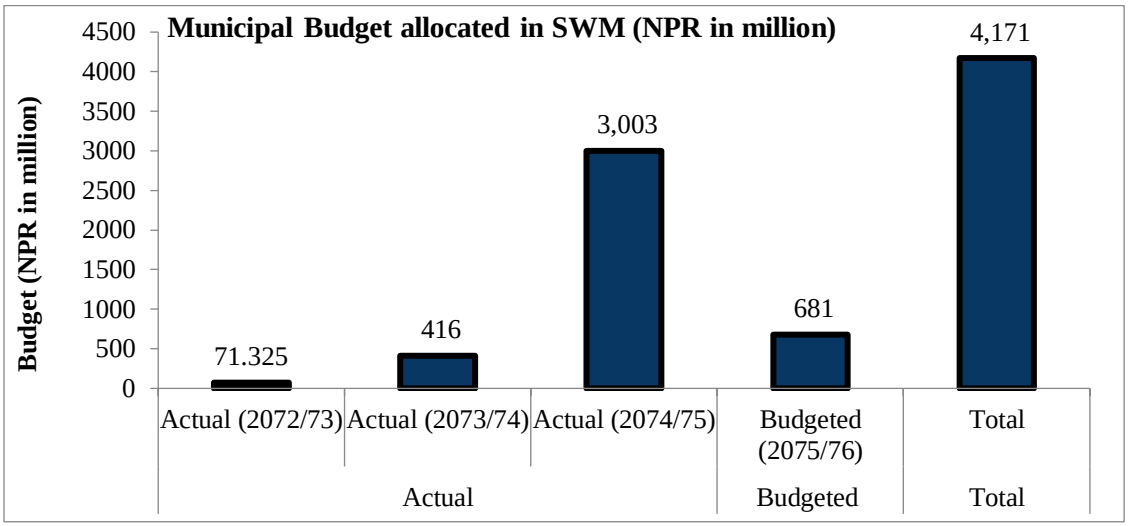
designated land for dumping waste; hence, illegal open dumping and waste burning is rampant. Even the recyclable items like plastic, paper and metals are burned as there are no recycling mechanisms in place, not even, local scrap shops. Out of 6 hill municipalities, only Kathmandu and Pokhara has sanitary landfill site
.

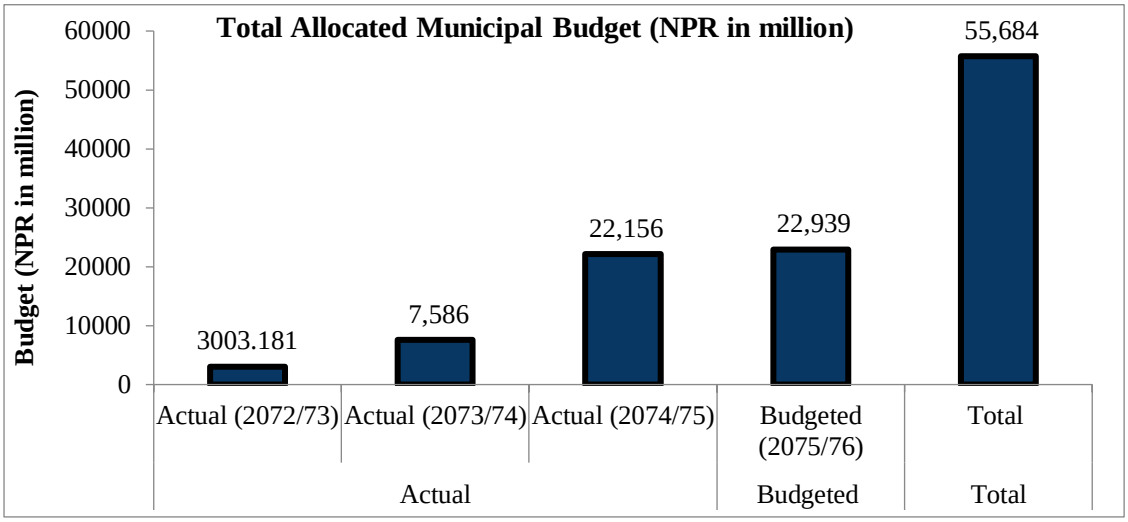
Not-in-my-backyard (NIMBY) syndrome is one of the challenges in designating landfill site in many municipalities, as locals often protest operation of such sites in their locality. In addition, lack of technical expertise and financial constraints are the major barriers the municipalities face in designating final disposal sites. Nonetheless, many of the surveyed municipalities including Dullu, Janakpur, Solududhkunda, Tansen, Chandranigahpur, Sikhar, Suryavinayak and Gorkha have mentioned the allocation of an official dumpsite as one of their SWM plans.

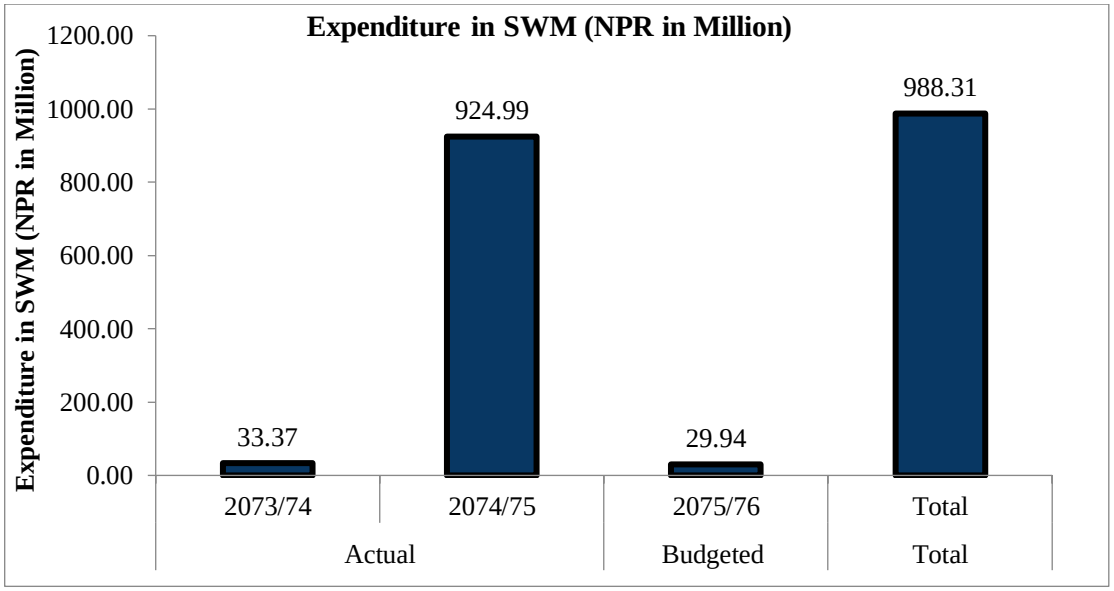
Resource allocation for waste management

Waste management is a costly affair particularly if the 3 R principal is not professionally applied. Financial constraints are often a major reason for the inefficient waste management by municipalities. Municipalities charge waste service fee from HHs, commercial establishments and institutions as one of the revenue generation mechanisms. Waste service fee differs from municipality to municipality ranging from Rs. 50- 200 per month for HH. Kathmandu municipality charges the highest fees followed by Hetauda and Gorkha municipality. The waste fee is not based on full cost recovery. The fees alone cannot cover the overall MSW management activities. Municipalities hence depend on other sources such as national budget, donor funding, and public private partnership.

Based on the analysis of survey data, on an average municipality spend 2.97% of its budget on waste management; from 0.036% (in Bheriganga) to 5.94% (Kathmandu) of its total municipal budget on waste management. The municipalities do not provide a breakdown of its waste management expenditure on collection, transportation, on disposal, or on salary of the SWM staffs. The total municipal budget for SWM in in the Fiscal year 2017/2018 is presented below:


Municipal Budget allocated in SWM (NPR in million)
Budget (NPR in million)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
71.325
416
3,003
681
4,171
Actual (2072/73)
Actual (2073/74)
Actual (2074/75)
Budgeted (2075/76)
Total
Actual
Budgeted
Total


Total Allocated Municipal Budget (NPR in million)
Budget (NPR in million)
60000
50000
40000
30000
20000
10000
0
3003.181
7,586
22,156
22,939
55,684
Actual (2072/73)
Actual (2073/74)
Actual (2074/75)
Budgeted (2075/76)
Total
Actual
Budgeted
Total


Expenditure in SWM (NPR in Million)
Expenditure in SWM (NPR in Million)
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
33.37
924.99
29.94
988.31
2073/74
2074/75
2075/76
Total
Actual
Budgeted
Total

SLCP emissions from the waste sector

Waste, a by-product of human activities has effects on human health and can have impact on air quality, water, soil and natural ecosystems. The waste sector has also global effects contributing to nearly 5% of anthropogenic GHG emissions[4]. Landfills are the third largest source of anthropogenic methane (CH4) emissions, accounting for approximately 11% of estimated global methane emissions[5]. The waste sector is hence responsible for both near and long-term climate impacts and other serious pollution to the environment.

SLCPs are air pollutants that have relatively short lifetime in the atmosphere and a warming influence on our climate. The municipal waste sector is a significant source of SLCP emissions such as methane (CH_4), black carbon (BC), NOx, and organic carbon (OC). As opposed to carbon dioxide (CO_2), which has an atmospheric lifetime of about 100 years, SLCPs have an atmospheric lifetime of a few years to even a few days. The most common SLCPs are methane and black carbon, which results from emissions from waste handling equipment, emission from trucks, and emission from landfill fires, open burning of waste, and emission from organic waste decompositions. Reducing these SLCPs through well-managed waste systems will contribute to overall efforts to mitigate climate change and could have significant health, environmental, and economic co-benefits, including improved quality of life for local communities.

