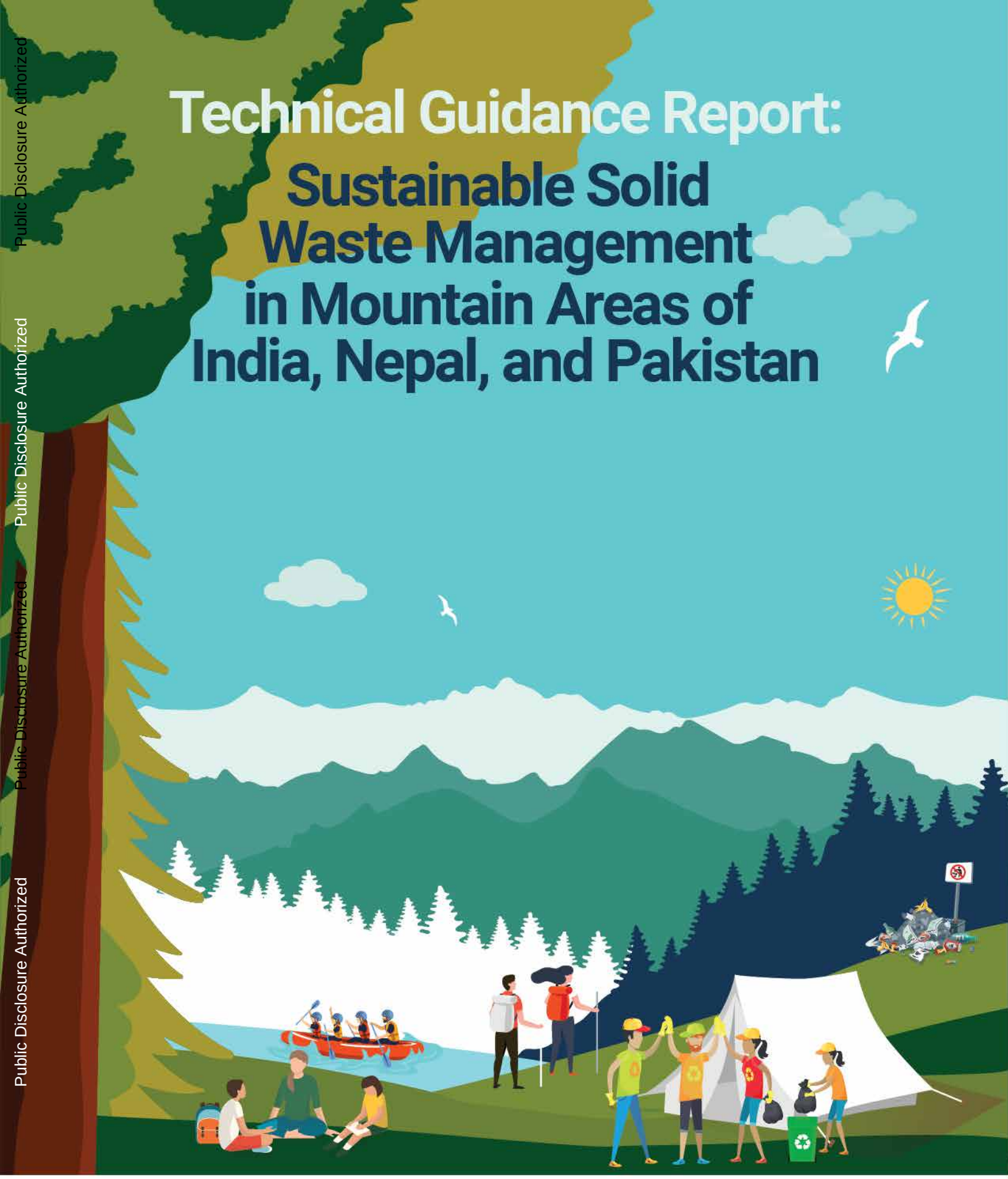
Technical Guidance Report:

Sustainable Solid Waste Management in Mountain Areas of India, Nepal, and Pakistan



WORLD BANK GROUP

Korea Green Growth Trust Fund

Publications part of this study

India: Sustainable Solid Waste Management in Mountain Areas

Nepal: Sustainable Solid Waste Management in Mountain Areas

Pakistan: Sustainable Solid Waste Management in Mountain Areas

Technical Guidance Report: Sustainable Solid Waste Management in Mountain Areas of India, Nepal, and Pakistan

Good Practice Options for Sustainable Solid Waste Management in Mountain Areas of India, Nepal, and Pakistan

Technical Guidance Report: Sustainable Solid Waste Management in Mountain Areas of India, Nepal, and Pakistan

January, 2021

Supporting the Development of Sustainable Solid Waste Management Strategies for the Mountainous Regions of India, Nepal and Pakistan

Technical Guidance Report: Sustainable Solid Waste Management in Mountain Areas of India, Nepal, and Pakistan
January 2021
SAR ENB

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Report design and layout: ShahRukh, SmarTek, Islamabad, Pakistan.

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Foreword

Waste management has become a major challenge all over the world, particularly in low- and middle-income countries. In this context, governments and communities are increasingly recognizing that, outside of large cities, waste management is also clearly a fast growing critical issue in environmentally-fragile areas. Mountains—a prime example of environmentally-fragile areas—face competing challenges of high poverty as well as, in specific locations, increasing impacts from tourism-related development. Geographical remoteness, limited access to civic infrastructure, lack of capacity, and topographical and temperature variations due to altitude differences complicate waste management. These mountain features make the provision of actions and services to address growing volumes of unmanaged waste even more challenging in mountain areas of India, Nepal, and Pakistan.

The impacts of growing volumes and evolving composition of unmanaged waste in mountain areas are increasing rapidly. Uncollected solid waste contributes to flooding, open burning leads to air pollution and causes respiratory ailments, and haphazardly dumped waste creates eyesores that may eventually have a negative impact on tourism. Poor waste management practices also affect areas downstream. Litter, in particular plastic, is carried in streams and rivers from mountains to the plains, and eventually to the oceans.

Addressing these challenges come with tremendous opportunities. Cleaner areas help provide a more attractive environment for tourism. Waste, if treated as a potential resource, can create jobs and new business opportunities for local entrepreneurs, in addition to being used as an energy source and fertilizer substitute. Adopting a landscape approach in management practices in mountain areas can increase coordination, awareness, and lead to behavior change around waste generation and segregation.

This study represents a first attempt to examine solid waste management in unique and ecologically-sensitive mountain areas. For this, I want to congratulate and thank the World Bank team behind this endeavor, especially the Country Management Units (CMUs) who led the team, as well as the clients and the stakeholders who contributed towards this study. The Korea Green Growth Trust Fund (KGGTF) deserves a special mention here.

The report is tailored to the South Asia Region—in particular India, Nepal, and Pakistan. But the recommendations and related actions are designed to guide discussions and actions in other mountain areas in the region and elsewhere. Recommendations have been developed using an integrated waste management framework, and related implementable actions are presented in order to overcome solid waste management challenges faced in mountain areas. A phased approach has been suggested to allow for flexibility, as implementation may follow different time frames and recommendations may be adopted concurrently.

We hope this report will contribute to furthering dialogue that can lead to much-needed action, including improving analytics and tools, engaging with stakeholders, and contributing to policy and institutional development to support local development.

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Acknowledgements

This report was prepared by the World Bank as part of Advisory Services and Analytics (ASA) on *Solid Waste Management in the Mountainous Regions of India, Nepal and Pakistan,* and is part of a series of Knowledge Products on the topic. The effort was generously funded by the Korea Green Growth Trust Fund (KGGTF), a partnership between the World Bank Group and the Republic of Korea. The report was prepared by a core team comprising Rahat Jabeen *(Environmental Specialist and Co-TTL, Pakistan focal point),* Pyush Dogra *(Senior Environmental Specialist and Co-TTL, India focal point*), Drona Raj Ghimire *(Senior Environmental Specialist and Co-TTL, Nepal focal point),* and Naysa Ahuja *(Consultant, Environmental Governance Specialist).*

The team is grateful for the overall support, guidance, and facilitation of technical partners consisting of officers and staff of Korea Environment Corporation (K-eco), including Dr. Chang-hwan Cho, and their local partners, during their field visits to India, Nepal, and Pakistan. The team sincerely appreciates the contribution of the local communities, both households and entrepreneurs, who participated in the field study.

The report benefited greatly from discussions between relevant ministries and public office holders and the delegates from the three countries during the Knowledge Exchange visit to the Republic of Korea. The team thanks Poonam Rohatgi for production management and logistical support for the Knowledge Exchange visit.

The team would like to thank Perinaz Bhada-Tata for a commendable effort in reviewing, updating, and editing the report. The report was updated with meticulous help and technical guidance from local resource persons: Swati Singh Sambyal (India), Santosh Shrestha (Nepal), and Aftab ur Rehman Rana, Azheruddin Khan, and Azher Ali (Pakistan). Farahnaz Zahidi Moazzam provided valuable assistance in preparing the report for publication.

Constructive comments on the report were received from the following World Bank peer reviewers: Frank Van Woerden *(Lead Environmental Engineer, SEAE1)*, Jiang Ru *(Senior Environmental Specialist, SSAEN)*, Farouk Mollah Banna *(Senior Urban Sanitation Specialist, SAFU1)*, A.S. Harinath *(Senior Environment Engineer, SMNEN)*, and Silpa Kaza *(Urban Development Specialist, SCAUR)*. The team is grateful to Marcelo Hector Acerbi *(Senior Environmental Specialist, SMNEN)* and Peter Kjaer Milne for their early engagement.

The study was prepared under the guidance of Christophe Crepin *(Practice Manager, SSAEN).* The team would also like to thank Kseniya Lvovsky and Lia Carol Sieghart *(Practice Managers, World Bank)* for their encouragement and support. The team gratefully acknowledges Eun Joo Allison Yi, Hyoung Gun Wang *(KGGTF Program Manager)*, John Hosung Lee, Hanul Oh, and the rest of the KGGTF team for their continued technical and administrative support.

Abbreviations

3 Rs	Reduce, Reuse, Recycle
ACA	Annapurna Conservation Area
ADB	Asian Development Bank
ASA	Advisory Services and Analytics
CBO	Community-based organization
CBS	Central Bureau of Statistics (Nepal)
CCAC	Climate and Clean Air Coalition
CDM	Clean Development Mechanism
C&D	Construction and demolition
CPHEEO	Central Public Health and Environmental Engineering Organisation (India)
CSR	Corporate social responsibility
ENB	Environment, Natural Resources, and Blue Economy
ENCORE	Enhancing Coastal Ocean Resource Efficiency
EPR	Extended producer responsibility
FAO	Food and Agriculture Organization
GDP	Gross domestic product
GHG	Greenhouse gas
GNI	Gross national income
IHR	Indian Himalayan Region
ILM	Integrated landscape management
ISWM	Integrated solid waste management
K-eco	Korea Environment Corporation
kg	Kilograms
KGGTF	Korea Green Growth Trust Fund
LDPE	Low-density polyethylene
LMI	Lower-middle income

LNG	Liquefied natural gas
MCLLMP	Meghalaya Community Led Landscape Management Project (India)
MDGs	Millennium Development Goals
MoEFCC	Ministry of Environment, Forest and Climate Change (India)
MSW	Municipal solid waste
NGO	Non-governmental organization
OECD	Organization for Economic Cooperation and Development
PforR	Program-for-results
PLEASE	Plastic Free Rivers and Seas for South Asia
PPP	Public-private partnership
RDF	Refuse-derived fuel
RFID	Radio-frequency identification
SAR	South Asia Region
SAWI	South Asia Water Initiative
SDGs	Sustainable development goals
SHG	Self-help group
SRF	Solid recovered fuel
SWM	Solid waste management
UN	United Nations
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNWTO	United Nations World Tourism Organization
VBWF	Volume-based waste fee
WIEGO	Women in Informal Employment: Globalizing and Organizing
WTE	Waste-to-energy

All dollar amounts are US dollars unless otherwise indicated.

Executive Summary

Millions of people depend on the mountain ranges of India, Nepal, and Pakistan either directly or indirectly. The Himalayas, Karakoram, and Hindu Kush ranges offer vast ecological biodiversity, help regulate the climate of the region, and support millions of people by providing freshwater for domestic, agricultural, and industrial activities as well as livelihood options.

Mountain areas present numerous challenges for sustainable solid waste management (SWM) by virtue of their remoteness, topography, scattered settlements, sensitive and fragile ecosystems, lack of infrastructure and road networks, and poor institutional and financial capacity. In addition, while tourism brings much-needed income to these areas, it results in various externalities such as increased traffic congestion, air and noise pollution, strain on local water and energy supplies, and growing quantities of waste.

While settlements in low- and middle-income countries—whether mountainous or not—face SWM challenges, mountain areas tend to face additional ones. These challenges are by virtue of their location, characterized by remoteness, topography, scattered settlements, sensitive and fragile ecosystems, lack of infrastructure and road networks, and poor institutional and financial capacity. This makes service provision in mountain areas all the more demanding compared to the plains.

Ecologically-sensitive areas—whether mountainous or not— face some similar challenges when it comes to SWM. Table ES.1 summarizes the challenges faced by all areas regardless of location, as well as the challenges unique to eco-sensitive areas, both in mountainous and non-mountainous regions. Moreover, not all mountain areas are the same, and vary by many localized factors, such as topography, climate, access, seasonality, waste volumes and types, and the impact of tourism. It is clear then that mountain areas require a suite of bespoke waste management solutions.

Table ES.1: Comparison of SWM challe nges in mountain, non-mountain, and eco-sensitive areas

SWM in all areas	SWM in mountain areas	SWM in eco-sensitive areas
Poor awareness and adoption of SWM practices	Topography and geology (e.g., steepness, ruggedness, soil stability)	Remoteness of settlements
Lack of waste segregation	Remoteness of settlements	Distance to developed infrastructure make waste collection and transport challenging
Inadequate collection and storage facilities	Scattered and low-density areas generating low volumes of waste	Tend to attract tourists
Poor or obsolete transportation options	Diverse temperature and weather conditions	Depending on the area, tourists may visit all-year long
Lack of or poorly functioning treatment facilities	Sensitive environmental and ecological conditions	Sensitive environmental and ecological conditions
Improper waste disposal techniques	Vulnerability from seismic activity and landscape	Space constraints for waste treatment and disposal
Competing priorities for local governments	Lack of road networks making access difficult	
Lack of skilled and technical capacity	Special types of waste generated (e.g., mountaineering waste), which require treatment and disposal	
Lack of institutional coordination	Waste transport requires vehicles suitable to mountain regions	
Lack of funding and poor cost recovery	Limitations of space for waste treatment and disposal	
	Poor socio-economic conditions in general	
	High variability of waste generation due to tourist seasons	

Background of this Study

This study represents the first attempt of the World Bank to examine SWM issues in these unique, ecologically-fragile areas that face concurrent challenges of high poverty and increasing pressures from tourism development. The World Bank, with funding from the Korea Green Growth Trust Fund, initiated a study to analyze the current SWM situation in mountain areas and provide recommendations towards sustainable SWM. The *Supporting the Development of Sustainable Solid Waste Management Strategies for the Mountainous Regions of India, Nepal and Pakistan* study had the following objectives:

1. Analyze the current situation regarding SWM in the mountainous regions of India, Nepal, and Pakistan; and

2. Provide data regarding region-specific models and technical recommendations that can be used by the World Bank in sectoral dialogues with country representatives to promote sustainable SWM in the mountainous regions of these three countries.

A field study was undertaken due to a lack of quantitative data available in mountainous regions. In India, a field study was undertaken at sites in two districts, Kullu and Kanga, in the Himalayan state of Himachal Pradesh in June 2019. In Pakistan, Abbottabad and Swat districts in Khyber Pakhtunkhwa Province were the focus of the field study in July 2019. In Nepal, the field study was conducted twice, during the non-peak tourist season (May 2019) and peak tourist season (September 2019) in the Annapurna Conservation Area (ACA).

The data collected during the course of the field study was collected via a two-pronged approach: One, waste sampling was undertaken to identify the types of waste being generated, as well as quantity and other factors. Two, qualitative surveys were carried out to understand the mindset and awareness level of residents, commercial establishments, and tourists in these areas. Together, the field studies can be considered to provide a snapshot of the current SWM scenario as well as confirmation of waste trends that one would expect to see in mountain areas.

The key findings from the field study are:

- Heavily frequented tourist establishments, such as restaurants and hotels, in mountainous regions generate more waste on average than commercial establishments in the valley/non-tourist areas.
- Readily biodegradable waste make up the largest fraction of total waste generated overall.
- Plastic is the main constituent of mixed waste in tourist hotspots.
- Biodegradable waste is the main constituent of mixed waste from other sources (that is, households, commercial establishments, and hotels).
- Few households reported using waste collection services. Accessibility is a key challenge for door-to-door collection.
- Nepal's households and hotels segregate biodegradable waste to an extent by burying it, using it to make compost, or as animal feed, despite no formal segregation system.
- Almost no segregation is done in India or Pakistan.
- The proportion of waste that is disposed of in drains, ravines/valleys, and along or in streams/rivers is high due to the lack of collection services.
- Waste is still disposed of indiscriminately despite collection services being available in certain localities.
- Dump sites are widely spread in the natural environment and have no sanitary structures.
- Open burning of waste occurs frequently.
- A majority of respondents show willingness to pay for services.
- Many households are unaware of current waste disposal practices and unconcerned about disposal methods.

The Way Forward

A framework on which solutions can be steadily built is important when thinking about mountain waste challenges. The factors to be considered include: landscape management, sources of waste, geography and location, types of waste, seasonality, and tourism-based waste. Recommendations and an action plan or policy would be developed based on these local factors, to set targets, create guidelines, generate public awareness, and promote a green economy.

This report presents various recommendations and related implementable actions in order to overcome SWM challenges faced in mountain areas. A phased approach has been suggested to allow for flexibility, as implementation may follow different time frames and recommendations may be adopted concurrently. The recommendations are summarized in Figure ES.1.

Figure ES.1: Summary of recommendations for sustainable SWM in mountainous regions

Institutions, Financing, and Stakeholders

- Develop local government policies and regulations in line with national guidelines and standards
- Operationalize the SWM system at the local government level through technical capacity development
- Involve local communities and CBOs in waste segregation and collection
- Create systemic opportunities to bring in economies of scale, engage the private sector as well as other stakeholders
- Enable integration of the informal sector to engage in waste management services
- Enable collaboration of related agencies, such as tourism, forest, and natural resource management
- Establish a monitoring and enforcement system to improve and sustain waste management services

Data Availability and Awareness of SWM Issues

- Coordinate with various agencies to improve data collection, availability, and to create public awareness
- Start data gathering as a continuous exercise in order to make better decisions, set targets, and monitor policy implementation
- Increase public awareness on managing waste and impacts of SWM in mountain areas
- Introduce and expand training programs to build capacity of local government staff and decision makers

Waste Generation and Segregation

- Enable source segregation to allow for value extraction and recycling of both biodegradable and non-biodegradable materials
- Enable separation of biodegradable waste for useful purposes at the household or community level
- Involve local communities and CBOs by considering various aspects, such as income generation
- Create policies to manage other wastes (C&D, hazardous, healthcare, e-waste) in mountain cities

Waste Collection, Transfer, Storage, and Transport

- Improve waste collection systems and upgrade service delivery
- Establish waste storage and/or transfer systems to manage waste
- Enable sorting and processing of non-biodegradables for higher monetary returns
- Find innovative ways to collect and transport waste from mountain areas that are particularly challenging due to remoteness, topography, and lack of road network

Waste Treatment and Disposal

- Ban the open dumping and burning of waste
- Find suitable alternatives for treatment of non-biodegradable waste and for waste disposal

Publications in this Study

Five reports make up the set of publications for this study, which together serve to inform positive change in the SWM sector in mountain areas in the South Asia Region (SAR). This report—*Technical Guidance Report: Sustainable Solid Waste Management in Mountain Areas of India, Nepal, and Pakistan*—summarizes the key findings and current understanding of mountain waste in the three countries. It provides an overview of the unique issues faced in the Himalayan region through a comparative analysis of SWM faced by each country. Based on the field study conducted for this project, as well as on experience and observations, recommendations are presented as a framework of overarching approaches with specific, implementable actions—not only to improve current SWM practices, but also to mitigate the negative impact of solid waste in mountainous regions. The actions are presented in a phased manner, considering that implementation of a mountain waste plan or policy may progress according to different time frames in different countries. The report concludes with suggested areas of World Bank and donor engagement to promote sustainable SWM in mountainous regions.