If no measures are taken, GHG emissions from waste management are expected to continue increasing in urban areas in developing and less developed countries. On the other hand, waste prevention, resource recovery, reuse, and recycling offer potential of reducing GHG emissions and other pollutants along the supply chain and in product disposal. Integrated and sustainable waste management provides significant opportunities to control environmental pollution and minimize the negative impacts of global climate change. Adoption of appropriate waste management technologies can transform the sector into a net carbon

Methane from leachate at Sisdol landfill

[4] https://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter10.pdf
[5] https://unfccc.int/news/mitigating-slcps-from-the-municipal-solid-waste-sector

reducer. The United Nations Environment suggests that appropriate waste management can reduce annual GHG emissions by 15 to 20%[6]. At the international level, waste management has attracted climate finance, initially through market mechanisms such as the Clean Development Mechanism under the Kyoto Protocol and later through Nationally Appropriate Mitigation Actions. Sustainable waste management projects also have the potential to obtain international finance from funding schemes aimed at climate change mitigation such as the Green Climate Fund. Due to the potential to reduce GHG emissions while decreasing overall pollution and creating jobs, appropriate waste management can also assist countries in achieving their commitments in the international arena, such as their NDCs under the Paris Agreement.

Measuring and tracking SLCP is one of the first steps in reducing their emissions. This baseline study hence attempted for the first time to quantity SLCP emissions from MSW handling and management in municipalities of Nepal. The CCAC-MSWI's SWEET tool was applied to Kathmandu and Hetauda, Pokhara, Birendranagar and Dhankuta municipality.

Introduction

Carbon dioxide (CO2) is responsible for more than half of the total current global warming impact from human-caused emissions (EESI, 2013). The CO2 emitted remains in the atmosphere for hundreds of years creating warming effects however, mitigation efforts solely focused on CO2 will not slow the climate change in the next few decades City and national strategies should focus on reducing short-lived climate pollutants (SLCPs), which are responsible for the half of global warming and have atmospheric lifetime of less than 20 years (EESI, 2013). SLCPs include black carbon, methane, tropospheric ozone and hydro fluorocarbons (HFCs). SLCPs emitted from the Municipal solid waste are mostly black carbon and methane. These SLCPs are generated throughout the municipal solid waste management process from source to final disposal. Landfills are the third largest source of anthropogenic methane (CH4) emissions which accounts about 11% of estimated global methane emissions (CCAC, 2017).

The national and local government in Nepal faces numerous challenges to reduce SLCP emissions from MSW. Improper waste management such as open burning, open dumping, dumpsites and the increasing amount of waste is a major concern. The Nepal National Integrated Waste Management Strategy and Action Plan 2020-2035 plans to reduce SLCP from the waste sector by 80% by 2035. Solid Waste Emission Estimation Tool (SWEET) tool is being used to estimate the SLCP and GHG emission.

The Solid Waste Emissions Estimation Tool

Climate and Clean Air Coalition (CCAC) is an intergovernmental organization including business, scientific institutions and civil society organizations committed to improving air quality and protecting the climate through actions to reduce SLCPs.

The Solid Waste Emissions Estimation Tool (SWEET) was developed by the U.S. Environmental Protection Agency (with assistance from Abt Associates and SCS Engineers) on behalf of the CCAC Municipal Solid Waste Initiative. It is an Excel-based tool that quantifies emissions of methane, black carbon and other pollutants from sources in the municipal solid waste sector. The updated version 3.0 of the SWEET (2019) has been used to estimate the SLCP emission from the waste sector and mitigate potential diversion from the landfill sites.

[6] http://sdg.iisd.org/news/unep-holistic-waste-management-can-cut-ghg-emissions-20-annually/

Limitations of the Study

The SWEET analyses were specifically target for Kathmandu and Pokhara metropolitan cities, Hetauda, Birendranagar and Dhankuta the three sub-metropolitan cities of Nepal. This is due to time and budget constraints. All the same, these analyses will forecast a clear understanding of the impacts of SLCP and GHG emission from the waste sector and the means of mitigation which can then be replicated in other municipalities in Nepal.

A number of assumptions were taken into concerning to complete this document which is listed below:

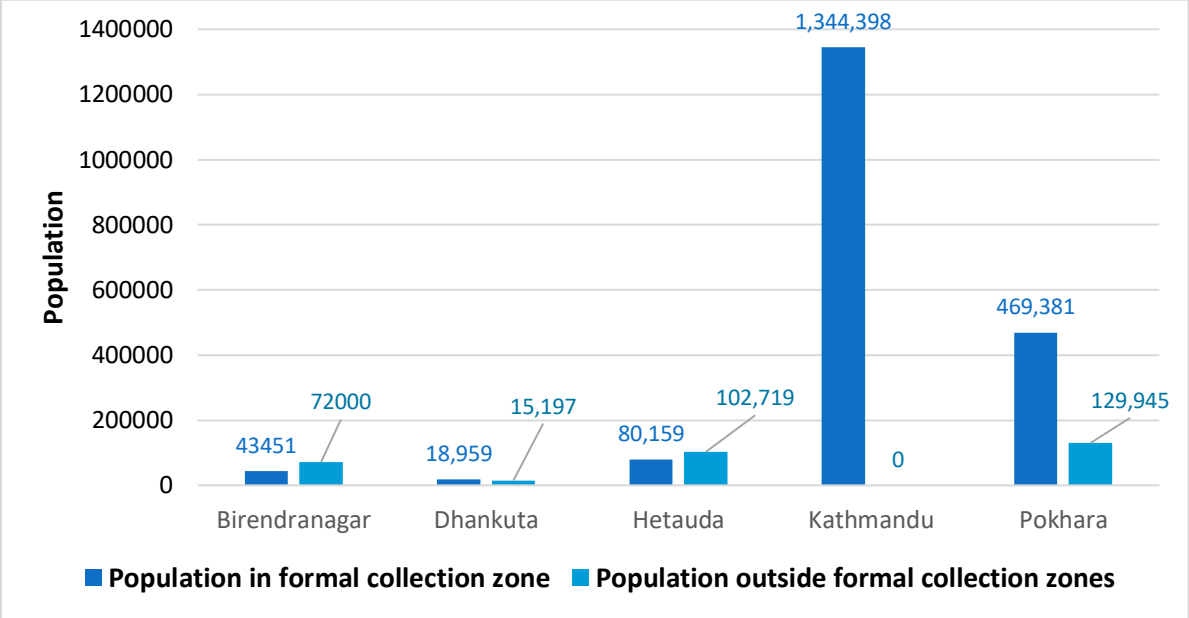
- Reduction of the proportion of waste burnt
- Reduction of fugitive dust emissions while handling, transporting and processing of waste
- Improvement in collection coverage and efficiency through,
  - Increased collection efficiency and coverage
  - Diversion of an increased amount of waste to different other treatment options and
    gradual reduction of landfilling
  - Encouraging composting and anaerobic digestion from organic waste
  - Promoting recycling of all possible recyclable waste
  - Maintenance of transport vehicles and equipment

Limitation of SWEET

SWEET with it many assets have few limitations which is mostly liked to developing country waste management practices. SWEET is not programmed to calculate the food waste that is fed to animals thus it remains in the recyclable segment of the tool which then show an increase of SLCP and GHG emission for some time. This is seen in the case of Pokhara when 47% of its food waste was fed to the pigs. This can also occur in case of cows where they are fed with the food waste which in 24 hours turns to manure and can be used as feeder for biogas plant or mixes with other green waste for compost.

Second, the SWEET only considers waste that are collected thus analyses is done only for population within the formal collection zone. Whereas the uncollected waste indicated in this document as outside formal collection zone is left behind, although it is producing equal or even more SLCP and GHG emission. Therefore, in developing countries like Nepal where waste collection is only limited the SWEET analyses will not portrait a holistic picture. A case for example, in Birendranagar Municipality only 37.64% population receive waste collection services and the rest 62.36% do not. As a result, the SWEET records CO2 emission in 2020 as only 22,588MT whereas in actual it is 60000 MT. Please see figure 1 for the detailed population inside and outside collection zone in the five municipalities.

Population distribution in the formal and outside formal collection zones



Implementation Timeframe:

The mitigation of SLCP and GHG emission from the waste sector is planned in three scenarios: short term (2020-2025), midterm (2025-2030) and long term (2030-2035) within a span of 15 years. This timeframe will complement the NNIWMS (2020-2035). The findings of the MoFAGA baseline survey of 2018 and 2019 will serve as the measurement foundation which is indicated in this document as business as usual condition (BAU). Please see table 2 For further clarification of the 3 scenarios.

Three Implementation Timeframe

Scenarios	Description
Business as Usual (2020)	BAU scenario projects the emission from the solid waste sector that produce GHGs and SLCPs based the MoFAGA baseline survey of 2018 and 2019.
Short-term (2025)	The improvements made in waste management within the 5 years period is anticipated to divert 24.09% waste from the landfill into different recycling activities.
Mid-term (2030)	This scenario focuses on the positive changes adapted over the course of 10 years from the baseline year and will divert 77.58% waste from the landfill site.
Long-term (2035)	The 15-year improvement period in waste management will divert 80% from the landfill site from the BAU condition. Thus, mitigating SLCP and GHG emission from the waste sector.

Waste Composition and Diversion Scenario

Based on the three-implementing timeframe Birendranagar Municipality within 15-year period will divert 92.86% of waste from the landfill site by adopting three recycling methods a) composting of 25.89%, b) anaerobic digestion of 36.02% and c) recycling of dry waste by 31.95%. Similarly, Kathmandu with its waste composition recorded at 66.55 wet and 33.45% dry waste proposes to divert 26.1% waste to composting, 12% to anaerobic digestion and 44.5% to recycling by end 2035. Pokhara projects to divert 3.1 % waste to composting, 10.7 to anaerobic digestion, 47% to animal feeder and 30% to recycling. Dhankutha, envisage to divert 47.6 % of waste to composting and 34% to recycling and Hetauda Municipality predicts to divert 12% waste to composting and 44.5% to recycling within the 15-year period. The table below provides the details.

Waste Diversion from Landfill Site within Short, Mid and Long Term

Alternative Scenario	Landfilling (%)	Composting (%)	Anaerobic Digestion (%)	Cattle Feeding (%)	Recycling (%)
Birendranagar Municipality					
BAU (2020)	99	1	0	0	0
Short term (2020-2025)	62.94	9.79	8.42	0	17.85
Mid-term (2020-2030)	29.64	8	16.9	0	8.4
Long term (2020-2035)	6.14	7.1	10.7	0	5.7
Birendranagar Municipality	**6.14**	**25.89**	**36.02**		**31.95**
Dhankuta Municipality					
BAU (2020)	49.7	37.7	0	0	12.6
Short term (2020-2025)	29.5	4.3	0	0	15.9
Mid-term (2020-2030)	23.7	2.8	0	0	3
Long term (2020-2035)	18.4	2.8	0	0	2.5
Dhankuta Muncipality	**18.4**	**47.6**			**34**
Hetauda Sub-metropolitan					
BAU (2020)	61.5	15.1	0	0	23.4
Short term (2020-2025)	48.5	3	5	0	5
Mid-term (2020-2030)	36.5	4	3	0	5
Long term (2020-2035)	17.4	4	4	0	11.1
Hetauda Sub-Metropolitan	**17.4**	**26.1**	**12**		**44.5**
Kathmandu Metropolitan					
BAU (2020)	88.0	0	0	0	12.0
Short term (2020-2025)	75.91	5.0	5.08	0	2.01
Mid-term (2020-2030)	46.52	15.2	10.2	0	3.99
Long term (2020-2035)	20.08	10.3	11.94	0	4.2

Alternative Scenario	Landfilling (%)	Composting (%)	Anaerobic Digestion (%)	Cattle Feeding (%)	Recycling (%)
Kathmandu Metropolitan	**20.08**	**30.5**	**27.3**		**22.2**
Pokhara Metropolitan					
BAU (2020)	41.9	0	2.2	47	8.9
Short term (2020-2025)	33.7	1.04	3.19	0	3.97
Mid-term (2020-2030)	22.1	1.06	2.71	0	7.83
Long term (2020-2035)	9.2	1	2.6	0	9.3
Pokhara Metropolitan	**9.2**	**3.1**	**10.7**	**47**	**30**

SWEET Analysis Results

Overall Emission of CO_{2e} based on three Implementing Scenarios

Birendranagar Municipality:

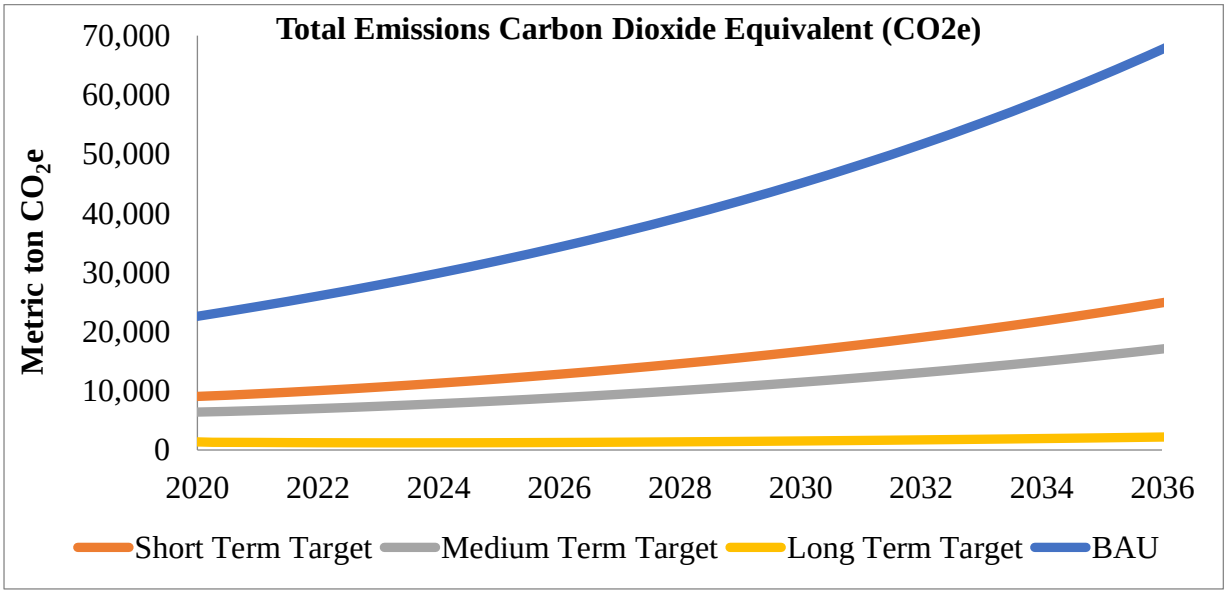
Figure … represents the overall CO_{2e} emissions from the waste sector based on three implementation scenarios and its diversion plans as stated above.

More specifically, the CO2e emission under the BAU scenario are measured to be equal to 22,588 MT in 2020 and 32,001 MT in 2025. In comparison, the 2025 emission under the short-term scenario are estimated to reach 12,010 MT. As a result, the reduction in CO_{2e} emission are estimated to be reduced by 62.47% in 2025.

In 2030, emission under the BAU scenario are found to equal 45,031 MT, while under the midterm scenario they reach 11,436 MT. In other words, comparing the baseline to the mid-term scenario reveals that in 2030 emission by be lowered by 74.60%.

Finally, in 2035 the emission under the BAU scenario stands at 63,243 MT and in the long-term scenario reach 2055 MT which represents a reduction of 96.74%.

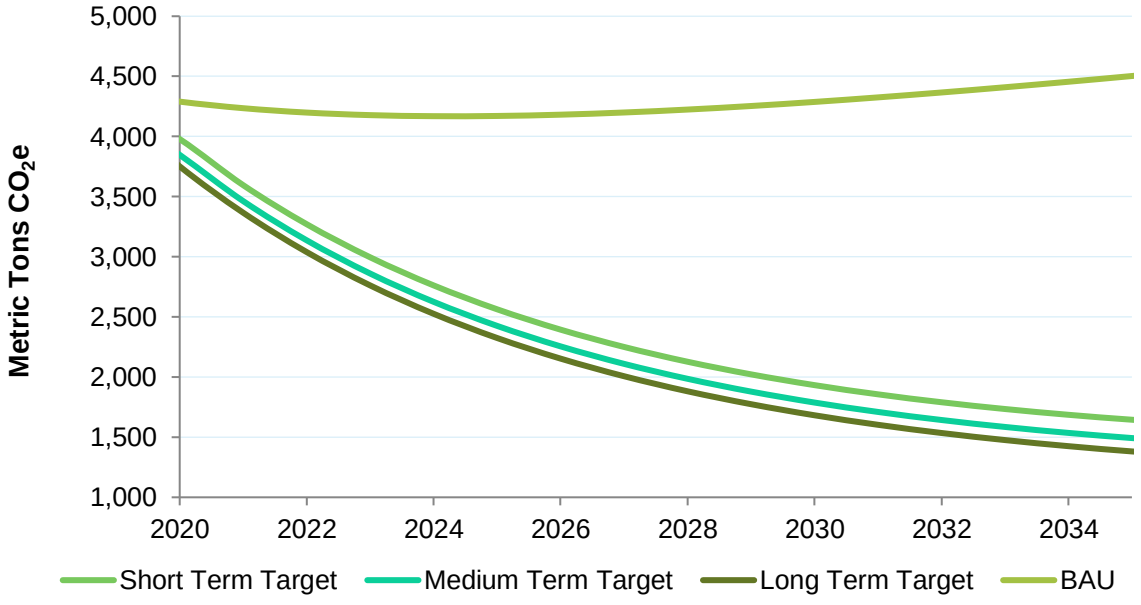
Overall Emissions of CO_2e based on the three Scenario (Metric Tons)



Dhankuta Municipality

Following the similar pattern as above the figure below illustrates that CO_{2e} emissions in 2025 has reduced by 38.55% from the baseline scenario**.** In the midterm (2030), with gradual improvements in waste management practices the CO_{2e} emissions decreased by 54.92%. Finally, in the long-term scenario that is in 2035, 69.33% CO_{2e} emissions was reduced from the BAU scenario. Compared with other municipality Dhankuta is recognized for its improved waste management practices in Nepal. Hence the emission is low and given the above implementation plan CO_{2e} emissions can further be reduced as indicated.

Overall emission of CO_{2e} (MT) based on the three implementing scenarios

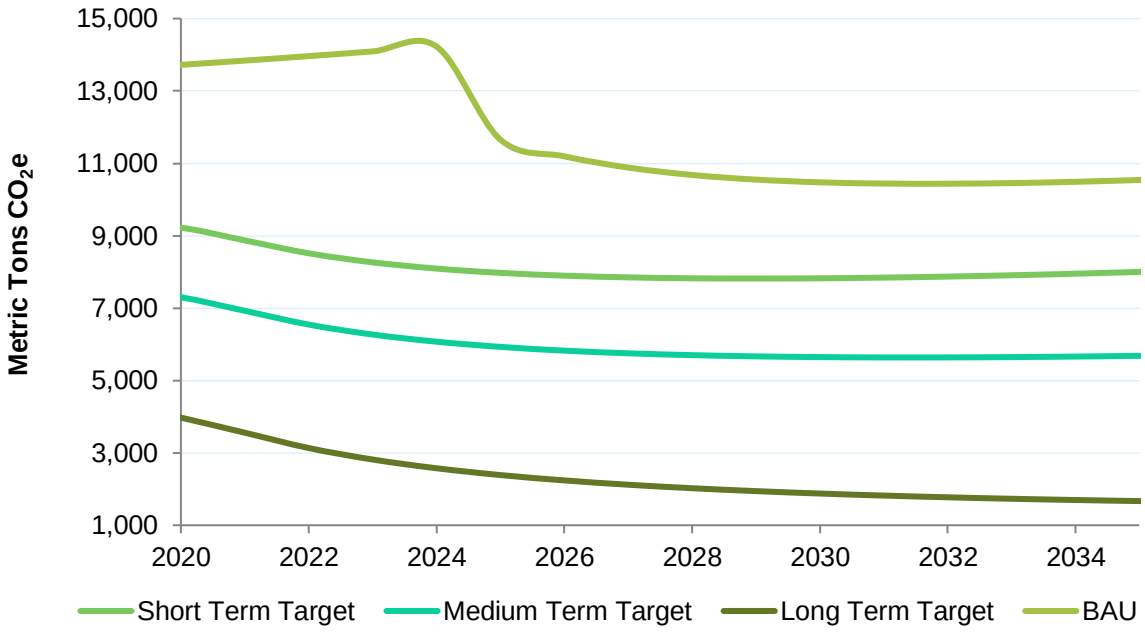


Hetauda Sub-Metropolitan City

The below figure reflects that CO_{2e} emissions is measured at 13,722 MT in 2020 and it dropped to 11,657 MT in 2025. Under the short-term scenario, emission is projected to reach 7,974 MT by 2025 that is a decrease of 31.61% emission in 2025. In 2030, it decreases by 45.53% and in 2035 the emission further to **84.42%** from the baseline line scenario.