The three country-specific reports on India, Nepal, and Pakistan, provide overviews of the municipal solid waste management scenario in each country. Furthermore, the reports investigate the impacts and challenges of mountain waste, including a detailed analysis of the data collected from the field study undertaken for this project. The reports present recommendations and specific actions—tailored to mountain areas—to improve SWM systems and practices. In conclusion, suggestions for further World Bank and donor engagement are provided.

The ***Good Practice Options for Sustainable Solid Waste Management in Mountain Areas of India, Nepal, and Pakistan*** document offers examples of successful implementation and coordination of SWM plans that have led to positive change in SWM practice in India, Pakistan, Nepal, and other countries, including the Republic of Korea, Mexico, and Georgia. It includes examples of successful SWM policies and practices that have led to improvements in the SWM sector. It thereby offers examples that could be implemented, scaled-up, or adapted to mountain areas in these three countries, not only in the Himalayan region but elsewhere as well. These practices may also be applicable to mountain areas in other countries.

1. Introduction

Pakistan, India, and Nepal share one common ecological characteristic: the snow-capped mountain peaks of the Himalayan mountain range. The mountains bestow these countries with pristine landscapes and are the headwaters of many rivers. Concurrently, this unique mountain ecology offers these countries an opportunity to foster a green economy that leverages these natural assets for economic growth. However, these mountain ecosystems are fragile and must be well managed to ensure the livability of communities and environmental sustainability. Continued urbanization, rapidly increasing population, and a steady influx of tourists in mountainous regions in India, Nepal, and Pakistan are straining these fragile ecosystems and are a significant cause of indiscriminate solid waste dumping. Solid waste management (SWM) is a challenge that negatively impacts the economic growth potential in these regions by contributing to poor aesthetics and cleanliness, odor, and leaching pollution into the ground water sources, among others. Key country indicators for the three countries are provided in Table 1.1.

Table 1.1: Key country indicators for India, Nepal, and Pakistan (2019)

Country indicators	India	Nepal	Pakistan
Population (millions)	1,366	28	217
GDP, PPP, current international $ (trillions)	9.1	0.09	1.0
GDP per capita, PPP, (current international $)	7,034	3,558	4,885
Urban population (% of total)	35	20	37
Urban population growth (annual rate %)	2.32	2.96	2.66
World Bank income classification	LMI	LMI	LMI
UN Human Development Index	129	148	151

Sources: UNDP n.d.; World Bank 2020b

Poverty is generally more widespread in mountainous regions than in the plains (FAO 2007). Many mountain communities have multiple, pressing concerns, such as economic development and food security, and as a result waste management is not given as much importance (Wilson 2007). In mountain areas of developing countries, 39 percent of people are food insecure, compared to an average of 12.5 percent in the plains (FAO 2015). Table 1.2 presents a profile of the three countries in this study, comparing their total populations living in poverty to those in the Himalayan mountain region.

Table 1.2: Poverty profile of the countries in the study

Country (Year of data)	Total population (millions)		Population below the poverty line (millions)		Population below the poverty line (%)	
	Countrywide	Mountain area	Countrywide	Mountain area	Countrywide	Mountain area
India (2011/12)	1,210.57	165.98	269.78	34.72	21.92	18.88
Nepal (2011)	26.5	17.8	6.68	7.53	25.2	42.3
Pakistan (2015/16)	200.8	27.9	48.8	5.0	24.3	18.0

Note: Mountain area in India refers to the Indian Himalayan Region, in Nepal to the mountain areas, and in Pakistan to the Khyber Pakhtunkhwa Province.

Sources: India: India, MoHA 2011b; RBI 2020; Nepal: Nepal, CBS 2011a; Nepal, CBS 2011b; Pakistan: World Bank 2021b, calculations based on HIES microdata published by PBS

In Nepal, poverty incidence in mountain areas (42.3 percent) is significantly higher than the national average (25.2 percent), the mid-hills (24.3 percent), and the *terai* or plains (23.4 percent) (Nepal, CBS 2011b).[1] The poverty gap index, which measures the severity of poverty by considering how far, on average, the poor are from the poverty line, is also higher in mountain areas than in the *terai* and mid-hills regions.

In developing countries, many mountain communities face significant challenges in managing growing amounts of solid waste. Mountain areas are not only dotted by rural villages and remote hamlets, but also large cities. For instance, the Indian Himalayan Region (IHR) is home to over 50 million people, and roughly half of Nepal's population lives in hilly/mountain areas (NITI Aayog n.d. and Nepal, CBS n.d.). In addition, tourism and mountaineering/trekking expeditions contribute to the ever-increasing volume of solid waste left behind in many remote and higher mountainous regions.

The inadequate treatment or disposal of waste creates risks not only for ecosystems and human health in mountainous regions, but also for downstream areas. Gravity and river flows can also enlarge the footprint made by waste from mountainous regions thousands of kilometers or more downstream, and even as far as the ocean. As such, the accumulation of solid waste in mountain areas has become an issue of truly regional and global concern.

Reliable estimates on the quantity and characteristics of waste are unavailable in the three countries, as these vary significantly depending on population, regional characteristics, seasonal factors, and tourist influx. Mountain areas present unique challenges such as (1) Sudden spikes in the quantity of waste generated during the tourist season; (2) Widely varying waste characteristics including large volumes of plastic and other special wastes; and (3) The varying constraints of land availability for waste sorting, treatment, and disposal, especially due to a number of environmental sensitivities in these areas. All of these factors require specific strategies and models of SWM in mountainous regions.

Many mountain communities in developing countries, especially those with tourist populations, are making concerted efforts to follow waste management practices suited to their region. However, given the scale of the challenge, these efforts are not enough. The types and characteristics of the generated solid waste and the means used to manage it in mountainous regions are more closely related to the level of development

1 *Terai,* meaning plains, is essentially an extension of the Gangetic plain and is the lowland area of Nepal. Approximately 23 percent of Nepal's land mass is in the *terai* region.

of the countries tackling the issue, rather than their elevation. A common trait is insufficient or poor waste management: Collection rates are typically low, ranging from 30 to 60 percent in low-income countries, and from 50 to 80 percent in middle-income countries, where mixed waste collection occurs without separation at source (Kaza et al. 2018). While open dumping is by no means unique to mountainous regions, mountain environments pose additional risks, particularly if these sites are located close to waterways with the potential to pollute water that is used by large populations downstream. One of the main ways in which mountains are linked to lower-lying areas is through rivers. These rivers bring much-needed water, but also carry plastic pollution downstream (Alfthan et al. 2016).

1.1 Background

The World Bank, along with generous support from the World Bank Group's Korea Green Growth Trust Fund (KGGTF), initiated a study on solid waste in mountain areas in India, Nepal, and Pakistan. This study represents the first attempt of the World Bank to examine SWM issues in these unique, ecologically-fragile areas that face concurrent challenges of high poverty and increasing pressures from tourism development.

The study—*Supporting the Development of Sustainable Solid Waste Management Strategies for the Mountainous Regions of India, Nepal and Pakistan*—was aimed at analyzing the current situation of SWM in mountain areas and providing recommendations for sustainable SWM to reduce negative impacts from the lack of collection, lack of treatment, and improper disposal methods in these countries. Specifically, the project has the following objectives:

1. Analyze the current situation regarding SWM in the mountainous regions of India, Nepal, and Pakistan; and
2. Provide data regarding region-specific models and technical recommendations that can be used by the World Bank in sectoral dialogues with country representatives to promote sustainable SWM in the mountainous regions of these three countries.

A field study was undertaken due to the lack of quantitative data available in mountainous regions of all three countries. It was informed by two main components: waste sampling and a qualitative survey. Waste sampling was carried out primarily at households and commercial establishments (primarily hotels) in order to understand waste generation and composition in mountain areas. Moreover, given the importance of awareness in sustainable behavior to improve the overall SWM scenario, qualitative surveys were conducted among residents and foreign and domestic visitors. The field study's waste sampling data and the qualitative survey analysis form the basis for three country-specific reports.

The target areas for this project were Himachal Pradesh state in India, Khyber Pakhtunkhwa Province in Pakistan, and the Annapurna Conservation Area in Nepal. Field studies were conducted between May and September 2019. Details of the field studies in the three countries are provided in Figure 1.1.

Figure 1.1: Field studies overview in India, Nepal, and Pakistan

	India	Nepal	Pakistan
State/province/area	Himachal Pradesh	Annapurna Conservation Area	Khyber Pakhtunkhwa
Districts	Kullu and Kangra districts	Kaski	Abbottabad and Swat districts
Locations	Kullu, Manali, Dharamshala, McLeod Ganj, and Triund	Ghandruk, Chhomrong, Kimche, and Syauli	Abbottabad city, Nathia Gali, and Mingora
Time frame (2019)	June	May and September	July
Individual samples	85	388	75

1.2 Publications in this Study

Five reports make up the set of publications for this study, which together serve to inform positive change in the SWM sector in mountain areas in the South Asia Region (SAR). This report—*Technical Guidance Report: Sustainable Solid Waste Management in Mountain Areas of India, Nepal, and Pakistan*—summarizes the key findings and current understanding of mountain waste in the three countries. It provides an overview of the unique issues faced in the Himalayan region through a comparative analysis of SWM issues faced by each country. Based on the field study conducted for this project, as well as on experience and observations, recommendations are presented as a framework of overarching approaches with specific, implementable actions. These are aimed at not only improving current SWM practices, but also to mitigate the negative impact of solid waste in mountainous regions. The actions are presented in a phased manner, considering that implementation of a mountain waste plan or policy may progress according to different time frames in different countries. The report concludes with suggested areas of World Bank and donor engagement to promote sustainable SWM in mountainous regions.

The three country-specific reports on India, Nepal, and Pakistan, provide overviews of the municipal solid waste (MSW) management scenario in each country. Furthermore, the reports investigate the impacts and challenges of mountain waste, including a detailed analysis of the data collected from the field study undertaken for this project. The reports present recommendations and specific actions—tailored to mountain areas—to improve SWM systems and practices. In conclusion, suggestions for further World Bank and donor engagement are provided.

The *Good Practice Options for Sustainable Solid Waste Management in Mountain Areas of India, Nepal, and Pakistan* document offers examples of successful implementation and coordination of SWM plans that have

led to positive change in SWM practice in India, Pakistan, Nepal, and other countries, including the Republic of Korea, Mexico, and Georgia. It includes examples of successful SWM policies and practices that have led to improvements in the SWM sector. It thereby offers examples that could be implemented, scaled-up, or adapted to mountain areas in these three countries, not only in the Himalayan region but elsewhere as well. These practices may also be applicable to mountain areas in other countries.

1.3 Overview of this Report

Chapter 2 of this report discusses the current landscape of the SWM sector in India, Nepal, and Pakistan. It explores key solid waste data in the three countries, such as MSW generation rates, composition, collection efficiencies, and treatment and disposal options. Furthermore, it provides a comparison of waste legislation relating to SWM. Lastly, the chapter discusses the important role the informal sector plays in the waste sector in these countries.

Chapter 3 looks at the complexity of managing solid waste in mountain areas as well as the various challenges and opportunities that arise. It presents why mountain areas face unique challenges in managing solid waste. It also discusses how mountain areas relate more commonly to other eco-sensitive areas, such as protected areas, small islands, and polar regions, compared to urban and rural areas in non-mountainous regions. The chapter concludes with the common SWM challenges found in mountain areas of India, Nepal, and Pakistan.

Chapter 4 presents the field study conducted in the mountain areas of the three countries. Further information regarding the parameters of the study, such as which areas were chosen and why, are also discussed. The analysis of the quantitative data gathered from the waste samplings and the qualitative information gained from the surveys from the three countries is then summarized for further analysis.

Chapter 5 proposes a framework or foundation on which solutions can be steadily built and presents recommendations and related implementable actions along a phased approach. A phased approach is suggested as it allows for flexibility by respective national, provincial/state, or local governments. The recommendations are suggested based on an integrated solid waste management (ISWM) approach.

In conclusion, Chapter 6 briefly summarizes the role of the World Bank in the SWM sector and how it can provide support to clients to improve SWM services and practices in mountain areas in the South Asia Region and elsewhere.

Snapshot 1: Importance of the Himalayan Mountains

Mountain Areas

Mountains may not be home to a large part of the world population, but they indirectly sustain much larger populations in the plains. They cover 25 percent of the world's land surface, and directly support 12 percent of the world's population living within mountainous regions (Mountain Partnership n.d.). At present, over one-quarter of mountain populations in the developing world now live in urban areas and cities (Alfthan et al. 2016).

Mountains are not only unique geographic landmasses defined by a certain altitude and steepness, but also distinct ecosystems that shape socioeconomic factors and, thereby, the governance of resources. About 915 million people currently live in mountainous regions. Ninety-one percent of the mountain population and 63 percent of the world's mountain areas are located in developing countries. In contrast, developed countries are home to about nine percent of the world's mountain population and 37 percent of world's mountain areas. The population density of mountainous regions in developing countries is about six times higher than that of developed countries (Alfthan et al. 2016).

Resources that originate in the mountains are invaluable to billions of people; however, due to the rough terrain and cold climate, the availability of food and necessities is limited. Thirty-nine percent of people residing in mountain areas struggle with food insecurity, compared with an average of 12.5 percent in the plains (FAO 2015). This, along with their remote location, has contributed to a surge in rural populations migrating to mountain urban centers. According to Alfthan et al. (2016), the share of mountain populations living in cities is steadily increasing in developing countries.

The lack of recognition and understanding of mountain specificities often leads to misconceptions regarding the socioeconomic conditions in mountain areas and to a misdiagnosis of the sources of poverty (Papola 2002). As a result, the strategies and interventions designed for development in mountain areas tend to be unsuitable and, therefore, ineffective.

A Closer Look at the Himalayas

The Himalayas are the range of mountains in Asia separating the plains of the Indian subcontinent from the Tibetan Plateau. The range has many of the earth's highest peaks, the highest being Mount Everest. The Himalayas include over 50 mountains exceeding 7,200 meters in elevation, including ten of the world's 14 peaks over 8,000 meters. The Himalayan mountain range runs west-northwest to east-southeast and is 2,400 kilometers long. The range varies in width from 350 kilometers in the west (Pakistan) to 150 kilometers in the east (Arunachal Pradesh in India). The Himalayas are inhabited by roughly 53 million people (2011) and are spread across five countries: Bhutan, China, India, Nepal, and Pakistan (Apollo 2017).

Fifty-two percent of the world's mountain population and 36 percent of world's mountain areas are found in Asia. Alarmingly, in the last fifty years (1961–2011), the Himalayan population (China, India, Bhutan, Nepal,

Pakistan) has grown by 250 percent, from 19.9 million to 52.8 million. If the population continues to grow at the same rate (3.3 percent annually) as the last fifty years (1961–2011), the number of people will exceed 260 million in 2061, a 13-fold increase from 1961 (Apollo 2017). On average, 31 percent of the total population of the Hindu Kush-Himalaya region lives below the poverty line (Wester et al. 2019).

Mountainous regions in India, Nepal, and Pakistan—similar to mountainous regions around the world—are rich in resources. They provide essential ecological services such as water, energy, food, and many more to millions of people living both in the mountains as well as downstream (Alfthan et al. 2016). As the "water towers" of the world, they supply half of the world's population with freshwater for drinking, domestic use, irrigation, industry, and hydropower. The ten largest rivers originate in the Hindu Kush-Himalayas alone, supplying water to over 1.35 billion people or roughly 20 percent of the global population (Mountain Partnership n.d.). As such, environmental problems in the Himalayas can affect millions of people in communities downstream.

Despite this, mountainous regions receive inadequate recompense for the roles they play. They receive unequal social, cultural, and economic benefits relative to downstream regions while simulatneously experiencing growing solid waste and environmental problems from expanding settlements and increasing numbers of tourists.

2. Overview of Solid Waste Management in India, Nepal, and Pakistan

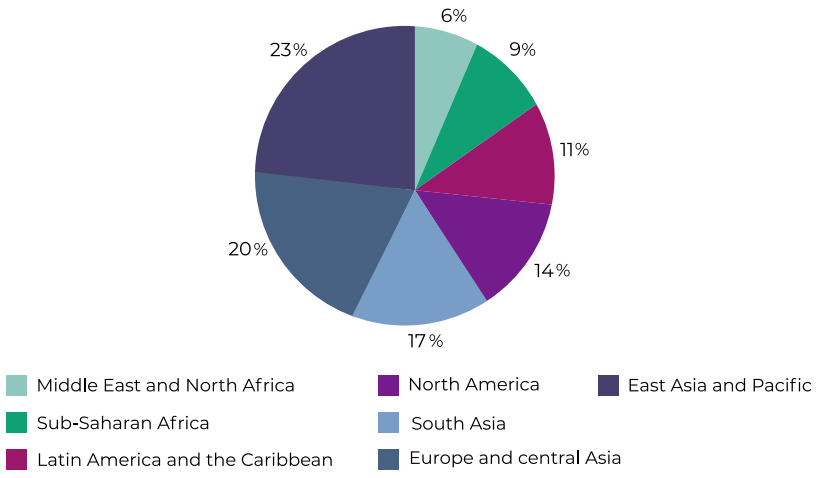
The three countries in this study share a number of similarities pertaining to the solid waste management (SWM) sector. Nevertheless, there are also some variations that make each country stand apart. This reiterates the need for tailored approaches to overcome SWM challenges unique to each country. This chapter provides an overview and comparison of municipal solid waste (MSW) in India, Nepal, and Pakistan. The country reports may be referred to for more detailed information about the SWM sector in each nation.

2.1 Municipal Solid Waste Generation

The South Asia Region (SAR) generated 334 million tonnes of waste in 2016, including both urban and rural waste (Kaza et al. 2018). Together, India, Nepal, and Pakistan generated more than 92 percent of total waste in SAR, with the bulk of the waste generation coming from India. In fact, in a year India alone generates more than eight times the MSW that Pakistan and Nepal generate together.

Figure 2.1 compares the total waste generated by region in 2016. At the time, the SAR featured relatively midway between regions that generated vast amounts of waste (Europe and Central Asia, East Asia and Pacific) and those that did not (Middle East and North Africa, Sub-Saharan Africa, Latin America and the Caribbean, North America). By 2030, SAR will contribute to one-fifth of the world's total waste generated. Table 2.1 provides various figures on waste generation and total population for the three countries, in comparison to the global and South Asia averages.

Figure 2.1: Waste generation by region, 2016 (%)



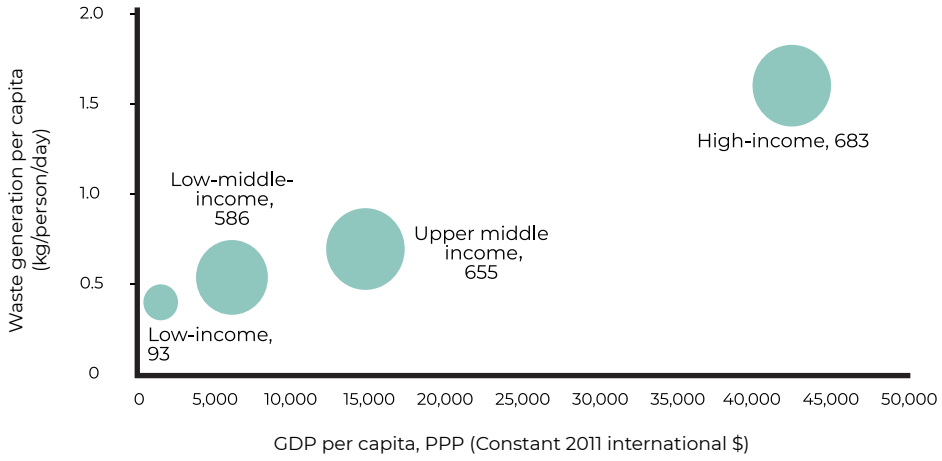
Source: Kaza et al. 2018

Table 2.1: Comparison of MSW generation in India, Nepal, and Pakistan to global and regional averages

Indicator	Global	South Asia	India	Nepal	Pakistan
Waste generation, 2016 (million tonnes/year)	2,010	334.23	277.14	1.77	30.35
Waste generation per capita, 2016 (kg/person/year)	0.74	0.52	0.57	0.17	0.43
Waste generation, 2030 projected (million tonnes/year)	2,590	466.24	388.77	2.21	42.43
Waste generation, 2050 projected (million tonnes/year)	3,400	661.18	543.28	2.97	66.38
Total population, 2016 (millions)	7,424	1,771	1,325	27	204
Urban population, 2016 (millions)	4,036	587.08	439.49	5.16	73.78
Urban population growth (annual rate %)	2.02	2.51	2.32	2.96	2.66
Rural population, 2016 (millions)	3,387	1,184	885.01	22.1	129.84
Rural population growth (annual rate %)	0.16	0.63	0.49	0.43	1.76
Total population, 2030 projected (millions)	8,548	285	1,504	33	263
Total population, 2050 projected (millions)	9,733	2,293	1,639	35	338

Sources: Kaza et al. 2018; UNDESA 2019; World Bank 2020b

Figure 2.2: Waste generation compared to GDP by income group (2016)



Note: Data are adjusted to 2016. Size of bubble denotes waste generated in millions of tonnes annually. Waste generation per capita per day: Low income = 0.43 kg, lower-middle income = 0.61 kg, upper-middle income = 0.69 kg, high income = 1.57 kg.