These changes in emission are based on the enhancement in waste management practices from collection to recycling and final disposal.

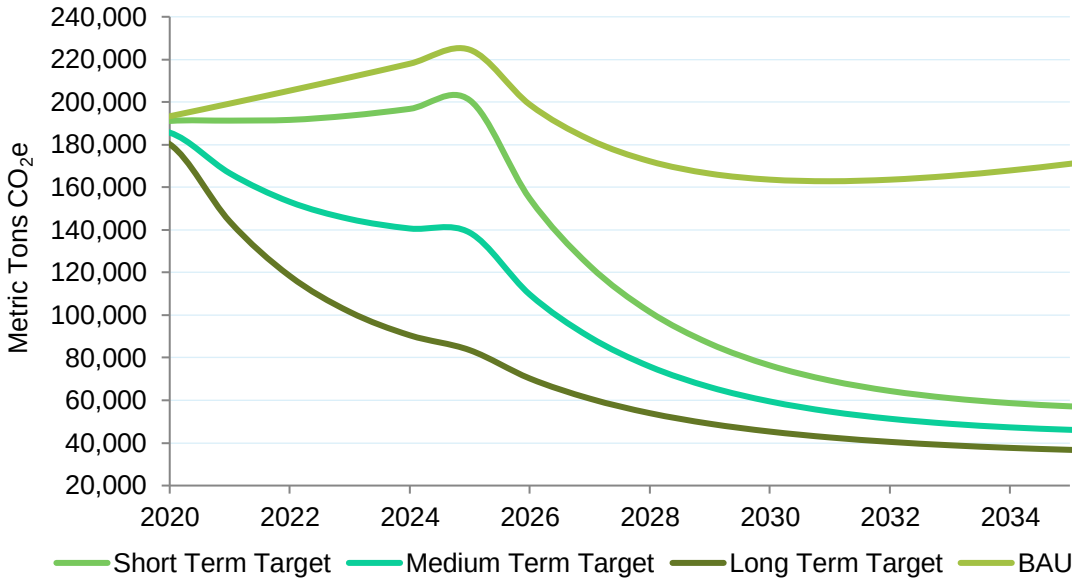
Overall emission of CO_{2e} (MT) based on the three implementing scenarios



Kathmandu Metropolitan City

Under the BAU scenario CO_{2e} emissions are valued at 193,312 MT, 224,534 MT, 163576 MT and 171,000 MT in 2020, 2025, 2030 and 2035 respectively. Under the short-term scenario, the emission is projected to be 200,837 MT in 2025 which is reduced by **10.55%** in comparison to the BAU scenario**.** Likewise, under the BAU scenario in 2030, CO_{2e} emission is projected to 163,576 MT and it reduced to 59,469 in given scenario of mid-term. It shows that in 2030, CO_{2e} emissions will be decreased by **63.64%** in comparison to the BAU scenario. Similarly, the emission under the BAU scenario in 2035 stands at 171,000 MT and in the long-term scenario reach 36,765 MT which represents **78.5%** reduction in, CO_{2e} emissions. The figure below gives a clear estimation.

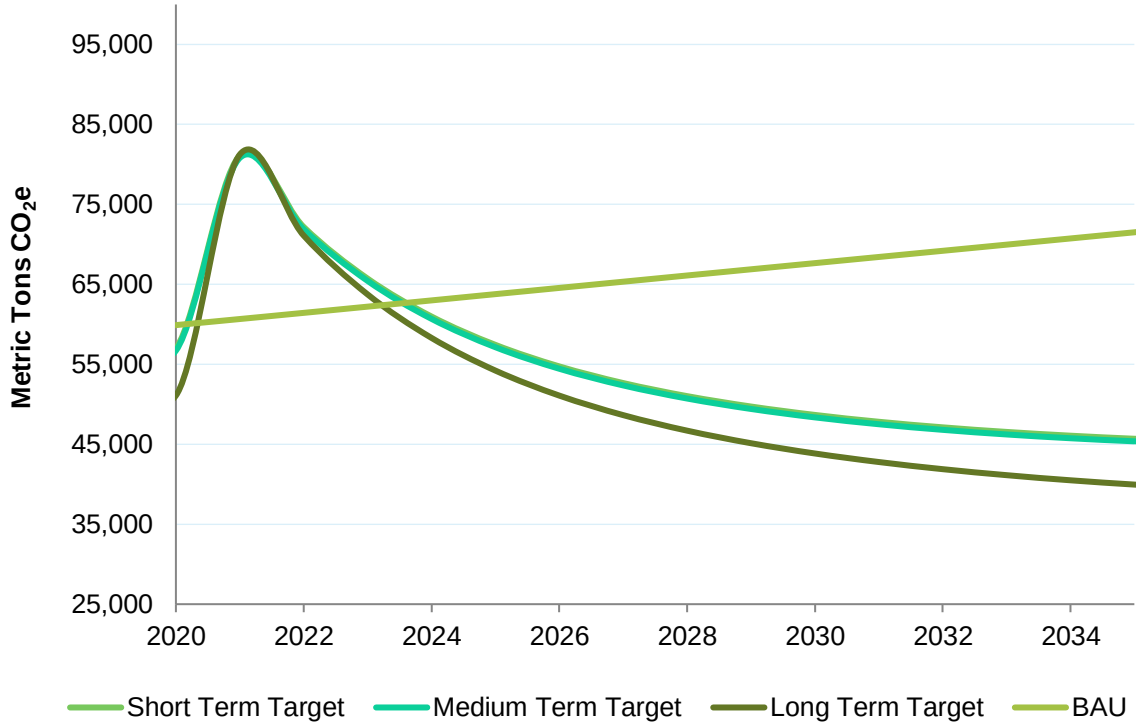
Overall emission of CO_{2e} (MT) based on the three implementing scenarios



Pokhara Metropolitan City

In 2020 the CO_{2e} emissions is recorded at 59,901 MT as shown in the figure below however, from 2020 to 2023 you see that CO_{2e} emissions has increased to 81,240 MT. This is because food waste that constitutes of 47% is directly sent to the piggery to feed the pigs and SWEET is not programmed to record this activity thus this 47% remains in the treatment options. As a result, increasing the emission to 81,240 MT. Nevertheless, by end 2025 CO_{2e} emissions is valued at 57,431 which denotes a reduction of emission by 9.94%. With further advancement in waste management in 2030, CO_{2e} emissions has reduced by **28.52%** as compared to the BAU scenario. Likewise, in 2035 the emission under the BAU scenario stands at 71,509 MT and in the long-term scenario the CO_{2e} emissions reach 39,955 MT which represents a reduction by **44.13%.**

Overall emission of CO_{2e} (MT) based on the three implementing scenarios



Total Emissions of CO_{2e} Reduction on Improvement Scenarios

The strict implementation of the NNIWMS (2020-2035) action plan in the five municipalities will bring about an estimate reduction of CO_{2e} emission of 238,970 MT. The short-term reduction at 55,322 MT, the mid-term at 164,323 MT and the long term at 238,970 MT. Kathmandu will achiever highest emission reduction which cumulates to 56.2% of the total emission reduction followed by Birendranagar with 25.6% reduction, Pokhara by 13.2%, Hetauda by 3.7% and Dhankuta by 1.3% CO_{2e} emission reduction.

CO_{2e} emission reduction improvement scenario of five municipalities

Local levels	Short-term (MT)	Mid-term (MT)	Long-term (MT)
Birendranagar	19,992	33,595	61,188
Dhankuta	1,608	2,500	3,122
Hetauda	3,683	4,830	8,872
Kathmandu	23,697	104,107	134,234
Pokhara	6,342	19,291	31,554
Aggregate Reduction	55,322	164,323	238,970

Emissions of CO_{2e} Based on Waste Management by Sources

The highest fraction of emission is triggered from waste thrown in the landfill and dumpsite (67.4%), followed by practice of open burning (13.4%), waste collection and transportation (12.7%), waste handling (6.4%) and organic management (0.1%). Table 3 below presents detail of the emission of CO_{2e} based on waste management by sources.

The table clearly identifies Birendranagar and Hetauda having a significant CO2 emission from waste burning. On the other hand, Kathmandu Metropolitan city has the highest emission from the landfill site followed by waste handling equipment's and waste burning. Pokhara the SLCP emission is largely cause from waste collection and transport, and waste burning. On a positive note the waste management of Dhankuta Municipality is found more progressive than the other four municipalities.

Total CO_{2e} emission by sources

Year	Emission by Source (metric tons)								
	CO_{2e} Emissions								
	Collection Transport	Waste burning	Landfill Dumpsite	Organic management	Waste handling equipment	PM_{10}	SO_x	$PM_{2.5}$	CH_4
Birendranagar Municipality									
2020: BAU	916	20,571	647	5	448	145	6	120	1778
2025: Short term	735	10,500	221	34	519	1	3	1	831
2030: Mid term	554	9,490	105	285	526	1	3	1	909
2035: Long term	361	459	61	265	908	1	1	1	352
Dhankuta Municipality									
2020: BAU	162	240	3,092	191	605	1	0	2	3,297
2025: Short term	170	168	1,632	429	164	0	0	0	2,070
2030: Mid term	179	89	954	442	125	0	0	0	1,401
2035: Long term	125	94	616	465	82	0	0	0	1,085
Hetauda Sub-metropolitan									
2020: BAU	177	9,723	3,005	119	698	41	2	34	3,434
2025: Short term	154	5,722	1,356	440	302	0	1	0	1,978
2030: Mid term	164	4,060	778	516	128	0	1	0	1,423
2035: Long term	135	435	499	603	72	0	0	0	1,116
Kathmandu Metropolitan									
2020: BAU	3,837	7,942	166,483	-	15,050	74	13	64	166,927
2025: Short term	4,145	9,207	172,298	1,456	13,732	17	13	16	174,264
2030: Mid term	4,805	6,497	33,750	6,380	8,037	10	8	10	40,489
2035: Long term	2,726	3,766	15,414	11,567	3,292	4	4	4	27,189
Pokhara Metropolitan									
2020: BAU	32,249	829	24,877	37	1,910	11	3	15	25,003
2025: Short term	30,967	698	23,775	164	1,827	10	3	9	23,981
2030: Mid term	32,498	553	13,349	292	1,670	9	3	9	13,676
2035: Long term	27,769	580	9,701	433	1,473	8	3	8	10,169

Comparison of the emission with national reports

The Third National Communication Report (2017) of the Government of Nepal records the solid waste management emissions at 278.76 Metric Gg of CO_{2e} (data from 2011). The report took into account the overall national urban population emissions from landfill sites which was 4.5 Million in 2011.

Based on this report the CO_{2e} emission of Kathmandu is measured at 62,150 MT in 2011 with population recorded at 1,003,285 as per the CBS census 2011. In comparison, the SWEET estimates CO_{2e} emissions at 193,312 MT for 2020 with projected population at 1,344,398.

368,812 total emission in 2020 reduction by

Likewise, Pokhara records CO_{2e} emission at 76,480 MT based on the projected population of 599,326 (2020) in contrast to emission measured at 25,641.80 with 413034 as its population. Birendranagar CO_{2e} emission is recorded at 60,000 MT, Dhankuta at 7,720 MT and Hetauda at 31,300 MT for the year 2020. All the municipalities in 2020 has measured significant higher emission than the 2011 data from the Third National Communication Report (2017). Kathmandu city with the highest emissions at 193,312 MT, followed by Pokhara at 76,480 MT, Birendranagar at 60,000 MT, Hetauda at 31,300 MT and Dhankuta at 7,720 MT respectively.

The higher emissions from the SWEET tool analysis could be due to more detailed and wider approach of emissions taken into account by SWEET tool as well as the population growth within the nine years including differences in data calculations and recording.

Comparison Chart

Cities	**National Communication Report (2017)**		**MoFAGA Baseline Findings 2018-2019**	
	Population (CBS, 2011)	Emissions (Metric Tons)	Projected Population 2020	Emissions (Metric Tons)
Birendranagar	47,914	2,968	115,451	60,000
Dhankuta	38,629	2,393	34,156	7,720
Hetauda	154,660	9581	182,878	31,300
Kathmandu	1,003,285	62,150	1,344,398	193,312
Pokhara	413,934	25,641.8	599,326	76,480

CHAPTER FOUR-WASTE GOVERNANCE

Institutional Arrangements

Political and economic context: Nepal has been through tumultuous political changes in the last 3 decades, including a decade-long armed struggle (1996-2006) and 7 constitutions in the last 70 years. On 20 September 2015, the newly adopted constitution transformed Nepal into a federal democratic republic with three government tires: central (federal), provincial (x7) and local (x753). Each tire has legislative, executive, and judicial functions and authority under exclusive and shared jurisdictions. Government in all three tires were formed in early 2018 following election in 2017.

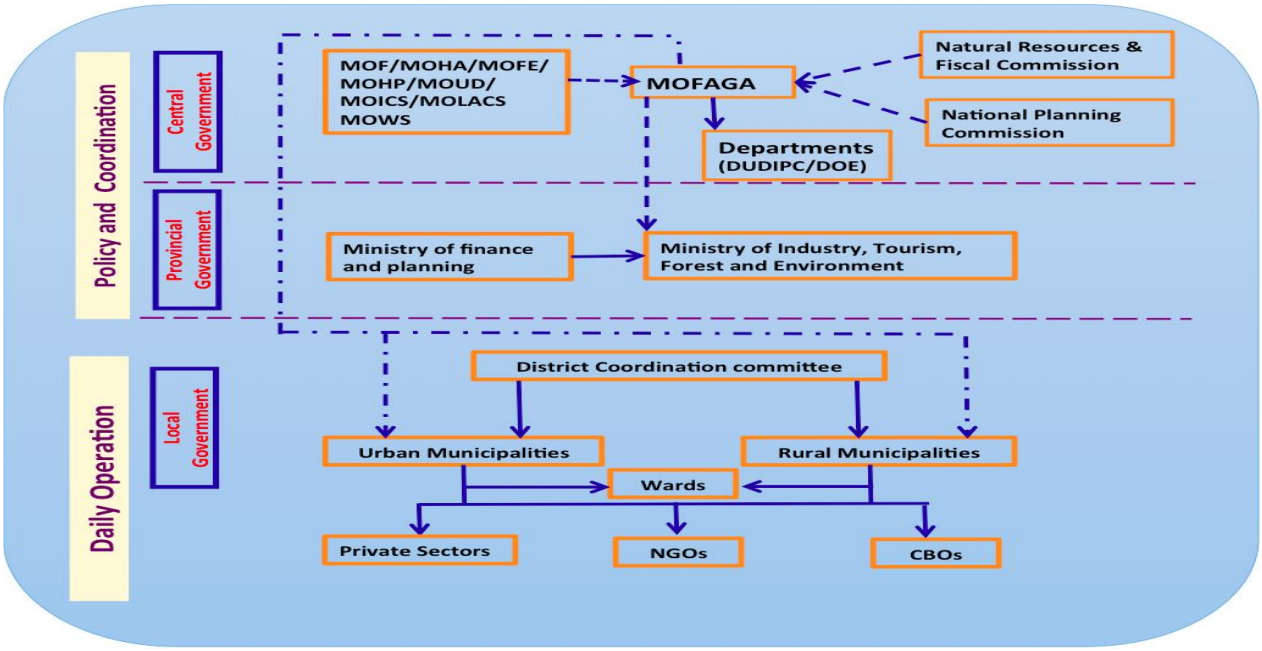
The National Planning Commission (NPC), Ministry of Finance (MOF), ad sector ministries are responsible for development planning and b. The government development strategy is outlined in the most recently development plan, the Fifteenth Five Year Plan (FY 2020-FY 2025).

Institutional arrangement in the federal structure:

Most sector ministries and departments at the federal level have been downsized or restructured as several functions have been developed to subnational governments (SNGs or local government). The function of the local government has been affected by the lack of human resources and low capacity of several staff members. Thus, Institutional development and strengthening of the local government and public institutes is one of the key reform priorities for the efficient implementation of federalism

National level institutions in the Waste Sector

The Constitution of Nepal 2015 authorizes local government to ensure basic health and sanitation services to the public and formulate local level development plans and project. Based on the constitution the Local Government Operation Act 2017 and the Solid Waste Management Act 2011 obliges the local municipalities to provide waste management services. While the direct responsibilities of the waste management service provisions are with the local authorities. The institutions at national level, which guide the overall policy for waste management for the local government. These institutional arrangement for waste management at the federal, provincial and local level is shown in figure15 below



Ministries and Institutional Arrangements

Waste with its numerous streams is a crosscutting issue within several line ministries. These major lines the Ministry of Forestry and Environment (MoFE), Ministry of Urban Development (MoUD), Ministry of Health and Population (MoHP), Ministry of Industry, Commerce and Supplies (MoICS), and the Ministry of Agriculture Land Management and Cooperatives (MoALMC) that have some indirect roles in the waste management. **Table 5** summarizes the specific roles and responsibilities of these line agencies in the context of waste management.

Table 5. Role of line agencies in policymaking and coordination in waste sector

Ministries and Institutions	Specific Roles and Responsibilities in Waste Management
National Planning Commission	A planning body appointed by the Cabinet to formulate national vision, periodic plans and develop policies. It provides a framework for policy for all sectors and serves as a central agency for monitoring and evaluating development plans policies and programs.
Ministry of Federal Affairs General Administration (MoFAGA)	MoFAGA is the ministry of Nepal accredited with the role of coordination, cooperation, facilitation and monitoring and evaluation of programs at the local government. It also formulates, implements and reviews policies and programs for recruitment, placement, promotions, salary, and disciplinary action of civil servants. It is the only ministry with direct linkage with the country's local governments, namely the municipalities, rural municipalities and the provinces related to federalism issues.
Solid Waste Management Council (Constituted under Article 23, SWM Act 2011)	The Solid Waste Management Council offers technical advice on solid waste management issues. The main responsibility of the Council is to; a) formulate national policy on the management of solid waste and to submit for approval of the Government of Nepal. b) To make policy arrangements among the concerned agencies for coordination. c) To approve a standard for fixing service charges for maintaining uniformity, while fixing service charges by the Local Body. d) To determine a percentage of the investment if any, investment is needed to be made by

	the Local Body for the proposal of the solid waste management works in an integrated manner. e) To perform other functions as prescribed.
Ministry of Forest and Environment (MoFE)	MOEF is responsible for developing and regulating the pollution control standards at national level.
Ministry of Urban Development (MoUD)	Responsible for urban development affairs including waste management
Ministry of Health and Population MoHP	According to SWM Act 2011, health care institutions are solely responsible and accountable for the waste management within their institution. MOHP plays a role to develop guidelines for the healthcare waste management and regulate the healthcare institutions on waste management.
Ministry of Industry Commerce and Supplies (MoICS)	In line with the standards developed by the MOFE, the MOICS regulates the industries and industrial waste
Ministry of Agriculture, Land Management and Corporative (MoALMC)	MOALMC is the focal ministry for managing agricultural waste. However, until now no database on agricultural waste has been generated.
Ministry of Finance (MOF)	Nationals financial manager, with oversight of revenues and expenditures, budget preparation and responsibility for maintaining a stable economy. Mobilizing and allocating resources, managing public investments and expenditures and strengthening the productive capacity of public enterprises.