Source: Adapted from Kaza et al. 2018

Waste generation generally increases with economic development and population growth, as depicted in Figure 2.2. As GDP increases, waste generation follows a similar path. In fact, waste generation tends to increase at a faster rate at lower income levels than at higher income levels (Kaza et al. 2018).

Currently, India, Nepal, and Pakistan all come under the lower middle-income category (that is, countries with a GNI per capita between $1,036-4,045), according to World Bank classification. According to the World Bank's 2016 report, *What a Waste 2.0 - A Global Snapshot of Solid Waste Management to 2050*, lower middle-income countries together generated more waste than low-income countries, but less than upper middle-income and high-income countries. Regions with high proportions of growing low- and lower middle-income countries are expected to experience the biggest increases in waste production. Therefore, by 2030, countries that are currently classified as lower middle-income will generate 36 percent of the world's waste, compared to 32 percent in 2016. And by 2050, these countries will be responsible for 40 percent of the world's waste (Kaza et al. 2018).

2.2 Municipal Solid Waste Composition

Similar trends in MSW composition are evident among the three countries, as shown in Table 2.2. The major proportion of waste in all three countries consists of biodegradable waste (that is, organic waste comprising food, green/garden, and wood). India reports a high fraction of inert waste, generally consisting of sand, rocks, rubble, ash, and so on, which the other two countries do not report. This is more the result of inconsistencies in methodology rather than an actual lack of inert waste. Conversely, plastics are more prevalent in Nepal compared to the other two countries, perhaps as the result of a higher tourist population. Regardless, the increase in plastics is a key challenge faced by all countries.

Table 2.2: Waste composition in India, Nepal, and Pakistan compared to South Asia average (%)

Component	South Asia	India	Nepal	Pakistan
Food	56	47	52	30
Green waste				14
Wood	1			2
Total Biodegradable	*57*	*47*	*52*	*46*
Paper and cardboard	10	8	18	13
Plastic	8	9	15	9
Glass	4	1	4	6
Metal	3	1	2	4
Rubber and leather	2	4	1	2
Inert	--	25	--	--
Other	16	4	7	20

Sources: CPHEEO 2016; Kaza et al. 2018

2.3 Municipal Solid Waste Collection

Similar to most low- to middle-income countries, India, Nepal, and Pakistan have little data available on waste collection or its efficiency. Table 2.3 shows the average waste collection rates for urban areas in the three countries. Rural MSW collection is almost negligible as there is not much budget available for MSW services or much waste generated in rural areas comparatively. The focus is primarily on improving waste collection in urban areas.

Table 2.3: Average MSW collection rates in India, Nepal, and Pakistan compared to South Asia average

Country	Collection efficiency (%)
SAR overall collection efficiency	*77*
India	80
Nepal	62
Pakistan	57

Sources: ADB 2013; Kaza et al. 2018; Pakistan, PBS 2015

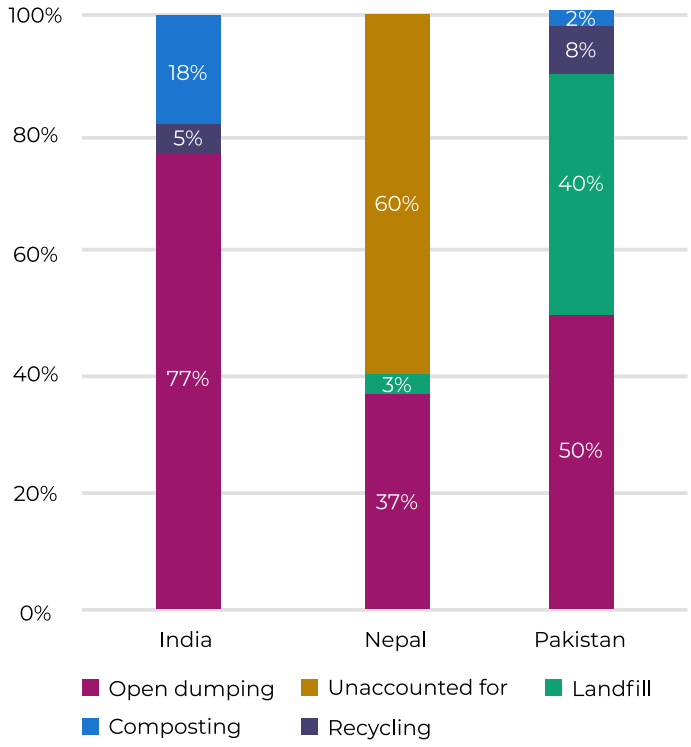
2.4 Municipal Solid Waste Treatment and Disposal

The open dumping and burning of MSW is common to all three countries, both in rural and urban areas. Nepal is in the initial stages of building sanitary landfill facilities but the process is much slower in India and Pakistan. As a result, waste is openly dumped in streets, empty plots, water bodies, or taken to open dump sites in and on the outskirts of urban areas.

In rural areas, non-biodegradable waste is burned in the open or buried. Uncontrolled burning of waste in open areas is a significant source of carcinogens such as dioxins and furans, and black carbon, a short-lived climate pollutant that contributes to climate change (CCAC n.d.). As such, open burning contributes to air pollution and exacerbates health issues such as respiratory diseases for the population residing in the area. Biodegradable waste is either mixed with non-biodegradable waste, composted, or used as animal feed.

Figure 2.3 shows the break-up of waste treatment and disposal options in the three countries. Note that for Nepal, unaccounted waste refers to uncollected waste, and although the waste is disposed of in sanitary landfills, it is done so in an unsanitary manner (ADB 2013). Often, the terms “dump sites” and “landfills” are used interchangeably, causing confusion about the actual method of disposal. Upon further observation, only a few sanitary landfills exist in any of the three countries.

Figure 2.3: Waste treatment and disposal methods in India, Nepal, and Pakistan (%)



Source: Kaza et al. 2018

2.5 The Informal Sector

As is common in similar developing countries, the informal sector is widespread in all three countries and plays an important role in the collection and sorting of recyclable materials. No formal recycling systems exist, so the informal sector plays a key role in salvaging valuable recyclables that would otherwise end up in waste dumps or in the ocean. In some cities, waste pickers make up the only form of waste collection there is, and the only revenue they receive is from selling whatever recyclables they can find. When properly supported and organized, informal recycling can create employment, improve local industrial competitiveness, reduce poverty, and reduce municipal spending on SWM and social services (Medina 2007). UN-Habitat (2010) found that waste pickers commonly collect five to 100 percent of MSW in cities in low-income countries, at no cost to municipalities. Thus, formalizing informal waste pickers could lead to improved waste collection and recycling.

While there is no official definition of an informal sector in waste management, it is broadly understood to be individuals or small businesses working in waste collection, trading, sorting, compacting, recycling, and converting processed waste into new materials. Given the informality of the sector, no official figures are available for how many are employed in this sector; estimates range from 19 million to 40 million globally (based on Medina 2010 and WIEGO 2013). These workers typically lack proper wages, benefits, and work under poor conditions. Given the nature of their job, they are often considered unsanitary and are not respected for their roles in keeping cities free of trash, enabling recycling, extending the life of landfills, and protecting the environment. This is in sharp contrast to the formal sector, represented by government sanitation workers or those who work in the private sector in solid waste collection, handling, or disposal. These formal sector

workers are recognized by the public as playing a key role in keeping their cities clean and receive fixed salaries, benefits, and have defined work hours.

Waste pickers are often a vulnerable demographic and are typically women, children, the elderly, the unemployed, or migrants. In many places, the number of female waste pickers outnumbers the number of male waste pickers. Furthermore, many waste pickers are children who face greater risks to physical development and loss of education than adults. In Vientiane, Lao People's Democratic Republic, and Cusco, Peru, 50 percent and 80 percent, respectively, of waste pickers are female (Arenas Lizana, 2012).

The informal sector chain of activity in India, Nepal, and Pakistan is generally as follows: Waste pickers sift through mixed waste dumped on the street or at dump sites and recover valuable recyclables. They may also collect mixed recyclables door-to-door from households. Some waste pickers even have their own carts or tricycles which make it easier to collect large amounts of material from a particular neighborhood. Waste pickers only collect recyclables that are of value, so materials such as plastic bags are often left uncollected and lead to the clogging of storm drains and eventually reach water bodies. At dump sites, waste is occasionally intentionally ignited in order to recover recyclables and reduce the volume of the waste. This is harmful not only to the workers and residents who work and live in the surrounding areas, but also adds to greenhouse gas (GHG) emissions.

The waste collected by waste pickers is then sold to small scrap shops (called *kabadiwalla* in India, *kabaria* in Pakistan, and *kavadiwala* in Nepal). These shops are found scattered across cities in many neighborhoods, anywhere that enables them to have a guaranteed supply of recyclable waste. They store, sort, and aggregate various types of recyclable material, which is then sold to larger aggregators. These large aggregators are generally found in the outskirts of cities, where they have access to more storage space, and they may only purchase select materials for further processing. The larger aggregators then sell the waste to processors or recyclers who then convert the material into new products (Hande 2019). In Nepal, there are informal sector associations in practically every district, especially in the hill and *terai* regions. These associations coordinate with one another to sell recyclable material to large recycling plants in the *terai* region or to sell to large industries in neighboring India.

2.6 Waste Legislation

All three countries have numerous policies and legislation related indirectly or directly to waste management but these are not effectively enforced. India and Nepal have dedicated laws related to SWM. In India, the Ministry of Environment, Forest and Climate Change (MoEFCC) established the Solid Waste Management Rules in 2000 under the Environmental Protection Act 1986 and revised them in 2016. The rules were revamped to apply to the entire country, including rural areas, and not solely urban areas as was done before. Hence, these rules would also apply to mountain areas.

In Nepal, the Solid Waste Management Act 2011 and its supporting Regulation (2013) provided local governments with the authority to contract private sector companies, collect tariffs from users for SWM services, and enforce fines for non-compliance, among other provisions. However, enforcement remains weak due to general apathy and lack of technical and financial capacity on the part of the government. At the time of publication of this report, the federal government is in the process of drafting a new umbrella act on SWM in line with the new Constitution adopted in 2015. The new Act is likely to maintain several provisions of previous acts, regulations, and guidelines and build upon experience in the present context. At the same

time, as per the 2015 Constitution, local governments are empowered to formulate their own regulations with regard to SWM.

In all three countries, local authorities have been given the responsibility of managing MSW but with varying degrees of "capacity to act." In terms of involving the private sector, the impediment arises in the technical capacity of designing public-private partnership (PPP) contracts and the overall financial status that deters the private sector. The main objective is to improve service delivery and not necessarily to involve the private sector. In many cases, when the private sector is involved in SWM, the responsibility is delegated with no flexibility or resources to strengthen the technical capacity. In the case of Nepal, land for facilities and infrastructure is usually provided by the municipality while the private sector is involved in operating the facilities.

National and sub-national legislation that specifically address waste management in mountainous regions in all three countries is largely non-existent. Mountain areas generally fall under the same waste legislation as other geographic regions within the country. What is needed is to customize rules for mountainous regions, especially the types of collection and transportation equipment/vehicles that are suitable, siting criteria for landfills (if landfills cannot be avoided), suitability of waste processing technologies, requirements for environmental impact assessments, and so on. The exception is India, which in the revised Solid Waste Management Rules 2016 included rules specifically for hilly/mountain areas, provided in Box 2.1. The 2016 rules also included specific provisions for littering, fines, waste treatment, and disposal. The responsibilities of local authorities that apply to municipalities in both the plains as well as in hilly areas are provided in Appendix 4.

At the international level, there are only two mountain-specific conventions that address sustainable development of mountainous regions: the Alpine Convention and the Carpathian Convention. Both have implications for waste management. The Alpine Convention is aimed at the protection and sustainable development of the Alps and was signed by eight Alpine countries—Austria, France, Germany, Italy, Switzerland, Liechtenstein, Slovenia, and Monaco—and the European Union and came into effect in 1995. The Carpathian Convention has similar goals and was adopted by seven countries: the Czech Republic, Hungary, Poland, Romania, Serbia, Slovak Republic, and Ukraine in 2003.

Box 2.1: India Solid Waste Management Rules (2016) specific to hilly/mountain areas

The following text provides the specific rules for solid waste management (SWM) in hilly areas in India as set out in the Solid Waste Management Rules 2016. Appendix 2 provides the rules under Rule 15 of Solid Waste Management Rules 2016 which are applicable to both the plains as well as hilly areas. The emphasis in bold has been added, but the text is unchanged.

> **20. Criteria and actions to be taken for solid waste management in hilly areas.-** In the hilly areas, the duties and responsibilities of the local authorities shall be the same as mentioned in rule 15 with additional clauses as under:
>
> (a) Construction of landfill on the hill shall be avoided. A transfer station at a suitable enclosed location shall be setup to collect residual waste from the processing facility and inert waste. A suitable land shall be identified in the plain areas down the hill within 25 kilometers for setting up sanitary landfill. The residual waste from the transfer station shall be disposed of at this sanitary landfill.
>
> (b) In case of non-availability of such land, efforts shall be made to set up regional sanitary landfill for the inert and residual waste.
>
> (c) Local body shall frame Bye-laws and prohibit citizen from littering wastes on the streets and give strict direction to the tourists not to dispose any waste such as paper, water bottles, liquor bottles, soft drink canes, tetra packs, any other plastic or paper waste on the streets or down the hills and instead direct to deposit such waste in the litter bins that shall be placed by the local body at all tourist destinations.
>
> (d) Local body shall arrange to convey the provisions of solid waste management under the bye-laws to all tourists visiting the hilly areas at the entry point in the town as well as through the hotels, guest houses or like where they stay and by putting suitable hoardings at tourist destinations.
>
> (e) Local body may levy solid waste management charge from the tourist at the entry point to make the solid waste management services sustainable.
>
> (f) The department in- charge of the allocation of land assignment shall identify and allot suitable space on the hills for setting up decentralised waste processing facilities. Local body shall set up such facilities. Step garden system may be adopted for optimum utilisation of hill space.
>
> **SCHEDULE I** - **Specifications for Sanitary Landfills**
>
> **I. Criteria for special provisions for hilly areas.-** Cities and towns located on hills shall have location-specific methods evolved for final disposal of solid waste by the local body with the approval of the concerned State Pollution Control Board or the Pollution Control Committee. The local body shall set up processing facilities for utilisation of biodegradable organic waste. The non-biodegradable recyclable materials shall be stored and sent for recycling periodically. The inert and non-biodegradable waste shall be used for building roads or filling-up of appropriate areas on hills. In case of constraints in finding adequate land in hilly areas, waste not suitable for road-laying or filling up shall be disposed of in regional landfills in plain areas.

Source: India, MoEFCC 2016

Snapshot 2: Evolution of Solid Waste Management Practices

It is well understood and widely recognized that as countries develop economically, their waste management scenarios evolve as a consequence. Although every country and city has its own specific circumstances, general observations can be made across low-, middle-, and high-income countries, as shown in Table SS2.1 (Hoornweg and Bhada-Tata 2012).

Generally, the solid waste management (SWM) sector in underdeveloped economies is characterized by poor collection efficiencies, the absence of formal recycling, improper waste disposal methods (including in water bodies, which eventually results in marine litter), and open burning. As countries develop, some improved waste management practices are gradually introduced, including improvements in collection services, robust informal recycling, composting, and controlled landfills. High-income countries have the ability and availability to devote more resources towards SWM infrastructure and therefore utilize state-of-the-art technology, provide better environmental monitoring, and engage with and create more awareness with users of waste services. High-income economies plan their SWM services in accordance with the 3 Rs (or 4 Rs, if recovery is included) and the waste hierarchy, and in this way work towards a more sustainable SWM system.

Countries—regardless of their income classification—are also now beginning to realize that given the growing levels of resource consumption and the negative impacts of waste generation and management, a further shift needs to take place from the traditional linear 'take-make-waste' economy to a circular economy approach. A key fundamental principle of the circular economy is to 'design out' waste, meaning that waste reduction or waste elimination is thought of at the drawing board stage itself, before a product is even manufactured. It prevents materials from becoming waste for as long as possible, and anything that unavoidably becomes waste is turned into a resource. While a complete shift to a circular economy is not possible overnight, this shift saves precious financial resources and may decrease the need for expensive foreign imports, thus conserving foreign exchange reserves. Figure SS2.1 shows the evolution of SWM practices from an improper SWM system eventually to circular economy.

While Table SS2.1 provides general global trends, it should be noted that just because a country is classified as low-income does not mean that it cannot manage its waste. Proper waste management practices do not rely solely on income level, but also on various factors such as awareness of decision makers and the public, the ability to get stakeholders to work together, and to entice changes in behavior. Sustainable SWM practices do not need to be expensive in order to be successful or attainable. There are numerous examples of small and struggling cities that have been able to make drastic improvements in their waste management by implementing low-cost technologies that suit their local context, having a champion, such as a local decision maker, to lead the way and who makes SWM a priority, and local NGOs who work with vulnerable populations to provide training and awareness. The *Good Practice Options for Sustainable Solid Waste Management in Mountain Areas of India, Nepal, and Pakistan* report in this set of documents provides numerous examples of how cities—in mountain and non-mountain areas—and countries can work effectively to overcome their challenges.

Box SS2.1 highlights the example of how the Republic of Korea used the 4 Rs and waste hierarchy concepts to build a green economy. The SWM sector in Korea transformed because of strong political will that not only adopted the 4 Rs and the waste hierarchy, but was also committed to systematically evolving Korea's laws and policies along with infrastructure and technology on SWM. This approach enabled Korea to transform its status from a waste-producing aid-recipient country to a resource-recirculating donor country with fast economic growth within one generation.