Provincial Level Institutions

The Constitution of Nepal adopted in 2015 affirms, Nepal as a secular federal republic that is divided into seven provinces. Each province is composed of 8 to 14 districts. The districts, in turn, comprise local units known as urban and rural municipalities.

The local governments enjoy executive and legislative as well as limited judicial powers in their local jurisdiction. The local and provincial governments exercise some absolute powers and some powers shared with provincial and federal governments as stipulated in the constitution of Nepal. The laws enacted by local governments may not contradict existing laws at the provincial and federal levels or the national constitution. Similarly, provincial legislature may not enact laws contradicting federal laws or the national constitution. The district coordination committee, a committee composed of all elected officials from the local governments in the district, has a very limited role.

District Coordination Committee

The District Coordination Committee currently is solely authorized to conduct monitoring and coordination between the municipalities with MoFAGA as the lead Agent. The representative will be an elected body under the umbrella of MoFAGA.

Local level institutions

Municipality

The municipal is responsible for overall management of waste in their jurisdictions while the central and provincial governments will look into policy and coordination affairs. The municipalities are divided into urban and rural municipalities.

Urban municipalities are further categorized into levels, a) Metropolitan city (Mahanagarpalika)b) Sub metropolitan city (Upmahanagarpalika) and c) Municipality (Nagarpalika). There are six metropolitan cities, 11 sub-metropolitan cities and 276 municipalities

Rural municipalities (gaunpalikas) were established in 2017, replacing the village development committees. The role and responsibilities of the rural municipalities resembles that of a village development committee, but it has more rights on collection of royalty and taxes and has a higher annual budget than the VDC. Several VDCs were combined into a new rural municipality. There are 460 rural municipalities in Nepal and each local unit is composed of wards. There are 6,743 wards in total.

During the baseline survey it was found that most of the municipalities do not have a separate waste management division or unit. Therefore, any budget or activities on waste management are obtained from the budget code and activity under the environment, social welfare or the urban development division. In Birendranagar the administration structure has nine divisions/sections and 27 sub-sections, but it is silent on a waste management hence the waste management activities and budged are derived from the Environment and Sanitation and the Disaster Management and Emergency Division. Therefore, to priorities sound waste management a dedicated Integrated Waste Management division or section has to be recognized. Please see Annex 3 for the administration structure of Birendranagar Municipality.

Non-government actors/institutions

At the local level, NGOs, CBOs, private companies, and informal waste collectors and scrap dealers and the community are an integral part of the waste management system. They are involved in different aspect of waste management from a lobbyist to collaborator, to change agent, educator, regulatory and policy implementer.

Policy and Regulatory Framework

Waste and climate related policy and regulatory framework in Nepal can be broadly set into five categories: a) set of fundamental principles according to which a state is governed, b) waste management related frameworks c) climate change related policies, d) generic environmental protection frameworks, and e) multilateral environmental agreements (MEAs) and international commitments guiding towards a better environment.

a) State Governance Frameworks	
Constitution of Nepal, 2015	The 2015 Constitution of Nepal broadly includes waste management and other environmental concerns through its right to clean environment to every citizen and allows obtaining compensation by the victim in accordance of the Law for any injury caused from environmental pollution. The Constitution permits the formulation of national policy to protect, promote and maintain natural resources in order to minimize environmental deterioration. The Constitution authorizes local government to collect local statistics and records, assure basic health and sanitation of the public, and to formulate local level development plans and projects.

Fifteenth Five-Year Plan (2019- 2023)	The fifteenth five-year plan, through its subchapter **10.9 Environment** aim to control pollution, manage waste and promote greenery so as to ensure the fundamental right to live in a clean and healthy environment. 10.9 of the sub-chapter has five objectives from which three are concerning waste management which are stated below: Objective 1: To prevent and control all types of pollution including air, water, soil, noise and electrical pollution. Objective 3: To manage waste generated from households, institutions, commercial establishments and hospitals and protect the environment and rivers and maintain greenery Objective 4: To formulate policies, laws on proper management of waste. Conduct research and build capacity on environment management and pollution control. In the objective of the strategy, it clearly mentions the importance of managing wet and dry waste separately using the appropriate technologies. Private sector engagement with innovative technologies is also highlighted and collaboration with universities and academia for effective research is suggested. The major achievement of this periodic plan is that they have integrated Disaster Waste Management into the waste management stream.

Local Government Operation Act, 2017	Local Government Operation Act 2017 is based on the constitution of Nepal. This act will supersede the previous Local Self Governance Act of 1999. This Act makes the Ward Committees responsible for managing the waste within their respective areas. The functions, duties and powers of each Ward Committee include cleaning the roads, bridges, drainage, ponds, lakes, wells, deep water, taps, etc. within the Ward. The Ward Committees have to arrange for disposal of wastes, dirt and rotten materials and to make arrangements to encourage the inhabitants of the Ward for maintaining sanitation. The 2017 Act defines the functions, duties and power of local government, including but not limited to the following: • Formulation of policies, laws, standards and directives suitable for local government; implementation of those standards related to the sanitation at local level, • Adoption of low carbon and environment friendly development, • Air and noise pollution control and regulation, and • Sanitation and waste management at local level • Awareness raising on sanitation and health wastes; • Collection, reuse, processing, disposal and fix tariff of the health wastes and function as a regulating body; and • Establish coordination, collaboration, and cooperation with private sectors along with non-governmental organizations (NGOs) for the management of health care waste. •
b) Waste Management Related Act, Policies and Legislations	
Solid Waste Management Act, 2011	The Solid Waste Management Act (SWMA) 2011 promotes the reduction of waste at source, reuse, recycling and the final disposal while maintaining a clean and healthy environment. In its ten chapters all functions and legality related to waste management is spelled out. The Act mandates the local bodies to take necessary steps to reduce, reuse, and recycle (3R), including segregation of MSW at source, construction and operation of waste treatment and disposal facilities. It also provides for the involvement of the private sector, NGOs, community-based organizations (CBOs) in sol- id waste management through competitive bidding. Besides the daily operations of the waste management, the Act also provides guidance in monitoring and compliance activities, and authorization for imposition and collection of waste service fees as part of financial resource mobilization· The Act further authorizes the local bodies to formulate rules, by- laws, guidelines and issue directives.
Health Care Waste Management Guideline, 2002	The Health Care Waste Management Guideline of 2012 sets a provision that each health care institution should develop a waste management policy and delegate responsibility to health care institution to comply with this guideline. It has given main focus on waste minimization, waste segregation, collection, transportation, treatment and disposal of the healthcare waste, while also prioritizing on the occupational health safety and needs of training to the waste handlers of the health care institutions. The need for monitoring is also specified in the guidelines.

Circular on plastic bag ban, 2016	The Ministry of Local Development (MoFALD), now the MoFAGA, issued a circular in 2016 to the Kathmandu Metropolitan City, and all sub-metropolis and municipalities to implement the ban on plastic bags referred to in the budget speech for the fiscal 2016/17. The government has imposed a ban on import, storage, sale, distribution and use of plastic bags less than 40 microns thick. Under this Circular, "Import, export, sales, distribution and use of plastic and polypropylene bags have been banned to eliminate the negative effects such materials on human health, environment and urban beauty". Industries manufacturing alternative products to plastic bags were encouraged by providing an exemption from value added tax and charged only one per cent customs duty on the purchase of machinery and equipment. This ban was taken by exercising the power conferred by Section 7(3) of the Environment Protection Act, 1997. Violation of this section is liable to a fine of Nepalese Rupees of fifty thousand.
c) Climate change related policy frameworks	
Climate Change Policy, 2019	Nepal formulated the climate change policy in 2019 to work towards building capacity of the vulnerable groups to adapt to the climate change. Develop resilient ecosystem; promote green economy with low carbon emission; mobilize the national and international resources on climate change adaptation and mitigation; develop research and technology of climate change and effectively communicate the findings; mainstreaming or internalize climate change into sectorial policies, strategies, plans and programmes; mainstream gender and social inclusion into the climate change adaptation and mitigation programmes. It has provisioned the promotion of waste segregation at source and managing organic waste converting it into energy so as to reduce GHGs along with black carbon emission from waste sector (8.7 (d). It also promotes environmental sound technology and site while developing physical infrastructure (8.5 (c)). It provisioned to adopt climate risk mitigation while designing and constructing the physical infrastructure (8.5 (d)). Under the research, technology development and communication policy, it has provisions to develop technology to mitigate black carbon and other GHGs emission from various sector; identify the sources of GHGs emission and estimate the emission and mitigate; conduct monitoring and evaluation of the emission estimation and mitigation measures in periodic basis. The climate change policy was recently revised and has included waste management and its connectivity to climate change in Nepal.