Table SS2.1: Comparison of SWM practices by country income level

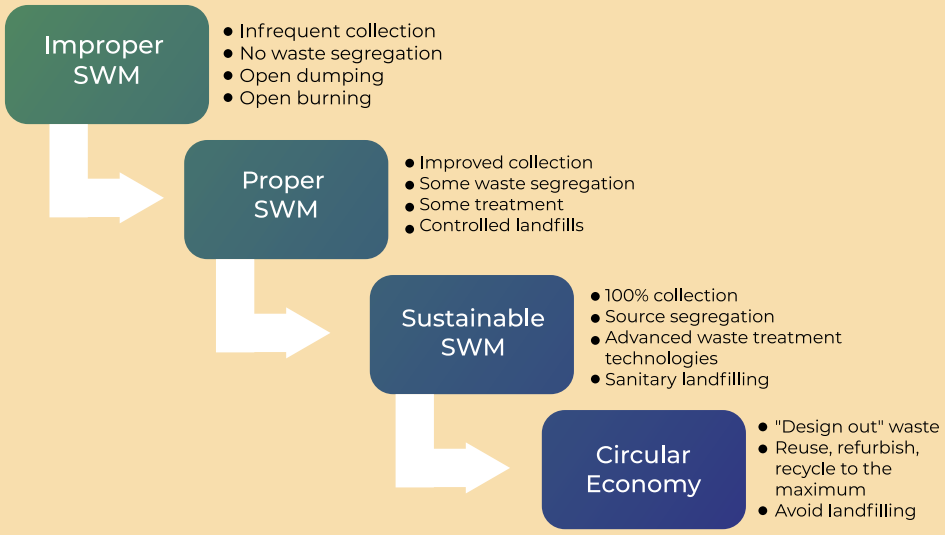
Activity	Low income	Middle income	High income
Source Reduction	No organized programs, but reuse and low per capita waste generation rates are common.	Some discussion of source reduction, but rarely incorporated into an organized program.	Organized education programs emphasize the 3 Rs—reduce, reuse, and recycle. More producer responsibility & focus on product design.
Collection	Sporadic and inefficient. Service is limited to high visibility areas, the wealthy, and businesses willing to pay. High fraction of inerts and compostables impact collection—overall collection below 50%.	Improved service and increased collection from residential areas. Larger vehicle fleet and more mechanization. Collection rate varies between 50 to 80%. Transfer stations are slowly incorporated into the SWM system.	Collection rate greater than 90%. Compactor trucks and highly mechanized vehicles and transfer stations are common. Waste volume a key consideration. Aging collection workers often a consideration in system design.
Recycling	Although most recycling is through the informal sector and waste picking, recycling rates tend to be high both for local markets and for international markets and imports of materials for recycling, including hazardous goods such as e-waste and ship-breaking. Recycling markets are unregulated and include a number of 'middlemen'. Large price fluctuations.	Informal sector still involved; some high technology sorting and processing facilities. Recycling rates are still relatively high. Materials are often imported for recycling. Recycling markets are somewhat more regulated. Material prices fluctuate considerably.	Recyclable material collection services and high technology sorting and processing facilities are common and regulated. Increasing attention towards long-term markets. Overall recycling rates higher than low and middle income. Informal recycling still exists (e.g., aluminum can collection.) Extended product responsibility common.
Composting	Rarely undertaken formally even though the waste stream has a high percentage of biodegradable material. Markets for, and awareness of, compost lacking.	Large composting plants are often unsuccessful due to contamination and operating costs (little waste separation); some small-scale composting projects at the community/ neighborhood level are more sustainable. Composting eligible for CDM projects but is not widespread. Increasing use of anaerobic digestion.	Becoming more popular at both backyard and large-scale facilities. Waste stream has a smaller portion of compostables than low- and middle-income countries. More source segregation makes composting easier. Anaerobic digestion increasing in popularity. Odor control critical.

Table SS2.1: Comparison of SWM practices by country income level (contd.)

Activity	Low income	Middle income	High income
Incineration	Not common, and generally not successful because of high capital, technical, and operation costs, high moisture content in the waste, and high percentage of inerts.	Some incinerators are used, but experiencing financial and operational difficulties. Air pollution control equipment is not advanced and often by-passed. Little or no stack emissions monitoring. Governments include incineration as a possible waste disposal option but costs prohibitive. Facilities often driven by subsidies from OECD countries on behalf of equipment suppliers.	Prevalent in areas with high land costs and low availability of land (e.g., islands). Most incinerators have some form of environmental controls and some type of energy recovery system. Governments regulate and monitor emissions. About three (or more) times the cost of landfilling per tonne.
Landfilling/ Dumping	Low-technology sites usually open dumping of wastes. High polluting to nearby aquifers, waterbodies, settlements. Often receive medical waste. Waste regularly burned. Significant health impacts on local residents and workers.	Some controlled and sanitary landfills with some environmental controls. Open dumping is still common.	Sanitary landfills with a combination of liners, leak detection, leachate collection systems, and gas collection and treatment systems. Often problematic to open new landfills due to concerns of neighboring residents. Post closure use of sites increasingly important, e.g., golf courses and parks.
Costs	Collection costs represent 80–90% of the municipal solid waste management budget. Waste fees are regulated by some local governments, but the fee collection system is inefficient. Only a small proportion of budget is allocated toward disposal.	Collection costs represent 50% to 80% of the municipal solid waste management budget. Waste fees are regulated by some local and national governments, more innovation in fee collection, e.g., included in electricity or water bills. Expenditures on more mechanized collection fleets and disposal are higher than in low-income countries.	Collection costs can represent less than 10% of the budget. Large budget allocations to intermediate waste treatment facilities. Up front community participation reduces costs and increases options available to waste planners (e.g., recycling and composting).

Source: Hoornweg and Bhada-Tata 2012

Figure SS2.1: Evolution of SWM practices



Box SS2.1: Adoption of the waste hierarchy in the Republic of Korea

The waste hierarchy is a set of principles to use resources efficiently and to manage wastes efficiently and sustainably. The principles are listed in order of priority, based on what is best in terms of the environment. The 3 Rs are the most favored option of the waste hierarchy and are at the top of the inverted pyramid. The highest priority, therefore, is to reduce the amount of waste generated in the first place, and the least preferable method is to dispose of the waste in landfills. It is worth noting, however, that the overall impact of specific waste management strategies will depend on waste composition and local circumstances. Not all materials can be reduced in their consumption, be reused, or even be recycled. In that case, every effort should be made to recover energy from the remaining waste. Biodegradable materials, such as food and garden waste, should be composted or sent to anaerobic digesters, where they are converted into useable products like compost, biogas, and sludge. Non-biodegradable materials that cannot be easily recycled could be sent to waste incineration plants which combust the waste to generate heat and electricity. Finally, waste that cannot be reused, recycled, or recovered should be disposed of in sanitary landfills, which are carefully constructed to avoid environmental pollution; this is the least favorable option. Dumping of waste should be avoided at all costs.

The adoption of the waste hierarchy was one of the first steps undertaken by Korea in the 1990s when the country was undergoing a financial crisis. The government adopted the 4 R approach of reduce-reuse-recycle-recover with a focus on waste reduction at source and the recovery of resources and energy from waste, with the ultimate goal of limiting the use of landfills. Figure SS2.2 shows the various waste-related policies along the solid waste management hierarchy that have been introduced in Korea over the years.

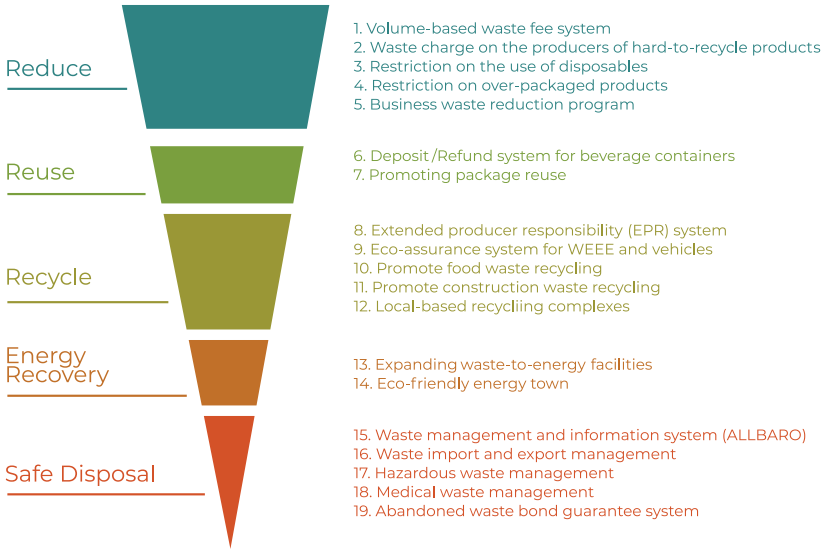
Legislative changes were enacted to mandate government institutions, businesses, and the public to meet certain requirements when dealing with solid waste. In addition, new systems and technologies were developed to assist in the implementation of these legal mandates as well as improve the capacity of all stakeholders. Some of the steps included:

- A National Master Plan for Waste Management with a vision towards zero waste that was developed and is updated every five years.

- Policies and interventions were introduced in the early phase to incrementally strengthen the waste management system at multiple levels.
- In 1990, separate collection of paper, metal, food waste, and plastics was initiated at the household level to reduce waste going to landfill.
- Recycling and segregated garbage collection bins began to appear in apartment complexes in 1990 and in single-family houses by 1992. This increased recycling waste by 50 percent, but the remainder was still being landfilled.
- The volume-based waste fee (VBWF) system was established in 1995 to change individual behavior around waste generation, where households were required to pay for the amount of waste they generated.
- Recycling complexes were established to create a platform for recycling businesses to treat, design, and process recyclable materials into new products.
- Food waste digesters were installed in housing areas to encourage waste segregation of wet waste, to recycle food scraps for feeding farm animals, and to ensure *in-situ* drying and processing of food waste.
- Radio frequency ID (RFID) technology was also introduced to weigh the amount of food waste discarded per household as a means of monitoring and charging waste fees.
- Laws were enacted to hasten the process of establishing incineration plants without social conflict. Incineration facilities were developed with strong public-private partnerships using cutting-edge technology to derive energy from waste. Companies managing incinerator facilities were mandated to support neighborhoods with assistance programs and made agreements with local governments to jointly use waste-to-energy facilities.

Overall, the VBWF in combination with other interventions encouraged segregation of waste and diverted 65 percent of waste to recycling in Korea.

Figure SS2.2: Waste-related policies along the SWM hierarchy in Korea



An undeniable commonality between India, Nepal, and Pakistan is that there are numerous barriers involved in the progression of SWM in these countries. These are summarized in Box SS2.2.

Box SS2.2: Barriers to the transition from improper to sustainable SWM in mountainous regions

- Significant risk in deriving and implementing a policy that is not based on a specific needs assessment.
- Lack of technical and financial capacity to rehabilitate dumping sites and restore surrounding ecosystem.
- Delays in decision-making regarding facilities and infrastructure required to meet long-term targets.
- Inter-agency coordination is a major challenge in boosting organizational capacity.
- Land scarcity and lack of investment to meet sustainable waste management targets.
- Public ambivalence and a lack of awareness about improper practices such as open dumping and burning of waste.
- Logistical difficulties in extending collection coverage and segregation systems in mountain communities due to remoteness and low population densities.
- Extreme weather conditions result in additional challenges along the SWM chain for collection, transport, treatment, and disposal.

Sources: K-eco 2019; Lee n.d.; SUSA 2017; Verma 2019

3. The Challenges of Solid Waste Management in Mountain Areas

Regardless of location, type of habitation, or elevation, the solid waste management (SWM) sector is complex and requires multiple aspects to work in synergy in order to provide efficient services, protect public health, and conserve the environment. In low- and middle-income countries, it is all the more challenging because SWM requires significant prerequisites. These include local government capacity, institutional coordination, stakeholder cooperation, sustainable funding mechanisms, infrastructure, technical knowledge, public awareness, behavioral change, monitoring and enforcement, data collection and analysis, and relevant laws and policies.

The uniqueness of mountain areas adds to the challenges of managing solid waste in high-altitude areas. While SWM challenges may be shared by many types of locations, mountain areas share challenges more commonly associated with other eco-sensitive areas rather than their counterparts in the plains. These points are further elaborated in the following sections.

3.1 What Makes Mountain Areas Unique?

Mountain areas are unique in the range of settlements, altitude and climate, topography and land availability, remoteness and connectivity, and accessibility by road, all of which have a combined effect on the range of SWM services that are needed and can be provided. Each of these issues is explained below, in the context of how mountain areas are distinguishable from settlements in the plains.

- *Settlement type:* One might assume that mountain areas are dotted with small settlements in remote areas, where waste quantities generated are negligible compared to larger cities in the plains. However, mountain settlements—especially in the three countries that are the focus of this report—range from large mountain cities that are home to hundreds of thousands of people, to small towns and rural villages that are connected to larger cities by a road or train network, to remote villages and tourist spots that can only be reached by foot and consist of few to no inhabitants. There are settlements that are tourist hotspots (for example, the "hill stations" in India and Pakistan established during colonial times), which see waves of population increases during peak season times, and others that are not popular tourist destinations.
- *Altitude and climate:* Mountain settlements in India, Nepal, and Pakistan span the gamut from low-to mid-altitude hills and plateaus offering a temperate climate to the largest concentration of the highest peaks in the world that are characterized by extreme climate throughout the year.
- *Topography and land availability for SWM:* These are inter-related issues, where the topography may be suitable to establish SWM facilities but there is a lack of land, to where there may be ample land available but the topography may not be suitable for infrastructure such as sorting, processing, and treatment centers and landfills.
- *Seismic activity:* The Himalayan region is vulnerable to earthquakes, with major earthquakes affecting all three countries. While earthquakes also occur in non-mountain areas, development of waste infrastructure, particularly landfills, needs to be carefully considered. Landfill liners may tear, landfill gas and leachate collection systems may shift, and landfill covers may crack following an earthquake. These outcomes can cause severe pollution to groundwater aquifers, streams, and alpine lakes that are a source of freshwater not only for mountain communities but also for settlements downstream that support millions.
- *Remoteness and connectivity:* The importance of road or train connectivity to mountain settlements cannot be minimized with regard to SWM. Many aspects, such as types of bins, storage containers and facilities, frequency and efficiency of collection services, and availability of treatment options, are directly related to whether mountain settlements can transport their wastes. Even in large mountain cities, neighborhoods and localities would need waste collection services to collect and transport the waste to nearby facilities. Obviously, the more remote a mountain settlement is, the more difficult and costly it is to provide SWM services.
- *Accessibility by road:* Mountain areas may or may not be connected by road to nearby towns and cities in the plains. Moreover, those that have road networks may not have all-weather roads and may be cut off during the monsoon and winter seasons. This adds an additional layer of complexity to SWM services as storage facilities and transfer stations may need to be developed.

3.2 Shared and Diverse Challenges

One may assume that mountain cities face the same SWM challenges as cities in the plains and that mountain villages and remote areas face the same issues as villages and remote locations in non-mountain areas. This assumption is both true as well as untrue. While all settlements face certain SWM challenges, mountain areas tend to face additional ones by virtue of their location. This makes improving service provision in mountain areas all the more demanding compared to the plains. Table 3.1 summarizes the challenges faced by all areas regardless of location, as well as the challenges unique to mountain areas.

Moreover, not all mountain areas are the same and vary by many localized factors, such as topography, climate, access, seasonality, waste volumes and types, and the impact of tourism. It is clear then, that mountain areas require a suite of bespoke waste management solutions. Recommendations and options for mountain areas are discussed in Chapter 5.

Table 3.1: Comparison of SWM challenges in mountain and non-mountain areas

SWM challenges in low- and middle-income countries	SWM challenges specifically in mountain areas
• Poor awareness and adoption of SWM practices • Lack of waste segregation • Inadequate collection and storage facilities • Poor or obsolete transportation options • Lack of or poorly functioning treatment facilities • Improper waste disposal techniques • Competing priorities for local governments • Lack of institutional coordination • Lack of skilled and technical capacity • Lack of funding and poor cost recovery	• Topography and geology (e.g., steepness, ruggedness, soil stability) • Remoteness of settlements • Scattered and low-density areas generating low volumes of waste • Diverse temperature and weather conditions • Sensitive environmental/ecological conditions • Vulnerability from seismic activity • Lack of road networks makes access difficult • Special types of waste generated (e.g., mountaineering waste), which require treatment and/or disposal • Waste transport requires vehicles suitable for mountainous regions • Limitations of space for waste treatment/disposal • Poor socio-economic conditions in general • High variability of waste generation due to tourist seasons

3.3 Shared Challenges with Other Eco-Sensitive Areas

Many mountain areas do not only share the same challenges as non-mountainous eco-sensitive areas, such as protected areas (for example, conservation parks and sanctuaries), small island states, remote villages in Arctic regions, and so on, but actually come under the category of being eco-sensitive, and hence present unique challenges. Both mountainous and non-mountainous eco-sensitive areas have the following in common:

- Remoteness and distance to existing infrastructure for waste treatment and disposal make waste collection and transport challenging.
- They are scenic or have a unique landscape that tends to attract tourists. While this brings important revenue to these areas, it also adds to the waste build-up.
- Depending on the area, tourists may visit regardless of season, adding considerably to the year-round waste generated in the area.
- They often have space constraints so allocating space for treatment and disposal is not always an option.
- Decentralized waste management solutions may be better suited to these areas.

These commonalities are worth mentioning because SWM practices that have been established in other eco-sensitive areas may also be suitable to mountain areas. The *Good Practice Options for Sustainable Solid Waste Management in Mountain Areas of India, Nepal, and Pakistan* report in this study highlights examples of solid waste practices in small island states such as the Maldives and the impact of tourism fees on islands in Indonesia.

3.4 Challenges in Solid Waste Management in Mountain Areas of India, Nepal, and Pakistan

Mountain areas are quite complex and require considerable coordination, planning, and financing. One cannot address mountain waste in India, Nepal, and Pakistan (or any country, for that matter) without addressing the specific challenges related to the SWM chain in mountain areas. From the lack of coordination and financing, to the poor infrastructure in place to deal with treatment and disposal, a detailed look at the current system is necessary in order to overhaul and amend it. Figure 3.1 summaries the common SWM challenges in the mountain areas of the three countries.

Figure 3.1: Combined SWM challenges in the mountainous regions of India, Nepal, and Pakistan

Institutional coordination and financing	Availability of data and Awareness	Waste generation and segregation	Waste collection and transport	Waste treatment and disposal
• Given the lack of monitoring and enforcement, wastes are dumped illegally; hazardous wastes, such as healthcare and industrial wastes, are often mixed with other general waste • No federal- or provincial-level institutions specialized in providing expert support in SWM to local governments exist • Lack of coordination among municipalities to cover spread-out areas • Limited technical and financial capacity at local government level to deal with SWM issues • Lack of adequate infrastructure, equipment, and skilled technical human resources • Lack of government funding for the solid waste sector • Lack of adequate mechanisms and capacity to collect user fees due to political will, socio-economic status of communities • Local authorities in mountainous regions require customization in terms of financial requirements, input material, and the capacity of local authorities	• Basic data is not consistently available nor collected, hence difficult to develop formal SWM plans • Only scattered data is available for remote mountainous regions regarding tourism-generated waste and waste generated by communities making SWM planning difficult • Lack of understanding of negative impacts on communities and natural resources of both residents and tourists • Citizens' lack of respect and disregard for the law • Lack of understanding of impacts on communities and natural resources	• Waste segregation is a major challenge in large cities as well as in smaller towns • Waste quantities vary significantly based on settlement type, and (more than double or triple) during peak and off-peak seasons • No formal system of waste segregation exists • Large amounts of plastic waste are generated in tourist destinations	• Waste collection efficiency is poor in many areas, and non-existent in rural and remote communities • Collection is challenging due to the terrain, making it difficult to cover all houses in a reasonable amount of time • Door-to-door collection may not be viable or efficient given the challenges associated with collection • Lack of systems established to support segregation • No (proper) storage bins/areas provided • Few vehicles available, if at all, for transport; lack of financial resources/funding to purchase more	• Besides some household composting and feeding kitchen waste to animals, other waste processing and treatment practices in mountainous regions are negligible • No treatment options available for non-biodegradable wastes; due to poor source segregation and erratic supply of feedstock, attempts at composting and WTE in these countries have generally been unsuccessful • High level of coordination, technical know-how, funding, and regular waste supply required for establishing treatment facilities • Open dumping and burning are common, and a major form of pollution • Mountainous regions lack appropriate disposal systems • Waste is disposed of in dump sites or areas in the natural environment (e.g., along roadsides, in drains, ravines, waterways)

Given the lack of research and knowledge on SWM in mountain areas, particularly in the mountain ranges of South Asia that are home to and that indirectly support millions of people, a field study was undertaken as part of this World Bank-KGGTF study to further understand the complexities of SWM in mountain areas in India, Nepal, and Pakistan. The field study is described in Chapter 4.


Anand

4. Field Study in India, Nepal, and Pakistan

There is a common phrase, "You can't fix what you can't measure". The same is true of solid waste management (SWM). Data collection is a critical first step in defining the problem before solutions can be proposed. Therefore, one of the primary objectives of the *Sustainable Solid Waste Management Strategies for the Mountainous Regions of India, Nepal and Pakistan* study was to analyze the current situation regarding SWM in the mountainous regions of these three countries. The first step was to engage in a field study comprised of waste sampling and a qualitative survey in the chosen locations. The field study provides an overview of the current SWM scenario as well as confirmation of waste trends that one would expect to see in mountain areas in these three countries. The remainder of this chapter summarizes the methodology and findings from the field study carried out in 2019 by Korea Environment Corporation (K-eco) in conjunction with local partners.

4.1 Objectives of the Field Study

The waste sampling was conducted to find out the types, amount, and composition of solid waste generated by various sources. This was followed by a survey of communities in specific mountain areas. The results of the survey can be used to clarify the waste stream and to formulate an appropriate system of SWM in these regions, specifically formulating effective collection and disposal systems, and developing solid waste utilization plans and strategies.

The qualitative survey was undertaken because it is important to know the degree of environmental awareness and public knowledge amongst both inhabitants as well as visitors. The qualitative surveys helped to better illustrate the behavior and habits of residents, commercial establishments, and tourists with respect to SWM. Table 4.1 presents the data gathered from the qualitative survey.

Table 4.1: Qualitative survey summary

Household survey	Hotel survey	Tourist survey
• Socio-economic information • Waste generation, types of waste, segregation, and management • Waste collection services • Environmental awareness • Effort and willingness to better manage solid waste	• Waste generation, segregation, and management practices • Waste collection services • Waste management in the area • Waste related to tourists • Staff training	• Visit type and purpose of visit • Awareness of environmental problems in the area • Waste generation from tourists • Prioritization of waste management in mountainous regions

4.2 Methodology of the Field Study

Due to time limitations and other constraints, the field study was conducted within a limited framework. As a result, it was supplemented by secondary data and through observation and experience from various organizations.

To gather information on current waste management practices in the selected sample sites, discussions were held with municipalities, tourist departments, and other stakeholders in each country in early 2019. Secondary literature from municipalities, district authorities, and tourism departments was collected. Sites that could serve as proxies were selected in consultation with key stakeholders, including local government officials, to represent the wider geographic area of the three countries. A summary of the locations, as well as the sampling for the field study are provided in Tables 4.2 and 4.3.

Table 4.2: Summary of selected field study sites in all three countries

Country	Province/state	Population of province/state	Site selected	Site type	Elevation (meters)
India	Himachal Pradesh	6.9 million (2011)	Kullu	Mountain city	1,279
			Manali	Town	2,050
			Dharamshala	Town	1,457
			Triund	Tourist/hiking spot, accessible only by foot	2,850
Pakistan	Khyber Pakhtunkhwa	35.53 million (2017)	Abbottabad	Mountain city (high-altitude)	1,256
			Nathia Gali	Hill station	2,410
			Mingora	Mountain city (mid-altitude)	980
Nepal	Annapurna Conservation Area	105,424 (1994)	Ghandruk	Remote village on trekking route, accessible by vehicles	2,012
			Chhomrong	Remote village on trekking route, accessible by foot	2,170
			Kimche	Mountain village	1,784
			Syauli	Mountain village	1,140

Sources: ICIMOD 1995; India, MoHA 2011a; Pakistan, PBS 2018

Table 4.3: Summary of field study samples in all three countries

Country	Site selected	Waste sampling (number of samples)	Qualitative survey (number of samples)
India	Kullu	6 households	27 households 24 tourists
	Manali	27 households 1 commercial area for 2 days 2 hotel waste collection vehicles 1 tourist spot for 2 days 1 dump site	
	Dharamshala	40 households 1 commercial area 2 hotel waste collection vehicles 1 tourist spot (Triund) 1 dump site	21 households 25 tourists
Pakistan	Abbottabad	30 households for 8 days 5 hotels for 8 days	--
	Nathia Gali	5 hotels	--
	Mingora	30 households for 8 days 5 hotels for 8 days	30 households 5 hotels
Nepal	Ghandruk	54 households	206 households 53 hotels 50 tourists
	Kimche	70 households	
	Syauli	40 households	
	Chhomrong	111 households	112 households

4.3 Key Findings from the Field Study

The key findings from the field study are summarized in this section. Please note that due to small sample sizes, as shown in Table 4.3, these values should not be considered representative and are only meant to provide a snapshot of solid waste practices in the sample locations. It is suggested that further corroborative research be done prior to any decisions being taken based on the data at hand. The data collected during the field studies in the three countries are summarized in Appendices 1-3.

Waste Generation

- Waste generation in remote mountain communities is much lower than in mountain cities.
- Heavily-frequented tourist establishments, such as restaurants and hotels, in mountainous regions generate more waste on average than commercial establishments in valley/non-tourist areas.
- *Pakistan:* High-income households generate more waste overall than low- and middle-income households.
- *Pakistan:* There is considerably more variance in the amount of the grass/wood portion of readily biodegradable waste between high- and low-income households.[2] This is probably due to high- and middle-income households having more green space compared to low-income households, and perhaps because low-income households use wood as a fuel source.

2 For the purposes of this study, the following definitions have been used: Readily biodegradable waste includes kitchen (e.g., vegetable peel, food scraps, bones) and garden (e.g., grass cuttings, leaves and twigs, wood) waste. Biodegradable waste includes recyclable paper, hair/fur, textiles, leather, and rubber.

Waste Composition

- Readily biodegradable waste makes up the largest fraction of total waste generated overall.
- Plastics are the main constituent of mixed waste in tourist hotspots, as well as the main component of non-biodegradable household waste, as shown in Figure 4.1.
- Biodegradable waste is the main constituent of mixed waste from other sources (that is, households, commercial establishments, and hotels).
- Waste from commercial areas has more cardboard, plastic, and glass compared to household waste.
- *India:* The most common type of plastic found in the waste sampling is LDPE, followed by multi-layered plastic, as shown in Figure 4.2.

Figure 4.1: Composition of non-biodegradable waste from households participating in the field survey (%)

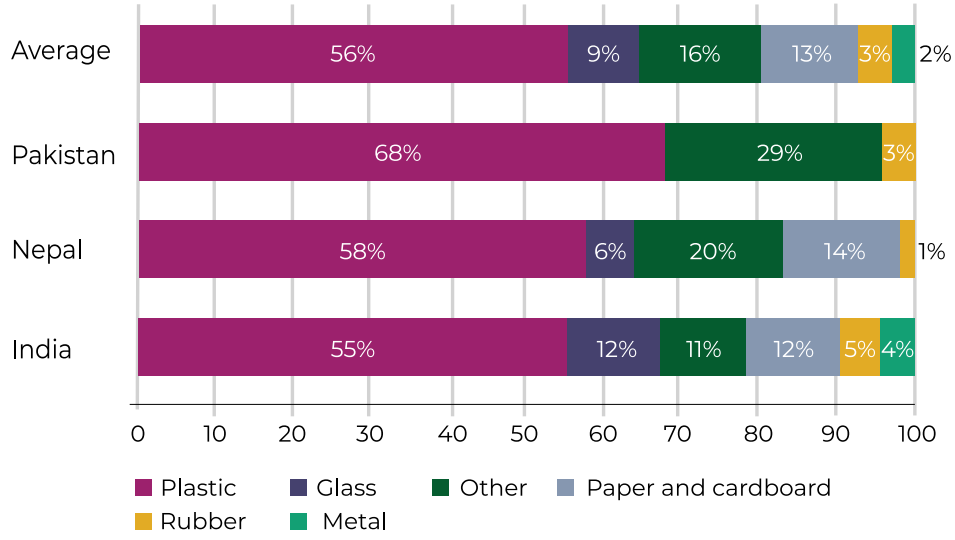
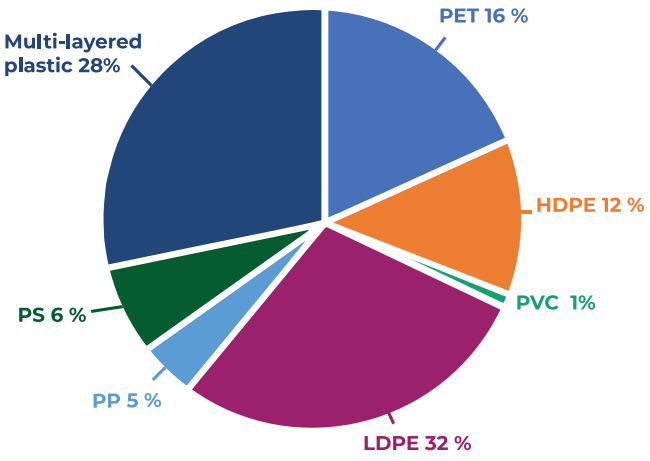


Figure 4.2: Composition of plastic waste at waste sampling sites in Himachal Pradesh, India (%)



Waste Segregation and Collection

- Despite no formal segregation system, over 60 percent of households in India and Nepal and a majority of hotels in Nepal's sampling areas segregate their biodegradable waste and bury it or use it to make compost or as animal feed. Almost no segregation is done in Pakistan, as shown in Figure 4.3.
- Comparatively, few households report having access to regular waste collection services, as shown in Figure 4.4. Accessibility in mountain areas is a key challenge for door-to-door collection.
- *Nepal:* During peak tourist seasons, hotels sort waste into more fractions than during off-peak tourist seasons.
- *Pakistan:* Just under half of the hotels segregate their waste into biodegradable and non-biodegradable fractions. The non-biodegradable waste is not further separated into various fractions.

Figure 4.3: Segregation of waste by households at surveyed sites in India, Nepal, and Pakistan (%)

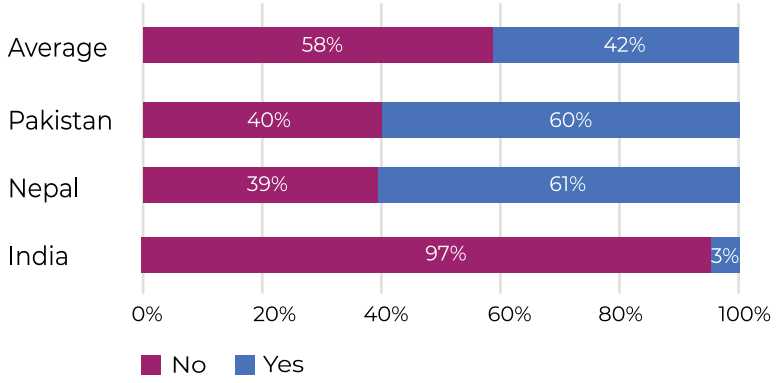
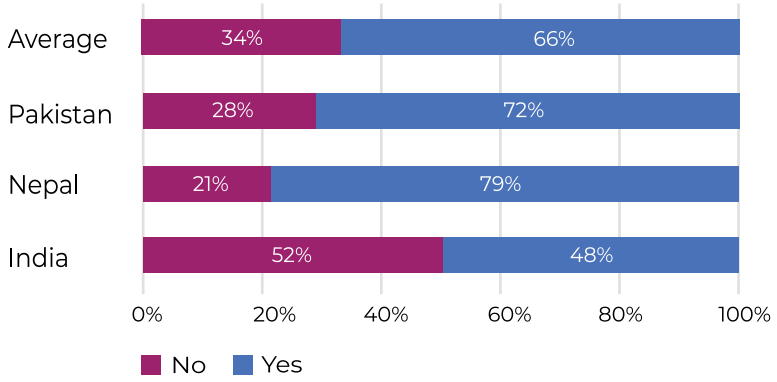


Figure 4.4: Access to waste collection services at surveyed sites (percent of households)



Disposal

- The proportion of waste that is disposed of in drains, ravines/valleys, and along or in streams/rivers is high due to the lack of collection services.
- Despite collection services being available in certain localities, waste is still disposed of indiscriminately.
- Dump sites are widely spread in the natural environment and have no sanitary structures.
- Open burning of waste occurs frequently.

Environmental Awareness and Willingness to Pay

- A majority of surveyed respondents show willingness to pay for SWM services, as shown in Figure 4.5 for households in the three countries and in Figure 4.6 for hotels surveyed in Nepal and Pakistan. This is not unusual and is seen in many other low-income country cities around the world. Residents are willing to pay for services if they perceive that the standard of service is efficient.
- *India and Pakistan:* Although most households think waste management is an environmental problem, they are unaware of current waste disposal practices and unconcerned about disposal methods.
- *India and Nepal:* Most respondents think door-to-door campaigning is the most effective way to build awareness.
- *Pakistan:* The majority of respondents say that television, social media, and door-to-door campaigning are the most effective ways to build awareness.

Figure 4.5: Willingness of surveyed households to pay for SWM services at surveyed sites (%)

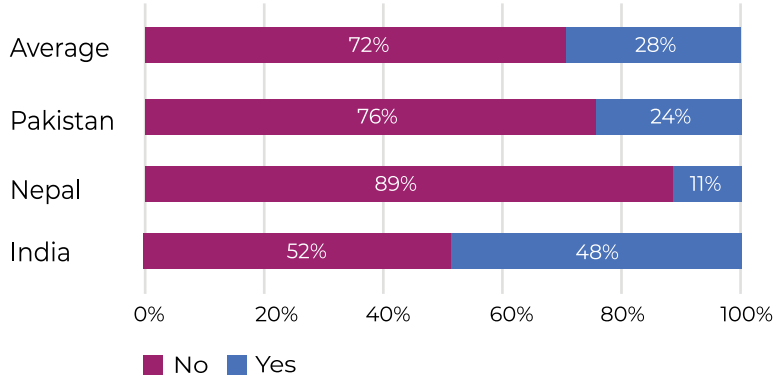
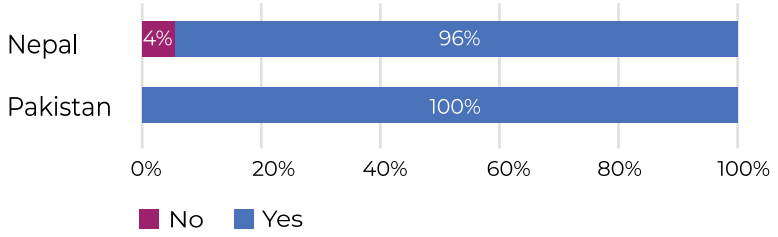


Figure 4.6: Willingness of surveyed hotels to pay for SWM services at surveyed sites in Nepal and Pakistan (%)



Tourist Surveys

- The surveyed tourists in India and Nepal were asked what they thought the most serious environmental problem in the area was. In both countries, litter and garbage on trails is the primary concern, followed by lack of sanitation facilities in India and dumping of waste in Nepal. Figure 4.7 summarizes the tourists' rankings of environmental issues in the two countries.
- By a large margin, the most common type of waste seen during the tourists' visit is plastic bottles, bags and wrappers, as shown in Figure 4.8.
- When asked what the top priority for solid waste management in mountain areas should be, tourists in India recommend more waste bins on trails, and tourists in Nepal suggest more public awareness on solid waste impacts. Figure 4.10 summarizes the key priorities for tourists in both countries.

Figure 4.7: Summary of tourists' rankings of environmental issues in India and Nepal (%)

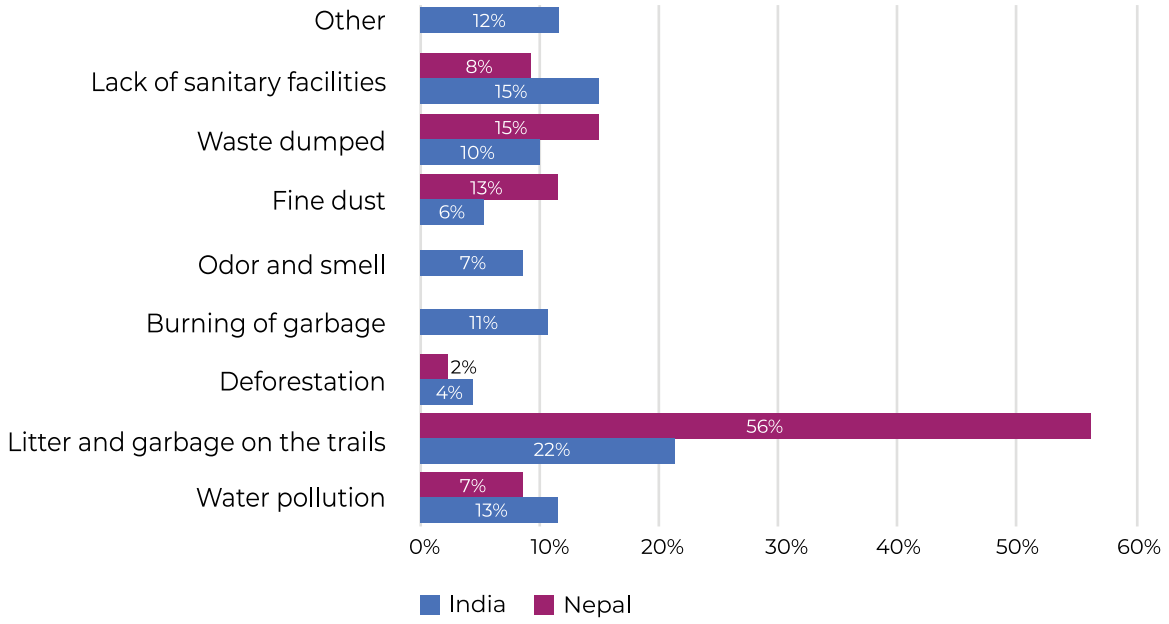


Figure 4.8: Common types of waste seen by surveyed tourists in India and Nepal (%)

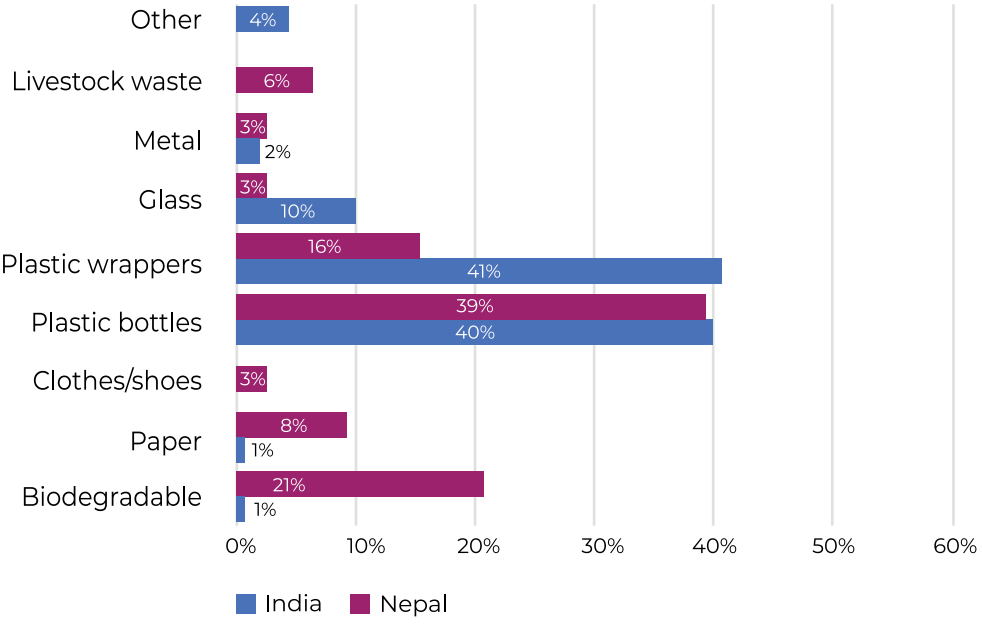
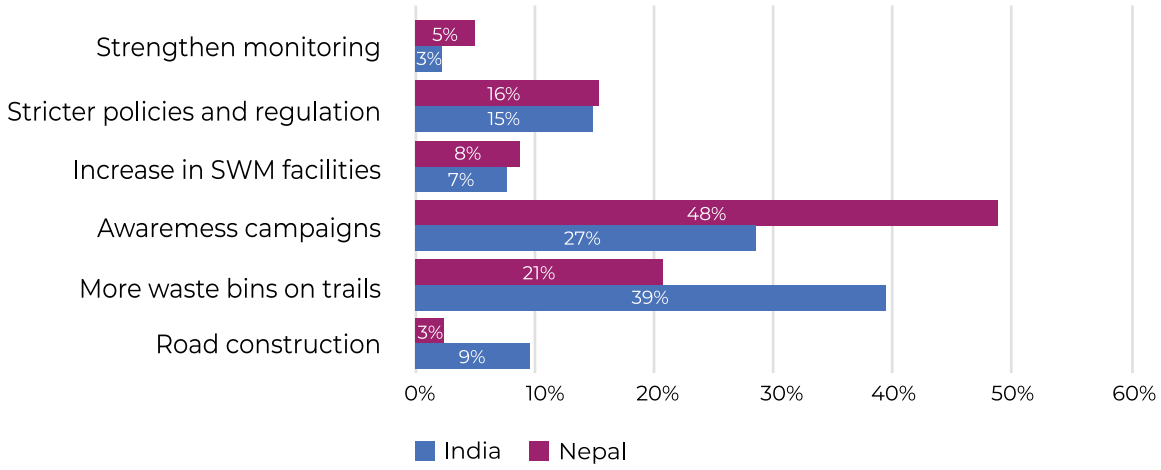


Figure 4.9: Summary of tourists' rankings of priority SWM-related actions (%)



Snapshot 3: Mountain Tourism and Solid Waste Management

Mountain Tourism

Of all the sectors in the world economy, tourism registers as one of the fastest growing. The UN World Tourism Organization (UNWTO) estimates that total international tourism receipts and passenger transport together was as much as $1.7 trillion in 2019 (UNWTO 2019). Every year, the influence of tourism is increasingly felt across the globe, and there is no region where the unique qualities of mountain landscapes are not acknowledged.