Nepal's Nationally Determined Contribution, 2016	In 2015, a history was made when 196 Parties of the UN- FCCC came together under the Paris Agreement aiming to strengthen the global response to the threat of climate change by • Keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels. • To limit the temperature, increase even further to 1.5 degrees Celsius. The Nationally Determined Commitments (NDCs) are at the heart of the Paris Agreement. The Paris Agreement (Article 4, paragraph 2) requires each Party to prepare, communicate and maintain successive NDCs, which requires all Parties to put forward their best efforts to reduce national emissions through domestic mitigation measures and adapt to the impacts of climate change. In response Nepal has submitted its NDC in October 2016. The NDC is ambitious with a list ten targets. In the context of waste and GHG emission the below are the strategy high- lights. 1. Formulation of Low-Carbon Economic Development Strategy that will envision country's future plan to promote economic development through low car- bon emission with particular focus on: (i) energy; (ii) Agriculture and livestock; (iii) forests; (iv) industry; (v) human settlements and ***wastes;*** (vi) transport; and vii) commercial sectors…promote the generation of energy from waste, managing waste better and minimizing the release of methane…". 2. Reducing Air pollution by 2025 through proper monitoring of sources of air pollutants like wastes, old and unmaintained vehicles, and industries. Promotion of clean energy technologies
d) General Environmental Frameworks	
Environmental Protection Act, 1996 and Environmental Protection Rule, 1997	The Environmental Protection Act (EPA) 1996 and the Environmental Protection Rule (EPR) 1997 have made pro- visions to deal with pollution control, Initial Environmental Examination (lEE), Environmental Impact Assessment (EIA), conservation of national heritage and so on.
Environmentally Friendly Local Governance Framework, 2013	Nepal is implementing an Environment-Friendly Local Governance (EFLG) Framework. Some of the relevant indicators that the framework prioritizes are: 1. Promoting renewable and clean energy and energy efficient technology, 2. Enhancing waste management through environment friendly technology, 3. Promoting sustainable and organic farming and reduce the use of agro-chemicals, and 4. Controlling industrial pollution through effective regulations.

Sustainable Development Goals and waste management

The Sustainable Development Goals (SDGs) cannot be met unless waste management is addressed as a priority. The GHG emissions from waste handling and disposal connects waste to a global phenomenon like climate change. The trans boundary import and export of waste and marine plastic litter through land-based plastic leakage, and inclusion of the waste management issue in the global goals, all of these have put waste in the global agenda.

No Poverty. One percent of the global urban population makes their living from recovering recyclable materials from waste. Trough the increased practice of 3Rs principles, the livelihood of individuals will improve, thereby reducing poverty and contributing to the second SDG 2

Seeks sustainable solutions to end hunger and achieve food security. Sound waste management protects the soil and water from contamination thus producing healthy food. Recycling of waste to fertilizer will enhance productivity and reduce the use of pesticide thus contributing to good soil quality, increase productivity and feeding next generation.

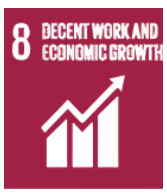
Aspires for Good Health and Well-Being. The un-controlled open dumping and burning of waste in open spaces including riverside is contaminating the air, water and soil. It therefore impacts negatively the population health and wellbeing"

Objective is to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. Teaching the benefits and impacts of sound waste management will enhance the quality of education and build resilience from a young age. Thus, the ministry of education must include sound integrated waste management practices into the education curricula".

Projects Gender Equality. Mainstreaming gender into the waste management sector is necessary to uphold this SDG. The 2018 & 2019 baseline assessment clearly revealed gender discrepancies in waste management. As previously presented, women in the institutional or commercial waste sector hold low paid and low power jobs with severe risks. Thus, interventions for gender equality are urgently required.

Objective is Clean Water and Sanitation. Waste when not managed appropriately is a key vector of diseases and a breeding ground for mosquitoes and can therefore poison water sources.

Aims an Affordable and Clean Energy. Converting waste to biogas and clean energy will support the paradigm shift turning waste into a valuable resource. In addition, it will increase the affordability of clean energy, provide livelihood and divert waste from landfill sites.



Hopes for Decent Work and Economic Growth: The establishment of innovative business in the waste sector and transforming waste in valuable resources will promote economic growth and decent standards at the workplace." Thus integrated resource recovery centre should be a priority for Nepal.

Encompasses, infrastructure, industrialization and innovation. Establishing resource recovery centre with environmental sound technologies is a sustainable solution to both economic and environmental challenges in the waste sector. By providing new jobs and promoting innovations in energy efficiency it is a crucial driver for green economic growth"

Hopes to Reduce Inequalities: Formalizing the informal work force, main-streaming gender and vulnerable social groups, ensuring fair wages, health, safety and security benefits to the waste workers will support SDG 10.

Foresee Resilient Cities: Sound waste management with good governance will promote clean water, soil and air resulting in resilient cities. Strong infrastructure and good governance will help build resilience and less waste will be generated from future disasters

Anticipates Responsible Consumption & Production: In 10 years the total domestic material consumption rose from 58.7 BT to 71 BT, some of this increase is from increased use of natural resources. 1.3 BT food goes wasted every year while 1B people go hunger and another 1B undernourished. Decreasing the use of natural resources and food waste by increasing recycling is seen necessary.

Promotes Climate Commitments: Waste segregation at source, improved collection system, transfer and transportation system with environmentally friendly technology and equipment's will reduce SLCP and GHG emission from the waste sector. "This will also stop open dumping and burning, and support waste diversion from the landfills. As a result, better waste management will contribute positively to SDG No 13."

Aims to protect the Life Under Sea. Three-quarters of the vastest open dumps in the world are on the coast; leaching hazardous materials flow into our oceans.

Large marine mammals are washed up on the shore dead with their stomach full of plastic. Sound management of waste will therefore help protect the life under sea.

Hopes to protect Life on Land. Mixed waste open dumping and burning decreases the quality of soils. The Life on land can only be protected and kept healthy with maximum good yield when waste is managed in a sound way.

Aims for Peace, Justice and Strong Institutions: Social groups working in the waste sector are discriminated based on gender and the nature of their work. Sexual and gender-based violence also exists amongst waste workers. Promoting the rule of law and human rights are key to ensure SDG 16.

Strengthen the means of implementation and revitalize the global partnership for sustainable development. Sustainable waste management cannot be achieved without the strong collaboration of all stakeholders. There must be robust partnerships between wealthy individuals and those less fortunate, the formal and informal sector, the vulnerable groups and the power holders, communities and the business world, governments and the international community, etc. "

Chapter 5: CHALLENGES AND POOSIBILITIES IN MSW MANAGEMENT

This section summarizes key challenges and possibilities. The findings are drawn from the situation analyses presented in Chapters 3 and 4, reflection of the ground realities in 35 municipalities, as well as through a detail key informant interview engaging the policy maker (government officials) at the central, provincial, and local level, business sectors, investors, researchers, and other key actors involved in Nepal's waste management.

Challenges

The waste sector receives little attention in Nepal's policy, legal, and institutional framework. The local government who is responsible for the waste collection and the removal is often suffering from the lack of financial resources, outdated equipment/technology, inefficient management or insufficient dialogue between the municipality and the citizens, between institutions, and among other stakeholders responsible for waste management. Some of the pertinent challenges include;

Increasing amount of waste

Increasing volume of waste due to population growth, urbanization, and consumerism-based lifestyles but the shortage of waste management resources as in collection services, landfill space, waste recycling technologies, finance etc. are the fundamental challenges that cities in Nepal face.

Policy and Institutional challenges

Nepal has postulated a number of SWM acts and policy, but weak enforcement is the challenge. Lack of coordination and overlapping roles and responsibilities of institutions involved in waste management is another common barrier that affects effective waste management.

Capacity and resource mobilization challenges

Lack financing and (technical and managerial) capacity of the institutions and human resources involved in waste management is another challenge that Nepal faces.

Technology and infrastructure challenges

Lack of appropriate technologies and infrastructure for waste management is the major problem that cities in Nepal are currently facing. Environmentally sound material recycling and energy recovery facilities are almost non-existing in the country. Majority of the municipalities do not even have a sanitary landfill for MSW. There are no treatment facilities for hazardous waste.

Challenges in mobilizing public participation

Waste management is often a neglected issue in communities too. Due to the lack of an existing waste management strategy, roadmap and infrastructure for proper waste separation, collection and 3R activities, public support for sustainable waste management are limited.

Possibilities

Amidst multiple challenges, there are also the opportunities to achieve sustainable waste management through careful planning, developing and enforcing enabling policy environment, investing in ESTs in waste treatment and recovery, mobilizing financial resources, building the capacity of the institutions, and encouraging public participation for a resource recovery-centric waste management practices. For these opportunities to materialize, few fundamentals, however, needs to be in place:

Improving waste management data

Build more reliable and comprehensive waste-related statistics

It is observed that comprehensive, reliable data on various waste streams in the municipalities are currently missing. For better interpretation, a compilation of associated socioeconomic, health and environmental indicators is also necessary. Lack of data makes it difficult to quantify the SLCP emissions as a baseline, hence difficult to monitor the reductions in the emissions. The scarcity of quality data affects system design, technology selection, and estimation of investment needs and assessment of policy development. Generally, some information on MSW is available, although it is often estimated by making several assumptions. Importantly, information on material flows (especially on recycling, livelihood creation and employment) in the informal sector that dominates Nepal's waste management regime has been difficult to obtain. The climate linkages of the waste sector are yet to be fully realized. There is no estimation of the sectoral contribution of GHG emissions at the municipal level. Therefore, a more accurate data collection and sharing system on waste have to be developed.

Standardize the waste terminologies

To improve on waste-related statistics across Nepal, it is important that standard and universally acceptable definitions of waste streams and related terminologies are followed. Currently, there are no such uniform or agreed definitions this makes a comparative assessment across the counties difficult and in some cases even misleading. A case for example, in Nepal the term "dumping site", is referred to landfill site as well as dumping on open vacant land or in the riverside.