Mountain tourism is important for many developing economies as associated qualities become assets: Snow, skiing and other mountain sports, adventure activities such as mountaineering, the diversity of local peoples and traditional cultural practices, mineral and hot springs, the sacred dimension attributed to many mountain sites and summits, biological and geological diversity, and so on. All of these resources will likely take on increasing importance in the coming decades, as urbanization exerts a growing impact on lifestyles and the appeal of travel and tourism continues to expand.

UNEP estimates that travel to mountainous regions accounts for 15 to 20 percent of global tourism (UNEP 2007). However, this figure likely conceals some diverse situations where there are tens of millions of tourists in certain mountainous regions to where there are few tourists or none at all, in other mountainous countries of the Global South.

Tourism offers a number of socio-economic benefits to mountainous regions. However, because tourism is so closely tied to the natural environment and to local communities that are more vulnerable and less resilient than elsewhere, it is all the more essential to consider if and how tourism can contribute to the sustainable development of these areas and peoples. The limited options for earning a livelihood, coupled with poor accessibility and infrastructure, have led to widespread resource degradation.

There is great potential for tourism to become a major driver for green growth—contributing to poverty alleviation—if sustainable packages, including innovative business models supporting the conservation of natural habitats and resources, are developed. The development of sustainable tourism may constitute an opportunity for less-developed mountainous regions, with significant potential for realizing various benefits in terms of conservation of biological diversity and sustainable use of its components.

Tourism intersects with and stimulates a wide range of other sectors in the supply chain, especially agriculture, infrastructure, communications, construction, and handicrafts. Tourism also stimulates a new market for local produce, especially high-value crops. As a complementary livelihood option, the development of tourism not only has the potential to generate socio-economic benefits for the region, but may also address wider social and socio-cultural concerns (Kruk 2010). Thus, the tourism industry is being strongly pursued and supported by the governments of this region through their National Development Strategies. For example, in 2016 the Government of Nepal launched the National Tourism Strategy 2016-2025, which envisages a five-fold increase in tourist arrivals by 2025 and includes conservation of cultural heritage and a zero-carbon target as important development goals. In these countries, other than Pakistan, tourism has become one of the largest service

sectors, generating much-needed foreign exchange earnings, contributing between 2 to 4 percent of GDP, and generating 2.8 to 9.6 percent of total employment (Gioli et al. 2019).

Tourism and Waste Management in Mountainous Regions

Only scattered data is available for remote mountainous regions regarding tourism-generated waste and its management. The available information is generally limited to the most popular mountain destinations, such as those in the Andes in South America and the Himalayas in South Asia. However, the general trend observed in these two regions is that dramatic growth in mountain tourism inevitably leads to a drastic increase in waste left behind, even in remote and uninhabited areas (Barros et al. 2015; Byers 2009; Lew and Han 2015; Nepal 2016).

The mountain tourism industry is often linked to small communities through the use of local facilities and services. On one hand, this leads to an increase of waste produced in these communities (Manfredi et al. 2010). Communities are often not prepared to cope with the amount and types of waste introduced by tourists, given that waste management systems are negligible (Anand and Singh 2014; Kuniyal 2005a and 2005b). Ineffective waste management practices can impede the provision of basic necessities for public health such as clean water, clean air, and safe food. Poor waste collection can, for example, lead to the spread of diseases. Improperly disposed of waste, such as hazardous waste indiscriminately mixed with other wastes, can be harmful for workers in the waste sector, nearby communities, and the environment. In addition to soil and water contamination caused by leachate and air pollution from the burning of waste that is not properly collected and disposed of, inappropriate waste management also contributes to climate change and will diminish the availability of natural resources.

On the other hand, mountain specificities that are generally considered constraints to development—including poor accessibility, fragility, and marginality—can be transformed into economic opportunities for tourism (Jodha 1992; Sharma 2000; Kruk 2010). The Himalayan Region has tremendous potential for mountain tourism, which can provide alternative, environmentally-friendly employment opportunities for local communities and contribute positively to their socio-economic well-being. Where no waste management exists, demand for waste management services by the tourism industry could trigger the establishment of waste management systems and facilities from income generated by tourism, and thus positively influence the well-being of local communities. If waste is treated systematically, it has the potential to become a source of income for many unemployed people. An appropriate SWM system involves the participation of each agency or person concerned—from segregation at source, to proper collection, transportation, recycling, and environmentally-safe disposal (Ladhar 1996).

The most common types of waste from mountaineering are human waste (excrement and urine), other solid waste material associated with equipment and supplies (for example, tin cans, oxygen bottles, batteries, plastic bags, etc.), as well as waste from pack animals (Semernya et al. 2017). The most common waste disposal method adopted by mountaineers in remote alpine environments is to leave the waste behind, bury it in soil or snow, or drop it in glacier crevasses (Semernya et al. 2017). With climate change now melting snow and glaciers on mountains, waste and even dead bodies of climbers are increasingly being exposed (Picheta 2019).

While post-consumer waste is a small contributor to global greenhouse gas (GHG) emissions (<5 percent), inefficient waste management and a lack of prevention, recycling, and recovery not only lead to greater GHG emissions, but also aggravate the loss of valuable resources, such as glaciers and alpine flora and fauna (Bogner et al. 2007).

5. The Way Forward

Based on the waste management challenges specific to mountain areas described in Chapter 3 and the issues identified in the course of analysis of the field study as provided in Chapter 4, it is clear that there can be no one-size-fits-all approach to mountain waste.

Nevertheless, taking a regional perspective of the three countries in the study, it is useful to think about the range of solutions that are warranted. Any proposed recommendation would require an understanding of the following factors and their inter-linkages. Proposed recommendations and related implementable actions along a phased approach are then presented in this chapter.

5.1 The Framework to Build Solutions

When thinking specifically about mountain waste and what is needed to overcome the relevant challenges, it is important to consider a framework on which solutions can be steadily built. The following factors need to be considered: landscape management approach, sources of waste, geography and location, types of waste, seasonality, and tourism-based waste.

5.1.1 Landscape Management Approach

An integrated landscape management (ILM) approach recognizes the inextricable links between forests, natural resources, and the value chains that depend on them, such as agriculture, timber, and tourism. This approach aims to ensure both an equitable as well as sustainable use of renewable natural resources such as forests, wildlife, water resources, and land, to improve livelihoods for the most vulnerable rural communities, while at the same time strengthening the health and resilience of surrounding landscapes.

Any long-term solution on mountain waste should be considered in the context of integrated landscape management. By doing so, it would help conserve, restore, valorize, and promote the sustainable use of natural resources in mountain habitats, such as forests and waterbodies (for example, streams and lakes). The approach also brings various stakeholders together around a common vision to manage trade-offs across different land use sectors within a given area (World Bank 2021a). See Snapshot 4 for more information on the ILM approach.

5.1.2 Sources of Waste Generation

Solid waste in mountain areas comes from two primary sources: settlements and tourism. Settlements include communities that live in these areas, many tracing back their heritage to ancient times. Tourism denotes outsiders who are temporarily visiting one or more locations either for leisure, pilgrimage, or for adventure tourism.

In India, Nepal, and Pakistan, settlements can be classified as mountain cities or urban areas, mountain villages or rural areas that are generally connected by some form of road network, and remote areas that are not connected by road and can only be reached by foot. Solid waste management (SWM) practices will vary depending on the type of settlement. For example, mountain cities in India, Nepal, and Pakistan have hundreds of thousands of inhabitants, all contributing to year-round waste generation, which needs to be constantly managed in terms of collection, treatment, and disposal. On the other hand, small villages and remote locations may require decentralized approaches such as household or community composting to manage their wastes.

The second source is waste generated from tourism in these areas. Tourists contribute significantly to the amount of solid waste generated in mountain areas, be they large cities or smaller isolated hamlets. In some places, tourism is a year-round industry and, therefore, the additional waste generated requires funding and coordination with tourism service providers, among other interventions. Tourism-related waste is described in further detail in Section 5.1.6.

5.1.3 Geography and Location

While the sources of waste can provide indications of the quantity and types of waste generated, geography and location help in determining the infrastructure, equipment and vehicles, man power, and, therefore, funding required to manage the generated waste. For instance, steepness and remoteness of settlements would hamper waste collection services.

Mountain cities are more likely to be connected by road and rail networks to cities in the plains, thus enabling sorting and processing of wastes before the wastes are shipped to a large processor or recycler. On the contrary, waste transport vehicles would not be able to reach remote locations; thus these areas would require different solutions from those in urban mountain areas.

5.1.4 Types of Waste Generated

The next consideration is the type of waste generated by these sources. Based on the type of settlement or by activity (tourism, in this case), it is possible to infer the types of waste generated. For instance, in mountain cities there is likely to be a mix of biodegradable and non-biodegradable waste, as well as special wastes such as construction and demolition waste, healthcare waste, electronic waste, and inert waste. In rural areas and remote communities, the primary type of waste would be biodegradable. In both these areas, biodegradable waste is higher in volume and weight compared to other wastes, and could be segregated and mostly managed at source. Understanding the types of waste generated in different communities would enable some planning or pre-planning for storage and collection systems, transportation vehicle requirements, and probable treatment and disposal options. For instance, in mountain cities, biodegradable waste may be better suited to community or centralized facilities due to the lack of space. However, in rural and remote areas, composting could easily be done at the household level.

5.1.5 Seasonality

When planning appropriate SWM systems in mountain areas, it is important to consider whether waste generation follows a pattern based on tourism, employment, or some other factor. Any popular tourist area, be it a mountain city or remote village, or even a base camp, will show fluctuations in waste quantities generated based on tourist seasons. For instance, in Pakistan, the peak tourist season is from May to September, while Nepal has two tourist seasons: from March to May and then from September to November.

Waste management infrastructure and services need to accommodate variations in waste amounts for collection, transport, treatment, and disposal. However, seasonality is complicated, and may change over time. For instance, in many hill stations across India the concept of peak tourist season is fading away as more families are able to afford weekend getaways. Conversely, in other countries like Nepal, not only do peak leisure tourism times vary from adventure tourism, but the climbing season takes place in a very short window of a few weeks every year, depending on the weather.

5.1.6 Tourism-based Waste

Mountain areas are magnets for tourism, and this brings with it an additional set of unique challenges related to SWM. Tourism is an interesting aspect of life in mountain areas because it has the potential to simultaneously be both economically lucrative as well as detrimental to the environment.

Leisure, pilgrimage, and adventure tourism—both domestic as well as international—are bringing growing numbers of visitors to mountain areas in the three aforementioned countries. Tourism-related activities (and the resulting waste generated) take place in mountain cities and towns, villages that act as transit points for trekking and climbing expeditions, and in uninhabited areas (high-altitude areas for mountaineering). Specific challenges associated with tourism waste include seasonality and the fact that tourists may care less about engaging in environmentally friendly behavior while on holiday.

With regard to tourists engaging in sustainable behavior, research from the University of Queensland in Australia shows that even typically environmentally-conscious travelers do not necessarily make environmentally-friendly choices while on holiday. Reasons for this include:

1. That it is the responsibility of the government or industry to manage waste;
2. A lack of information/awareness on prevalent waste practices;
3. Comparisons to other tourists' behavior; and
4. While on holiday, tourists do not want to think about their environmental responsibilities (Dolnicar 2015).

An important aspect of tourism in mountain areas is associated with adventure tourism in uninhabited areas, such as high-altitude areas where mountaineering and trekking expeditions take place. In this case, no waste management services exist. Moreover, in high-altitude areas like the Himalayas, waste—whether human excrement or the remains of climbers—does not decompose easily due to the low temperatures. The only appropriate waste management strategy under these conditions is Leave No Trace, and specifically for solid waste, "Pack it in, Pack it out" (LNTCOE 2020).[3]

It has been observed that when areas become popular with tourists, the non-biodegradable waste fraction, e.g., plastic packaging, Tetra Paks, and glass, generated in these areas tends to increase. In addition, adventure tourism generates specific types of waste associated with climbing equipment and supplies such as tin cans, oxygen bottles, batteries, ropes, and tents. When this happens, waste systems must adapt to changing waste compositions. In this way, tourism affects the types of waste generated, and thus will have a cascading effect on how this waste is collected, where it is transported to, and how it is treated and disposed of.

5.2 Recommendations and Actions

Understanding that solutions for SWM in mountain areas need to be devised in a framework considering waste sources, geography and location, types of waste generated, seasonality, and tourism-based waste, it is recommended that an action plan or policy specific to mountain waste be created at the national level. An action plan or policy would detail the current waste situation in mountainous regions in the country, set

3 Leave No Trace is a set of seven ethics principles designed to promote conservation in nature while participating in outdoor recreational activities. One of the principles is to dispose of waste properly. "Pack it in, Pack it out" essentially means taking back unused materials and waste to be disposed of in waste bins or back home and not leave them in the outdoors.

targets for the sector (on collection, treatment, recycling, and disposal), and create guidelines and targets on financial sustainability, public awareness, promotion of a green economy, and rehabilitation of contaminated sites.

In support of this suggestion for a specific mountain waste plan or policy, this report presents various recommendations that are supported with implementable actions. These actions have been elaborated in a phased manner, rather than in a time-bound fashion, taking into consideration that implementation of a mountain waste plan or policy may progress according to different time frames in different countries. A phased approach allows for flexibility by respective national, provincial/state, or local governments. The recommendations are suggested taking into account an integrated approach of solid waste management. The concept of integrated solid waste management (ISWM) is described in Box 5.1.

A number of the suggested actions may be initiated simultaneously, regardless of the phase they are in, and may work concurrently with one another. For example, open dumping should be banned only once waste storage sites are opened, otherwise the ban is likely to be ineffectual; fines for littering should ideally run simultaneously with awareness campaigns so that so that residents and tourists alike are aware of the new regulations.

It should be noted that these recommendations and various implementable actions have been developed primarily with mountain areas in mind; however, the recommendations listed here may work for non-mountain areas as well, as a number of challenges are the same (as given in Table 3.1). While individual communities can manage certain aspects of SWM by themselves, such as household composting for small villages or remote hamlets, integrating measures by connecting sub-areas in order to provide centralized services such as regional treatment facilities is also needed. This will depend on local conditions, geography, and location of settlements, so needs to be developed at an intrinsically local level.

At each stage constant monitoring is required to see how effective programs have been:

- If something has worked, it is important to track what made it successful and how it can be scaled-up to a higher level that benefits the rest of the region or even country.
- If something did not work, it is important to identify the factors behind the failure as well as the barriers to implementation so that changes can be made to support implementation.

It is important to note that the recommendations and implementable actions provided in the remainder of this chapter are meant to propose ideas for the way forward, and should not be considered unalterable. It is expected that respective governments, should they wish with assistance from the World Bank, would develop a mountain waste plan or policy based on the specific scenario regarding mountain waste in their countries. A note on how to use the tables of implementable actions is provided in Box 5.2.

Box 5.1: Integrated solid waste management

Integrated solid waste management (ISWM) is a comprehensive framework for solid waste management (SWM), pictorially depicted in Figure B5.2.1. It includes all aspects of running an efficient, coordinated waste system, including the waste hierarchy, stakeholders, policy and legal, technological, financial, economic, environmental, and institutional aspects. The ultimate aim of ISWM is to manage an SWM system in a way that is environmentally, financially, and socially sustainable.

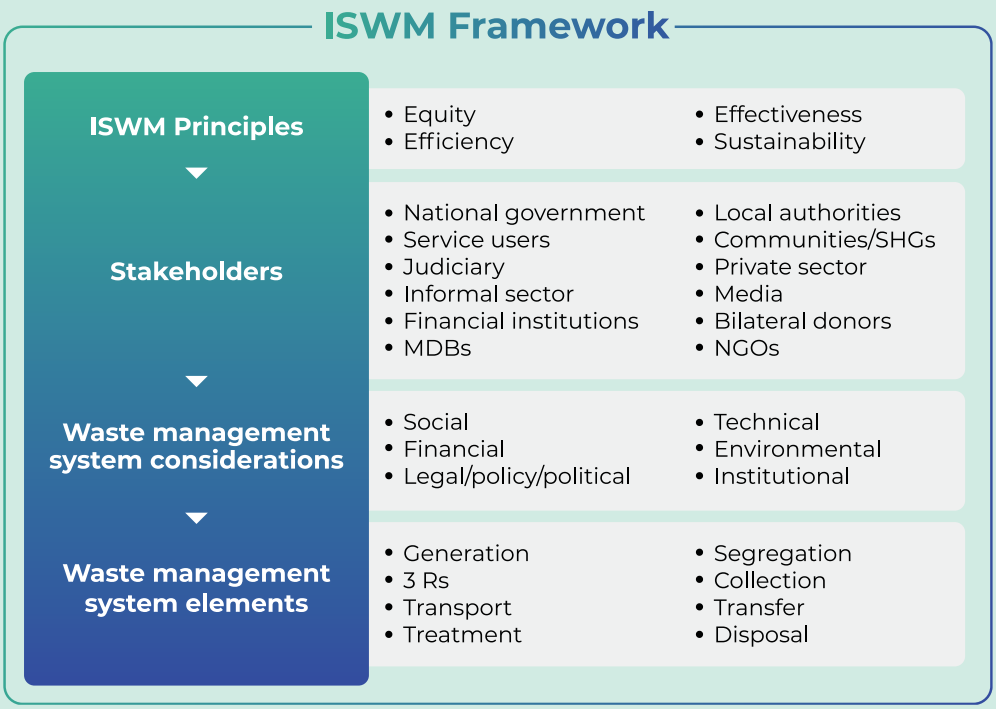
ISWM is based on four basic principles:

- Equity: Everyone is entitled to a functioning waste management system that protects human health as well as the environment.
- Effectiveness: Any SWM plan must meet its objectives; at minimum, all waste should be collected and disposed of in a safe and environmentally friendly manner.
- Efficiency: Maximizing benefits, minimizing costs, and optimizing use of resources.
- Sustainability: The system should be effective, maintained over time, and without exhausting resources.

An ISWM framework should ideally consider all aspects of government, from national waste policies and directives to local-level implementation. It is intended to be used as a practical tool to evaluate local conditions and needs and then to select the most appropriate waste strategies, given legal conditions, technical capacity, know-how, and financial capacity. For instance, a city that does not have the financial ability and technical knowledge to establish a waste-to-energy facility should not consider waste incineration in its ISWM plan.

Notice that the waste hierarchy and 3 Rs are only one aspect of the ISWM framework. A number of other factors need to be considered and fit together like a jigsaw puzzle in order to have a truly integrated solid waste management plan.

Figure B5.2.1: Illustrated representation of ISWM



Box 5.2: A note on how to use the tables on suggested actions

- Recommendations are grouped based on an integrated solid waste management framework.
- Each table focuses on a set of recommendations and related implementation actions.
- The solid waste management challenges have formed the basis for these recommendations.
- Proposed actions are organized horizontally into three phases, loosely denoting immediate, medium-term, and long-term, with the assumption that once the actions in the first phase are achieved, the recommendations in the next phase can be worked on, and so on.
- Actions are also organized vertically in a logical flow for each phase.
- Each action proposes suggestions for which stakeholders may be most appropriate in implementing these recommendations. These may change according to the local situation, or as required.

5.2.1 Recommendations Related to Institutional Coordination, Financing, and Stakeholders

Recommendations related to institutional coordination, financing, and stakeholders in mountain areas include:

- Develop local government policies and regulations in line with national guidelines and standards
- Operationalize the SWM system at the local government level through technical capacity development
- Involve local communities and community-based organizations (CBOs) in waste segregation and collection
- Create systemic opportunities to bring in economies of scale, engage the private sector as well as other stakeholders
- Enable integration of the informal sector to engage in waste management services
- Enable collaboration of related agencies, such as tourism, forest, natural resource management
- Establish a monitoring and enforcement system to improve and sustain waste management services.

Suggested actions based on the recommendations above to be implemented in a phased manner are presented in Table 5.1.

Table 5.1: Suggested actions related to institutional coordination, financing, and stakeholders

Issue	Phase 1	Phase 2	Phase 3
Policy/strategy for mountain waste	Approach the problem of mountain waste via an ILM approach, which would provide livelihood options while at the same time preserving and protecting the environment and developing related sectors in a sustainable manner G I	Prepare a mountain SWM policy/ strategy with input from all stakeholders and based on ISWM principles and considering an ILM approach G I N P S	Enforce and monitor the adoption of mountain SWM policy/strategy G
	Adopt the goal to develop a policy/ strategy for mountain waste G	Convene all stakeholders at regular intervals in order to facilitate cooperation and understanding and to promote a coordinated approach G I N P S	When national policies regarding waste are created, ensure that mountain areas are not only considered, but that their unique issues are accomodated G I
	Provide policy support for development of bylaws and regulations to meet national guidelines and standards G I N		Local SWM plans should incorporate a climate and disaster waste management focus to prepare for earthquakes, landslides, and floods, especially in the seismically active Himalayan region, and the impact on waste sites G I N
	Adopt ISWM and 3 R goals for mountain waste G N S		Develop SWM plans for waste types other than MSW (e.g., healthcare, household hazardous, C&D), depending on the data collected on these waste types G I
	Acknowledge that rural areas also are an important part of SWM and can no longer be ignored. With improvements in road networks, waste composition is changing (e.g., increase in use of sachets); tourism waste also increases non-biodegradable fraction G		
	To work towards a decentralized approach, analyze the "capacity to act" of various institutions and stakeholders G I N P S		
Institutions	Establish SWM department at the local level G	Incentivize local governments and institutions to adopt policies G I	Set-up formal structures for inter-municipal cooperation to help with procurement of bins, vehicles, storage and treatment equipment, disposal facilities G I N P
	Set up facility for inter-agency cooperation (e.g., tourism, forest, natural resource management, SWM), which is essential in an ILM approach G I	Build capacity of waste management governance G I	

Table 5.1: Suggested actions related to institutional coordination, financing, and stakeholders (contd.)

Issue	Phase 1	Phase 2	Phase 3
Financing	Review methods of user fee collection and what is most applicable and practical to implement G I	Consider various forms of sustainable financing (e.g., user fees, taxes, gate fees, EPR, etc.) G I N P S	User fee collection should be well established by now and close to 100%; can then shift to variable pricing, such as based on volume or weight generated G I
	Identify ways to support micro-enterprises; micro-loans for those who want to generate income from waste G I N S	Determine appropriate model for fee collection based on local context (e.g., polluter pays, cross-subsidy across income levels, flat fee) and how to collect it (e.g., through utility bill, property tax, door-to-door, etc.) G I	Consider other methods such as results-based financing to improve service delivery and cost recovery G I
	Identify options for segregated waste (e.g., sell in nearby cities, take to the plains) that could earn revenue for collectors of the waste G I N	Review methods to improve cost recovery G I	Initiate local-level EPR such as tourism tax through hotels, companies being responsible for collection of materials, deposit-refund schemes, eco-tax, etc. G I
	Identify options for providing small-scale financing or microloans to the most vulnerable populations G I	Initiate microfinancing on a pilot basis for vulnerable populations G N S	Institute and/or enforce refundable fees for protected areas to support waste collection, clean-up campaigns, etc. G N
			Expand micro-financing options to reach a wider section of people as well as to cover wider areas G N S
Stakeholders	Approach NGOs, SHGs, and CBOs as stakeholders and invite them to participate in the decision-making process G N S	Establish a think-tank to connect policy makers with academics, private sector, informal sector, and civil society to develop the best possible solutions G I	Establish public-private partnerships to improve efficiency in the SWM chain, if private sector participation is desired G P
	Identify ways to include or formalize participation of the informal sector in providing mountain SWM services G N S	Formalize participation of informal sector in mountain SWM services G N S	The role of local government shifts from service provision to regulation as private sector gets increasingly involved in providing SWM services G N P
	Identify whether private sector would be better suited to provide services than the municipality G I	Develop and provide incentives for reuse of materials (e.g., wood from demolition) by including informal sector as well as other stakeholders G N P	Ban single-use plastics once substitutes are available in the market G
	Encourage private sector as part of their CSR to fund clean-up activities, e.g., “adopt a highway” G P S	Promote women’s representation and leadership in committees and decision-making roles at the community level G S	Encourage development of susbstitutes for single-use plastics by providing initiatives G I N P S

Table 5.1: Suggested actions related to institutional coordination, financing, and stakeholders (contd.)

Issue	Phase 1	Phase 2	Phase 3
Monitoring and enforcement	Review enforcement and monitoring processes **G**	Initiate a score card system for citizens in mountain areas to rank implementation of policies, service delivery, cleanliness, etc. to provide an additional layer of monitoring **G I N**	Encourage action by citizens to participate in monitoring of mountain SWM services **G N S**
	Strengthen monitoring capacity and enforcement of penalties by installing cameras as a deterrent, spot fines, etc. **G**	Develop monitoring and evaluation capacity of civil society by supporting CBOs to use sound methodologies and systems to measure results **G I N S**	

Note: **G:** Government (includes all levels of government: national/central, state/provincial, and local; urban and rural local governing bodies); **I:** International/bilateral agencies, multilateral development banks, donor funds; **N:** Non-governmental organizations; **P:** Private sector; **S:** Self-help groups, including CBOs

5.2.2 Recommendations Related to Availability of Data and Public Awareness

Recommendations related to data and public awareness in mountain areas include:

- Coordinate with various agencies to improve data collection, availability, and to create public awareness
- Start data gathering as a continuous exercise in order to make better decisions, set targets, and monitor policy implementation
- Increase public awareness on managing and impacts of SWM in mountain areas
- Introduce and expand training program to build capacity of local government staff and decision makers.

Suggested actions based on the recommendations above to be implemented in a phased manner are presented in Table 5.2.

Table 5.2: Suggested actions related to availability of data and public awareness

Issue	Phase 1	Phase 2	Phase 3
Data gathering, analysis, and implementation; record-keeping	Conduct rapid assessments to gather data on key waste indicators to indicate how to move forward G I N	Detailed data gathering exercise to identify specific types of waste, amounts, etc., especially seasonality of waste based on tourism and climate G I	Identify other types of waste generated (e.g., healthcare, household hazardous, C&D) besides MSW which may require different procedures and processes for collection, treatment, and disposal G I N
	Set up short and long-term targets to monitor newly established systems to analyze whether they are successful or need tweaking G I	Institute recordkeeping, preferably digitally, of waste data G I	
		Establish or adopt performance monitoring/benchmarking G	
Public awareness and behavioral change	Generate public awareness through social media, websites; schools and education; door-to-door campaigns G I N P S	Create a regional/global network for knowledge sharing, capacity building for solid waste in mountain areas G I N	Strengthen ability of residents/civil society to monitor SWM activities; give them a sense of ownership through citizen reporting apps G N S
	Acknowledge the changing nature of waste (even in rural areas) and thus flexibility needed to make changes G I	Require tourism industry to be up-to-date on waste regulations and educate tourists through websites, tour companies, brochures, posters, etc. G N P S	Implement waste monitoring programs G N S
	Plan behavioral change campaigns for better SWM practices through media (e.g., press, radio, digital) and education (e.g., schools) G I N P S	Implement and expand behavioral change campaigns for better SWM practices; utilize community health workers to deliver regular training on the importance of better SWM practices G I N P S	Create regional platforms to share dialogue on mountain waste management practices G I N
			Foster community responsibility for improved SWM by building community awareness and equipping citizens with resources and training to practice those behaviors G N S

Table 5.2: Suggested actions related to availability of data and public awareness (contd.)

Issue	Phase 1	Phase 2	Phase 3
Training on SWM in mountain areas	Work with various stakeholders to encourage clean-up campaigns **G I N P S**	Initiate training for local government staff on practical aspects such as cost recovery, comparing technologies **G I N**	Build capacity of mountain communities and local governments to meet SWM challenges **G I N S**
	Work with mountaineering associations and tour guides to generate ideas to reduce SWM issues on trails/expeditions **G N**	Design data toolkits to easily gather data in hard to reach places. Make it easy to use so that anyone can use it **G I N**	Create training programs through regional platforms to offer wide-spread training and opportunities to learn from various regions **G I N S**
	Promote 3 Rs and offer training on sustainable SWM to schools and colleges **N S**		

Note: **G:** Government (includes all levels of government: national/central, state/provincial, and local; urban and rural local governing bodies); **I:** International/bilateral agencies, multilateral development banks, donor funds; **N:** Non-governmental organizations; **P:** Private sector; **S:** Self-help groups, including CBOs

5.2.3 Recommendations Related to Waste Generation and Segregation

Recommendations related to waste generation and segregation in mountain areas include:

- Enable source segregation to allow for value extraction and recycling of both biodegradable and non-biodegradable materials
- Enable separation of biodegradable waste for useful purposes at the household or community level
- Involve local communities and CBOs by considering various aspects, such as income generation
- Create policies to manage other wastes (C&D, healthcare, e-waste) in mountain cities.

Suggested actions based on the recommendations above to be implemented in a phased manner are presented in Table 5.3.

Table 5.3: Suggested actions related to waste generation and segregation

Issue	Phase 1	Phase 2	Phase 3
Waste generation at household and commercial entity level	Distribute waste bins for free to promote segregation into wet and dry fractions G N S	Scale-up three-stream source segregation in cities/large towns that generate considerable amounts of non-biodegradable waste, provide ways to encourage segregation G I N P S	Waste segregation at source becomes mandatory G
	Pilot source segregation into three streams, e.g., biodegradable (wet), non-biodegradable (dry), and domestic hazardous (e.g., diapers, household hazardous waste) fractions G I N S		Introduce segregation of dry waste into various categories depending on results of waste characterization studies (e.g., paper, cardboard, plastic, metal, glass) G
			Segregation of domestic hazardous waste (e.g., batteries, engine oils, paints, etc.) and storage until they can be shipped to the plains G N P S
Composting at source	Pilot or scale-up composting options such as in-vessel, vermicomposting, and biomethanation at household- and community-level G N S	Study use of biodegradable waste for biomethanation, which has multiple co-benefits like reducing use of kerosene or LNG for cooking at source level G N	Promotion of organic farming through the use of compost G N P S
	Scale-up segregation of biodegradable waste to be used as compost, animal feed, or for biomethanation in mountain areas itself G N P S	Provide subsidies for home composting techniques, such as vermicomposting or bin composting G	Phase out the use of chemical fertilizers in public parks, gardens, and nurseries and mandate the use of local compost G N P S
	Provide awareness and training on how to compost at home G I N S		Compost made from biodegradable waste can be marketed and sold to farmers, nurseries G I N P S
Generation of mountaineering/ trekking waste, waste from adventure tourism	Develop and promote awareness of guidelines for mountaineering/ trekking waste and waste from adventure tourism G I N S	Require mountaineering associations, tour guides, etc. to strictly enforce Leave No Trace/"Pack it in, Pack it out" policies G N	Institute and enforce refundable fees for protected areas to support waste collection, clean-up campaigns, etc. G N
	Introduce Leave No Trace/"Pack it in, Pack it out" to reduce waste from adventure tourism G N P S		

Table 5.3: Suggested actions related to waste generation and segregation (contd.)

Issue	Phase 1	Phase 2	Phase 3
Construction and demolition (C&D) waste	Identify companies involved in construction/renovation to use C&D waste generated by them as landfill cover G N P	Companies to begin minimal processing of C&D waste in order to make it suitable for use as landfill cover and other uses G P	Inert waste (e.g., C&D material) transported directly to nearest sanitary landfill for use as daily cover G P
	Identify other uses of C&D waste G I N	Consider policies related to using C&D waste for slope stabilization and other uses G P	Implementation of other uses for C&D waste G I N P S
Other wastes (mountaineering, healthcare, e-waste)	Understand the types and quantities of other wastes generated in mountain areas G I N S	Prepare guidelines/plans for segregation, collection, storage, and transport of these wastes to locations/facilities that can treat and dispose these wastes G I N	Implement and enforce guidelines/ plans for other wastes developed in previous phase G

Note: **G:** Government (includes all levels of government: national/central, state/provincial, and local; urban and rural local governing bodies); **I:** International/bilateral agencies, multilateral development banks, donor funds; **N:** Non-governmental organizations; **P:** Private sector; **S:** Self-help groups, including CBOs

5.2.4 Recommendations Related to Waste Collection, Transfer, Storage, Processing, and Transport

Recommendations related to waste collection, transfer, storage, processing, and transport in mountain areas include:

- Improve waste collection systems and upgrade service delivery
- Establish waste storage and/or transfer systems to manage waste
- Enable sorting and processing of non-biodegradables for higher monetary returns
- Find innovative ways to collect and transport waste from mountain areas that are particularly challenging due to remoteness, topography, and lack of road network.

Suggested actions based on the recommendations above to be implemented in a phased manner are presented in Table 5.4.

Table 5.4: Suggested actions related to waste collection, transfer, storage, processing, and transport

Issue	Phase 1	Phase 2	Phase 3
Waste collection	Identify existing collection routes, collection schedules, and mapping, if available, to see how they can be improved and how efficiently they work G I N P S	Improve collection coverage in all areas, including streets, tourist spots, etc. G I N P S	Expand collection coverage to 100% to reach all areas G N P S
	Explore the best ways to collect waste, keeping in mind that in hilly and mountain areas, door-to-door collection may not always be possible G I N	If source segregation has commenced, separate collection of biodegradable and non-biodegradable waste required G I N P S	
	Waste collection frequency should be increased so that users of the service recognize that the government is serious about SWM; this will positively impact user fee collection G	Involve the informal sector in waste collection, street sweeping, and segregation activities through NGOs, cooperatives/associations G N S	
	Identify spots that are frequently littered (e.g., tourist spots) and set up waste collection bins there G N S		
Budgeting waste collection	Local governments to allocate budget for waste collection so that once residents see an improvement in SWM, they are likely to pay for services G	In-depth study on waste fee systems as collection rates increase to identify most suitable options G I	Enforce waste fee system, starting with a flat fee to pay-as-you-throw system eventually G
Clean-up campaigns	Increase street sweeping in crowded areas as cleanliness provides an important first impression and will make residents proud and tourists aware of the no littering policy G	Incentivize tourists and pilgrims to bring their waste back to more populated areas where waste can be sorted by giving them vouchers, discounts in areas G P	Institute refundable fees or tourist fees in protected areas to support waste collection, clean-up campaigns, etc. G N
	Implement clean-up campaigns to bring down waste left over from previous mountain expeditions G N S	Add signage in popular tourist areas regarding cleanliness and littering G N S	
Collection bins	Waste collection bins should be frequently emptied so that they are not an eyesore nor attract vermin or animals G	Upgrade waste collection bins to source-separated bins that are clearly labeled to ensure separation of waste G P	
		As far as possible, use locally-made bins as they are easily available and less expensive G N P	

Table 5.4: Suggested actions related to waste collection, transfer, storage, processing, and transport (contd.)

Issue	Phase 1	Phase 2	Phase 3
Waste storage, transfer, and sorting	Identify sites to store recyclable and non-recyclable waste before they can be taken to the plains for further processing G N S	Establish storage sites/mini-transfer stations for both biodegradable and non-biodegradable waste G N P	Establish deposit centers/storage facilities for domestic hazardous waste G N P
	Identify sites for treatment of biodegradable waste, especially in mountain cities where households and communities lack space for individual composting units G N P S		Sorting of recyclable and non-recyclable waste at sorting/ mini-transfer stations by local inhabitants to create livelihood opportunities N P S
Waste processing and upcycling	Identify ways to sort/process waste in mountainous regions in order to provide livelihood opportunities G I N P S	Work with cottage industries, provide training to women's groups to process waste before selling non-biodegradables in order to gain more value G N P S	Work with cottage industries, tourism agencies, women's groups to upcycle waste into products that can be sold (e.g., souvenirs at tourist shops) G N P S
	Identify opportunities and areas for jobs creation and local entrepreneurship (e.g., fiber-based packaging) G I N P S	Initiate micro-financing loans on a pilot basis to encourage vulnerable populations, such as the poor and women, to participate in livelihood activities G I N S	Expand micro-financing options for broader outreach both in terms of numbers of people as well as by geography G I N
Waste transport	Consider various options for transport, including non-motorized modes and pack animals, keeping in mind that not all mountain communities are connected by road G I N S	Design transportation systems based on waste characteristics (e.g., volume, moisture), which can be done only after thorough waste data is collected G I P S	Transport equipment/vehicles and labor should meet 100% collection efficiency and source segregation goals G I N P S
	Transportation options need to be considered in concert with waste segregation and collection practices, as well as taking into account transportation costs, which can be considerable in these areas G I N	Transport equipment/vehicles must be able to handle source segregated waste G I N P S	

Note: **G:** Government (includes all levels of government: national/central, state/provincial, and local; urban and rural local governing bodies); **I:** International/bilateral agencies, multilateral development banks, donor funds; **N:** Non-governmental organizations; **P:** Private sector; **S:** Self-help groups, including CBOs

5.2.5 Recommendations Related to Waste Treatment and Disposal

Recommendations related to waste treatment and disposal in mountain areas include:

- Ban the open dumping and burning of waste
- Find suitable alternatives for treatment of non-biodegradable waste and for waste disposal.

Suggested actions based on the recommendations above to be implemented in a phased manner are presented in Table 5.5.

Table 5.5: Suggested actions related to waste treatment and disposal

Issue	Phase 1	Phase 2	Phase 3
Waste treatment	Initiate review of various waste treatment technologies that could be applied while considering all variables (see Table 5.6 for menu of possible options) G I N	Design of treatment and disposal facilities should be done based on the characteristics of waste; this can be done only after thorough waste data is collected G I	Identify if RDF/SRF processing can be established and nearby entities that can use RDF/SRF as feedstock, such as local or regional cement plants G N
	Analyze technical options in the context of cultural norms, political and societal feasibility, as well as costs and benefits G I	As far as possible, identify and use locally-available technology as maintenance, repair, and spare parts are easily available and less expensive G I N P S	Establish combined/regional treatment and disposal facilities to provide services to multiple municipalities G I N P S
Mid- to large-scale composting	Biodegradable waste generated in sufficiently large quantities to be treated in mid- to large-scale facilities, e.g., windrow composting, biomethanation G I N P S	Identify markets for ready compost, provide certification of compost quality in order to increase revenue from composting treatment G I P	Enforce phase-out of synthetic, petroleum-based fertilizers and switch to compost; facilitate organic farming through the use of locally-made compost G I N P S
Dump sites	Identify and map out illegal waste dumps and areas where waste is routinely dumped (e.g., ravines) G I N S	Institute a complete ban on waste dumping and burning by levying large fines on offenders, at the same time that storage facilities become operational G	Close all illegal dumping areas by clearing out the accumulated waste and installing signage regarding closure G N S
Landfills	As far as possible, avoid constructing sanitary landfills in mountain areas; if unavoidable, keep in mind that mind topography, depth to aquifer, control of inflowing water, availability of daily cover are necessary G I N	If landfilling is unavoidable, construct smaller landfills close to densely-populated areas and away from water sources G I P	Construct sanitary landfills if only absolutely necessary; identify options for landfill sites in the plains, if possible G I P
	Initiate zero-landfill strategies for mountainous regions G I N	Develop sanitary landfill site selection criteria and operating guidelines specifically for mountain areas G I	

Note: **G:** Government (includes all levels of government: national/central, state/provincial, and local; urban and rural local governing bodies); **I:** International/bilateral agencies, multilateral development banks, donor funds; **N:** Non-governmental organizations; **P:** Private sector; **S:** Self-help groups, including CBOs

5.3 Menu of Options for Collection, Transport, and Treatment of Mountain Waste

Keeping in mind that waste collection, transport, and treatment are challenging in hilly and mountain areas, a menu of broad options are presented in Table 5.6. The table also shows which mountain area(s) a particular option might be most suited to. Some of these methods are already used in mountainous regions and are highlighted in the *Good Practice Options for Sustainable Solid Waste Management in Mountain Areas of India, Nepal, and Pakistan* report. Many of these options may be applicable (or modified to suit) non-mountain areas also, but these options have been presented here based on their applicability to mountain areas. It should be noted that this is not meant to be an exhaustive list, and there may be other options that may be better suited depending on the local context.