Proactive policies and sound institution solutions

Improve compliance on waste-related regulations

Nepal has policies and regulations in place however, implementation of these policies and regulations has been rather slow and not very effective. The first step, therefore, should be to achieve compliance with the existing policies and regulations through strict enforcement and monitoring. Increase the coverage of segregated waste collection, introduce sufficient covered vehicles, and practice shared waste processing facilities amongst municipalities, proper closure of existing dumps/landfill sites and construct shared sanitary landfills as priority tasks. These activities will need to be addressed along with an integrated perspective covering the entire waste to resource management cycle (3R).

For implementation purposes, the private sector and CBO's should be involved by offering attractive business models and by involving communities and informal sectors. The waste management hierarchy needs to be followed when building a sustainable waste management infrastructure. Only then onwards, that compliance will then be achieved proactively on a cost-effective, sustained basis.

Policy Coordination

In Nepal management of various types of wastes and resources fall under the portfolio of national and local bodies that operate independently. For example, solid waste is managed by local bodies and air and water pollution caused by the solid waste is monitored and controlled by pollution control authorities (Ministry of Forest and Environment), while resources like water, energy and raw materials are managed by line ministries such as ministries of water resources, energy and irrigation, and so on. To integrate management of waste and to establish circular economy, a dialogue and coordination between various ministries and departments is key.

Again, there is a challenge where a number of functions are overlapping within line ministries. A case for example, the Ministry of Forest and Environment formulates legislation on environment protection and develop pollution standards and monitoring requirements. Based on this they conduct monitoring functions. At the same time the ministry of Industry Commerce and Supply based on the Industry Operation Act also fulfils their monitoring functions for all industrial pollution, hence duplicating the monitoring role. MoFAGA formulates legislation for municipal waste management and its infrastructure requirements; on the other hand, the Ministry of Urban Development is also responsible for urban infrastructure development such as waste infrastructure thus another duplication of work.

Sectorial Integration

The line Ministries is obligation to integrate waste management issues into all their sectorial policies. However, this is applied scarcely, a case for example, the Ministry of Industry is silent on the management of waste produced by the industries established in Nepal. Therefore, the waste management policy has to be amended mandating all line Ministries to include waste management clause in all their sectorial functions.

Promote investment in waste management

The Nepal Government annually assigns budget for waste management but at a minimal fraction therefore for sustainable waste management investments in the waste sector must increase. If not, national and the local governments will face significant costs of inaction, and simultaneously public health and ecosystems will face significant risks. A case for example is the 2015 earthquake, seismologists had predicted a major earthquake in view of the Himalayan fault line, but Nepal did not have trained human resources, necessary equipment's, safety protection gears nor a contingency plans to deal with disaster related waste which was about 4 million tons in just a weeks' time. Gathering such evidence and data are necessary to sensitize city administrators and political leadership to put waste management as one of the priority development activities and secure investments. Hence, encouraging private sector investment in waste management as well as mobilizing international cooperation is essential for improving governance and building local capacity and infrastructure necessary for waste management.

Encourage entrepreneurship and innovative business

There is a need to increase and effectively implement waste management-related budgets, simultaneously it is important to encourage entrepreneurship and private investment flows which in the long run will supplement the government resources which are often limited. The current need is to turn waste management into lucrative, innovative businesses to attract entrepreneurs and both public and private investments.

Waste to resource management is emerging as an attractive business incentive and can thus become an important "channel" for promoting entrepreneurship and investment flows in the waste management sector. Therefore, Governments should integrate an enabling framework in the policies and laws of the land. Entrepreneurs in Nepal face many challenges including lack of access to risk capital and support systems. The governments can partner with development agencies to encourage young entrepreneurs and students to pursue waste management as a career. The support can come from public and private entities like national grants, venture capital firms, commercial banks and from mechanisms such as direct foreign investment, public-private partnerships, and socially responsible investments.

Inclusive waste management

Informal sector inclusion

The informal sector is an important stakeholder in waste collection and processing in Nepal. Integration of the informal sector with the formal sector would be a good start. Efforts are to be taken to ensure social inclusion, health and safety, dignity of labor of the informal sector and ensure sustained livelihoods.

Mainstreaming gender in waste management

Understanding the gender dynamics is necessary for achieving sustainable waste management. Therefore, integration of gender at household, community, and local authority through gender considerations in formulating waste management policy, planning and designing waste management programs, and allocation of a gender-sensitive budget is the way ahead.

Education, research, and capacity building

Promote awareness and capacity building

Public awareness is needed at both the "upstream" as well as the "downstream" stages of the waste management cycle, starting with the reduction of waste generation to segregation, re-use or recycling followed by collection, transportation, treatment and disposal. This could be achieved by publication campaigns on 3R methods, education on the waste management and its impact to air water and soil.

Publication & campaigns

The communities need to be sensitized on a massive scale and on sustained bases on the impact of poor waste management on health and climate by applying both visual and practical innovations. Short films, audio-visuals, exhibitions, street plays, social drives and social media campaigns can be a medium. To undertake this task the governments could partner with NGOs and CBOs keeping in mind the culture and social characteristics of the local communities.

The advertising community and media houses should be invited by public and private entities to communicate powerful messages to the community through photographs, videos, short films and television advertisements. Media houses can announce public competitions and awards for communities, schools or groups that demonstrate positive impacts towards waste management.

Education

Schoolchildren and university-age students should be the primary target to introduce waste management and climate change mitigation. In addition, communities should be empowered through informal education on waste management and its impact. E-learning courses could be a priority for policy makers, academia and practitioners. The UN Environment's International Environmental Technology Centre has developed a curriculum on holistic waste management in partnership with five academic institutions, led by the Asian Institute of Technology in Bangkok, Thailand. This work, for instance, could be used to develop e-learning courses on holistic waste management.

Training & development

One of the key challenges to sound waste management is the lack of training and capacity among key stakeholders. A one-size-fits-all approach does not work when planning and delivering training and capacity building programs to diverse stakeholders in three ecological zones of Nepal. A training needs assessment could be conducted for each type of stakeholder to identify areas where awareness and skills need to be developed. Tools like practical hands-on demonstrations, national and international case studies and field visits thus developing stakeholder capacity.

Investment in research and technology development

Technology should be pre-assessed based on the characteristics, composition, volume of waste and its potential to reduce GHG and SLCP emission. Pilot testing and adoption are, thus, necessary to ensure that technologies can handle high moisture content, contamination and low calorific value for example in Kathmandu. The landfill are the major contributors of the methane emission from the waste sector and Nepal should allocate budget for research on estimating the GHG and SLCP emission and assess technology required based on the findings.

Much experience is now available in the management of MSW and special waste streams like plastic and healthcare waste which we still need to apply in Nepal. Experience on cost-effective management of new waste streams such as e-waste, Disaster Waste, Industrial waste needs to be explored. Therefore, developing databases and proper management mechanism for these waste streams through research and development is a must.

Conclusions

The baseline study compiles information on MSW quantity, composition, and management practices in 35 municipalities across seven provinces in Nepal. The per capita MSW generation rate was estimated to be 0.37 kg/capita/day. In terms of MSW composition, organic waste constituted the largest fraction (57.95%). Other potential recyclable materials such as plastic, paper and paper products, glass and metals cumulatively accounted for another 40.51%. While chemical hazardous materials were at 1.54%.

Source segregation of waste is almost negligible at 17%. Out of 35 municipalities, only 14 provides waste collection services. Open dumping and open burning are the most common methods of waste management practices. 19 out of 35 municipalities do not even have a designated space for dumping waste. Currently, only one municipality operates a fully functional sanitary landfill. Recycling is at a nascent stage, with the recyclable material collection and trading being done by informal scrap collectors. One of the changes in recycling effort is that as compared to the past, new recycling industries are being established in Nepal allowing the scrap dealers to sell the materials inside the country. However, the informal nature of it discounts the recycling efforts as the revenue is not accounted in the formal economic contribution to the government. Similarly, the informal waste sector falls victim to the negative social stigma attached to their occupation. In addition, the low investment capacity of these informal sector compromises the quality of the recycling technology adopted, hence polluting the environment. It is, therefore, necessary to institutionalize and upscale the recycling activities in Nepal by inviting larger investment and environmentally sound technologies for recycling, however, keeping the informal waste sector as an important part of the system.

Only a fraction of municipal budget (on an average 2.97% of the total municipal budget) is designated to waste management. Waste service fee collection is one of the financing mechanisms for SWM in its jurisdiction, however, the waste fees are far from full cost accounting and are insufficient. The national and local government are opening their doors for private sector participation in waste management, especially in waste collection.

In case of policy and legislative framework, with a new federal structure, the SWMA 2011 needs to be translated into policy, directives, strategies and guiding principles and a time-bound implementation plan.

Nepalese municipalities have not conducted studies on accounting SLCPs emissions from the waste sector. An attempt was made during this baseline study to quantify SLCP emissions from the waste sector at the municipal level. It was estimated that the total GHG emission from MSW sector in Kathmandu municipality was 197,482 Metric tons CO2e, and 7,791 Metric tons CO2e in Hetauda municipality. Such quantification of SLCPs from waste sector in Nepal would encourage to develop select appropriate ESTs for waste management that relays two-fold results, that is, combating the GHG and SLCP emission reduction while achieving sustainable waste management as well as achieve various SDG targets.

This baseline study confirms that waste management is at an early stage with pertinent technology, financial, and capacity challenges that both national and local level government faces. Nonetheless, these challenges open an avenue for municipalities to implement proper solid waste management planning by instituting waste reduction, segregation and recycling habits, diversion of organic waste into compost or biogas, channelizing innovative funding mechanisms, creating an enabling environment for stakeholders' participation.

A strong political will and commitment to enact, coordinate and support enforcement of appropriate actions is a requisite in attaining sustainable waste management. With a new federal governance system, local municipalities can aptly work towards prioritizing waste management activities and creating an enabling legislative, financial and technological environment for the sustainable management of waste while tapping various co-benefits such as fulfilling the climate commitments by utilizing the unused potential to mitigate GHG and SLCP emissions from the waste sector as well as achieving a number of sustainable development goals through better management of waste.

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