Table 5.6: Menu of options for collection, transport, and treatment of mountain waste

Option	Mountain cities and towns	Rural areas with road access	Remote areas not connected by road	High-altitude areas (mountaineering/ trekking waste)
Collection and Transport				
Use of pack animals to collect non-biodegradable waste			✓	✓ (base camps)
Use of non-motorized options (e.g., tricycles, animal-drawn carts)		✓	✓	
Use of locally-available motorized options (e.g., three-wheelers, tractors)	✓	✓	✓	
Use of containerized handcarts, three-wheelers for segregated waste	✓	✓		
Use of dump trucks and waste transport vehicles suitable to mountain regions	✓	✓		
Workers collect non-biodegradable waste in back-packs provided by service provider[4]			✓	✓ (base camps)
Drop-off waste at specific collection points	✓	✓	✓	✓
Pooling resources through inter-municipal cooperation to improve service delivery and reduce costs	✓	✓	✓	
Special non-biodegradable wastes (e-waste, climbing equipment): Ensure collection through EPR/deposit fees, which factor in costs of transportation to nearest processing/disposal center	✓	✓	✓	✓
Treatment				
Biodegradable waste: Composting at source (e.g., pit, bin, vermicomposting, pile)	✓	✓	✓	
Biodegradable waste: Composting at community-level (e.g., bin, vermicomposting, black soldier fly larvae)	✓	✓	✓	✓ (base camps)
Biodegradable waste: Medium- to large-scale composting	✓	✓		

4 This option is provided in *Swachh Bharat* Mission guidelines for hilly areas in India (CPHEEO 2016).

Table 5.6: Menu of options for collection, transport, and treatment of mountain waste (contd.)

Option	Mountain cities and towns	Rural areas with road access	Remote areas not connected by road	High-altitude areas (mountaineering/ trekking waste)
Biodegradable waste: Community-scale biomethanation to be used output as cooking or energy source	✓	✓	✓	✓ (base camps)
Biodegradable waste: Combine household and animal/ livestock waste to improve biomethanation		✓	✓	
Biodegradable waste: Large-scale composting facilities	✓			
Non-biodegradable, recyclable waste: Sorting and minimal processing for value addition at transfer stations	✓	✓	✓	
Non-biodegradable, non-recyclable waste: Conversion to RDF/SRF for use in nearby cement, WTE plants	✓	✓		
Non-biodegradable waste: Upcycling waste for local use and tourists	✓	✓	✓	

Snapshot 4: Understanding the Integrated Landscape Management Approach

The idea behind integrated landscape management (ILM) is to sustainably manage landscapes by bringing together multiple stakeholders with different land-use objectives. Instead of a sector-focused approach where sectors work in isolation, the ILM approach aims at simultaneously focusing on natural resource management, development, climate change, livelihoods, and food security, as well as other socio-economic and governance issues for a defined landscape or place. In this way, the landscape-based approach is increasingly recognized as an effective means to address challenges in food security, ecosystem conservation, and climate change (World Bank 2021a).

Defining the Concept

The overarching objective of ILM is to maintain social, economic, and ecological functions in a balanced manner, and to contribute to sustainable development and the reduction of negative external impacts in a region. While there are multiple ways of approaching ILM, they all share some common salient points including (1) broad stakeholder participation, (2) negotiation around multiple objectives and strategies to develop shared understanding of multi-functional landscape, (3) adaptive management, based on shared learning, and (4) place-based and decentralized processes, emphasizing the role of local actors and their empowerment. Even defining the boundary of a landscape is done through the lens of what is locally feasible and spatially informed (World Bank 2021a).

Since an ILM approach includes several sectors, actors, and may even have a variety of objectives, it is important that all related institutions, even informal bodies, and stakeholders have an established, integrated framework on which to collaborate and build upon in order to achieve their common goals. It is essential that stakeholders understand the workings and dynamics of a place and use locally-appropriate mechanisms as the basis for their actions.

In the context of ILM, landscapes can include multiple, interlinked functions and can provide a variety of services (for example, food, water, shelter, livelihood, economic growth, biodiversity, climate change regulation, and human well-being). The landscape, thus, becomes an ideal unit for planning and decision-making, allowing various sector plans and programs to be integrated into a single spatial context.

Designing an ILM Approach

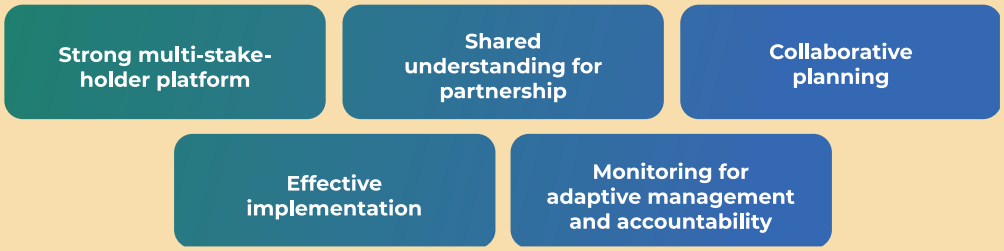
ILM is based on dynamic interactions with multiple partners, who collaborate to meet diverse goals and expected outcomes "through a cycle of adaptive planning, collaborative action, and reflective monitoring" (Brouwer et al. 2015).

The key aspects of using an ILM approach include the following: Starting with interested stakeholders for dialogue in a multi-stakeholder platform to exchange information and perspectives, followed by developing a

shared understanding of the challenges and opportunities to manage the landscape. This creates an enabling environment to collaboratively plan and develop an action plan. Following this, stakeholders collaboratively implement the agreed plan to ensure systematic and inclusive progress towards shared commitments. During the implementation process, monitoring and evaluation play an important role both to ensure accountability and to learn from the process for adaptive management (Denier et al. 2015).

Some of the key design features and the conditions to maximize the implementation of ILM are summarized in Figure SS4.1.

Figure SS4.1: Key design features and conditions to maximize implementation of an ILM approach



Applying the ILM Concept

An ILM-based approach includes enhancing the living conditions of rural communities and promoting sustainable natural resource management through a cross-sectoral portfolio of projects. This could be especially useful in ecologically-fragile and geographically remote areas like mountainous regions, which have additional pressures due to challenging landscapes and excessive pressure on ecosystems from increases in tourism. A regional/landscape approach linked with individual towns and settlements, each of which may have its own customized system/approach, could be a framework for mountain areas with downstream linkages in the plains. Depending on the scale, unique features, and objectives of a landscape management approach, the concept of a nature-village or eco-village in which SWM may be an integral part could also be part of such regional landscape approach. Two examples of the ILM approach in practice, such as the current World Bank projects in Meghalaya, India and Mozambique, are described below.

Meghalaya Community-Led Landscapes Management Project

Meghalaya, a mountainous state in northeastern India, once boasted a forest cover of almost 70 percent. Due to widespread land degradation caused by deforestation, mining, and shifting agriculture, 40 percent of this forest cover has degraded into open forests and shrubs (Meghalaya Basin Development Authority 2017). The Meghalaya Community-Led Landscape Management Project (MCLLMP), supported by the World Bank with a $48 million loan, was launched in 2018. The project aligns with landscape management for sustainable natural resource management. It is aimed at strengthening rural communities and traditional institutions in order to manage their natural resources, such as land, springs and other water sources, forests, and biodiversity by implementing community-led sustainable management plans in a systematic manner.

The project has prioritized about 400 villages in 'critical' and 'very critical' (degraded) landscapes over five years for the planning and treatment of these landscapes. Planning and investments will be preceded by training for communities and project management staff at the field level. The project has also extended such training to communities beyond the targeted 400 villages to amplify the reach of the MCLLMP approach to a larger

cohort of villages to take up landscape-based management with funds from other government programs. This approach will also facilitate planning for funds from other government programs for convergence of development programs at the village level (World Bank 2018).

ILM Portfolio in Mozambique

Mozambique's ILM portfolio brings together a series of projects to promote the sustainable management of renewable natural resources (forests, wildlife, land, and fisheries) and to improve livelihoods in the country's most vulnerable rural communities. In a country where over 70 percent of households rely on natural resources, the ILM portfolio promotes a healthy coexistence between humans and nature by tackling deforestation and resource exploitation, together with challenges such as rural poverty, community rights, and land management.

At a time when an integrated approach to natural resource and forest management is gaining prominence worldwide, the ILM portfolio takes advantage of shared knowledge and resources, facilitating cross-sectoral coordination and dialogue. The result is greater national capacity in natural resource and protected area management, as well as environmental, social, and economic benefits that extend far beyond the lifecycle of the projects (World Bank 2020a).

6. Looking Ahead: Role of the World Bank and other Donors

Multilateral development banks can assist client countries in developing policy, institutional, technological, financial, and capacity building changes. This chapter focuses on the role of the World Bank and other donors in contributing to improved waste management services in mountain areas in low- and middle-income countries.

The World Bank finances and advises on solid waste management (SWM) projects using a diverse range of products and services, including traditional loans, development policy financing, Program-for-Results (PforR), results-based financing, and technical advisory services. World Bank-financed waste management projects encompass the entire waste management chain, from generation to collection and transportation, and finally treatment and disposal. The various objectives that guide the World Bank's SWM projects are summarized in Box 6.1.

Box 6.1: Objectives that guide the World Bank's SWM projects and investments

- **Infrastructure:** The World Bank provides capital investments to build or upgrade waste sorting and treatment facilities, close dumps, construct or refurbish landfills, and provide bins, dumpsters, trucks, and transfer stations.
- **Legal structures and institutions**: Projects advise on sound policy measures and coordinated institutions for the municipal solid waste (MSW) sector.
- **Financial sustainability**: Through the design of taxes, fee structures, and long-term planning, projects help governments improve waste cost containment and recovery.
- **Citizen engagement:** Behavior change and public participation is key to a functional waste system. The World Bank supports designing incentives and awareness systems to motivate waste reduction, source-separation, and reuse.
- **Social inclusion:** Resource recovery in most developing countries relies heavily on informal workers, who collect, sort, and recycle 15-20 percent of generated waste. Projects address waste picker livelihoods through strategies such as integration into the formal system, as well as the provision of safe working conditions, social safety nets, child labor restrictions, and education.
- **Climate change and the environment:** Projects promote environmentally-sound waste disposal. They support greenhouse gas mitigation through food loss and waste reduction, organic waste diversion, and the adoption of treatment and disposal technologies that capture biogas and landfill gas. Waste projects also support resilience by reducing waste disposal in waterways, addressing debris management, and safeguarding infrastructure against flooding.
- **Health and safety**: The World Bank's work in MSW management improves public health and livelihoods by reducing open burning and mitigating pest and disease vector spreading.
- **Knowledge creation**: The World Bank helps governments plan and explore locally-appropriate solutions through technical expertise and data and analytics.

Source: World Bank 2019

Since 2000, the World Bank has committed over $4.7 billion to more than 340 SWM programs in all six regions of the World Bank. Numerous initiatives to develop infrastructure and technical assistance have been implemented. For instance, the following projects in South Asia itself:

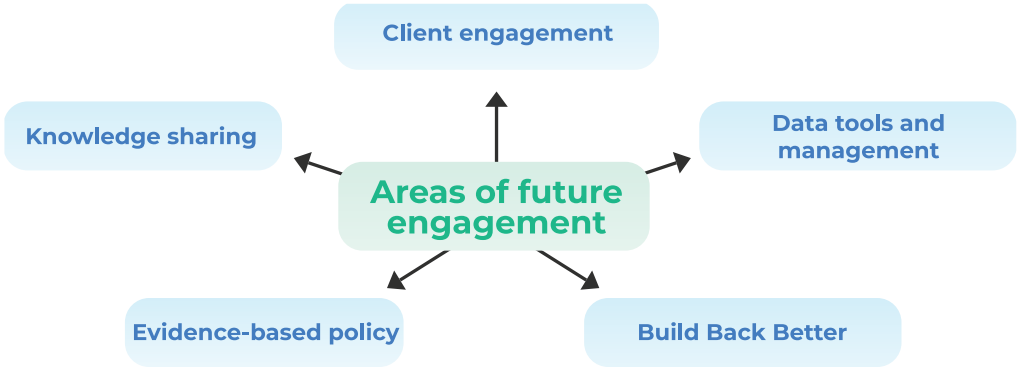
- In Nepal, a results-based financing project of $4.3 million increased user fee collection and improved waste collection services in five municipalities, benefitting 800,000 residents.
- In Pakistan, a $5.5 million-dollar project supported a composting facility in Lahore in market development and the sale of emission reduction credits under the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC). Activities resulted in reductions of 150,000 tonnes of carbon dioxide equivalent and expansion of daily compost production volume from 300 to 1,000 tonnes per day (World Bank 2019).

World Bank engagement in SWM is supported through valuable partnerships such as with the Korea Green Growth Trust Fund (KGGTF), which provided funding for this project.

National and state/provincial governments are generally supportive of efforts to accelerate improvements to the SWM sector although this is fundamentally a municipal function and challenges have to be addressed at the municipal level. Support to clients to improve SWM services and practices in mountain areas in the South Asia Region—and elsewhere—could include the following, as summarized in Figure 6.1:

- **Client engagement:** The World Bank supports its client countries in the form of analytical advisory activities as well as through operations. The World Bank supports infrastructure creation and service provision though various financing mechanisms such as traditional loans, PforR, results-based financing, private sector financing and guarantees, to name a few. It can guide client countries on capacity building, training, and initiating pilot studies. It also supports the development of institutions, promotes institutional coordination, and facilitates inter-municipal cooperation in order to enable economies of scale through green procurement policies.
- **Data tools and management:** There is a significant need for a well-defined system to collect and use SWM data from mountain areas. This is required in order to make informed decisions, as data is the backbone of any policy. Assistance could be provided in the form of rapid data assessments, devising robust data collection, recordkeeping, and monitoring systems.
- **Build Back Better:** Like many other countries, India, Nepal, and Pakistan face unprecedented challenges of managing the consequences of the COVID-19 pandemic. While all three countries have initiated stimulus packages to include investments and drive the creation of jobs, not all stimulus spending has long-term benefits. The World Bank has started a sustainability checklist through a new initiative, Build Back Better, to help policymakers identify potential projects, policies, and measures that are best suited for inclusion in a stimulus package, with the key objective to deliver both short- and long-term gains. Combining the Build Back Better approach with landscape management techniques or nature-based solutions could have numerous long-term potential benefits in these three countries, and elsewhere. Particularly in mountain areas, it can help create green jobs in the SWM sector.
- **Evidence-based policy:** In-depth examination is required about which laws and polices support the development of better waste strategies in mountain areas. If current policies do not support better SWM implementation, the World Bank can effectively support clients in this regard. In addition, it can also help to coordinate various sectors to adopt a landscape approach.
- **Knowledge sharing:** The World Bank can assist in setting up a knowledge-sharing network especially for mountain waste in order to learn from similar communities about how they manage specific challenges. Policy think-tanks, such as the ones created specifically for SWM in Korea, connect government agencies with academia and communities, thus supporting and sharing research and enhancing coordination, not only in mountain areas but also in the rest of the country.

Figure 6.1: Potential areas of future World Bank engagement for mountain waste



To achieve sustainable growth, the World Bank supports improved natural resource management, environmentally-friendly fiscal policies, greener financial markets, and effective waste management programs. In South Asia (SAR), the World Bank's Environment, Natural Resources, and Blue Economy (ENB) Global Practice is working regionally to meet the goals of a clean, green, and healthy environment. Box 6.2 summarizes related ongoing World Bank studies in the region.

Box 6.2: Related regional World Bank projects

This Advisory Services and Analytics (ASA) activity on sustainable management of solid waste in mountain areas is spread across the Himalayan regions of India, Nepal, and Pakistan. It represents the first attempt by the World Bank to examine solid waste management in ecologically-sensitive areas that face unique challenges. The lessons and recommendations from this study may also be applicable to mountain areas in other regions and countries.

Other current regional projects across SAR that integrate the environment, including water resources, with improved waste management practices include PLEASE and SAWI. A PROBLUE study in Pakistan looks at the impact of marine pollution in the Arabian Sea. These projects are further described below.

Plastic Free Rivers and Seas for South Asia (PLEASE): The objectives of the PLEASE project are to strengthen innovation as well as coordination of circular economy approaches across South Asia in all SAR countries. The project consists of three components that will be implemented over a period of five years and hopes to sharply drive innovation and results for plastics waste and plastic pollution reduction that would lead to cleaner coasts, rivers, and seas across the region.

South Asia Water Initiative (SAWI): The South Asia Water Initiative (SAWI) is a multi-donor trust fund in support of a program of activities to develop a shared understanding of trans-boundary river pollution across countries in South Asia (Afghanistan, Bangladesh, India, Nepal, Pakistan, Sri Lanka), with a particular focus on plastics. Projects under SAWI include assessments of plastics leakage and pathways into rivers, identifying commonly used and problematic single-use plastics, and water quality and related pollution data collection and analysis, among others.

In the three countries of this regional study on mountain waste, SAWI-funded projects include:

India: The study will inform Enhancing Coastal Ocean Resource Efficiency (ENCORE) Program on plastic waste management activities that are (1) suitable for communities' engagement, (2) cost effective, (3) sustainable, and (4) easy to upscale.

Nepal: Studies on plastic material flow analysis, estimating plastic leakage in five cities across Nepal, including in the Kathmandu Valley, and estimating the types and quantities of plastic healthcare waste expected to be generated during the COVID-19 pandemic.

Pakistan: This study looks at plastic pollution at selected sites across the Indus River Basin to understand the volume and nature of plastic load in the river. Targeted recommendations to stakeholders will include policy and institutional solutions and behavior change.

Pakistan Marine Pollution & Marine Waste Management: The Pakistan Marine Pollution & Marine Waste Management study, funded by PROBLUE, aims to present a diagnostic analysis of marine pollution (including solid waste, plastics, sewage, industrial wastewater, and microplastics) and develop recommendations for a roadmap to control marine pollution and marine waste management. The study will inform the first-of-its-kind PLEASE project to combat plastic pollution ending up in rivers and seas. PROBLUE is a World Bank-administered multi-donor trust fund that supports the sustainable and integrated development of marine and coastal resources in healthy oceans.

Snapshot 5: The Sustainable Development Goals and Solid Waste

The Sustainable Development Goals (SDGs) are a set of goals adopted by all United Nations Member States in 2015 towards the achievement of the 2030 Agenda for Sustainable Development.

Recognizing that ending poverty goes hand-in-hand with strategies to improve health and education, reduce inequality, stimulate economic growth, tackle climate change, and preserve biodiversity, the Member States adopted 17 goals and 169 targets which build on the previous Millennium Development Goals (MDGs).

On the face of it, four goals are directly related to solid waste, including in mountainous regions:

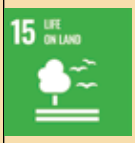
- Goal 11: Sustainable Cities and Communities
  - By 2030, reduce the adverse per capita environmental impact of cities, including paying special attention to air quality and municipal and other waste management.
- Goal 12: Responsible Consumption and Production
  - By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses.
  - By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment.
  - By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.
- Goal 14: Life Below Water
  - By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution.
- Goal 15: Life on Land
  - By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development.

All SDGs are related to waste in some way. It is imperative that the negative impact of solid waste on human health and the environment, and the positive impact that solid waste management can have on livelihoods and communities be considered for these SDGs to be met. Table SS5.1 outlines the relationship between solid waste and SDGs.

Table SS5.1: Relationship between SDGs and solid waste

SDG	Link to solid waste
	• Provide livelihood opportunities to millions in the informal sector • Provide employment opportunities along the SWM chain e.g., in waste collection, recycling, treatment, and disposal
	• Ending food waste will provide more access to poor and vulnerable populations • Any leftover food waste can be used as animal feed or for other uses
	• Eliminating open burning and indiscriminate dumping of waste decreases air, surface water, ground water, and soil pollution • Better human health from less air pollution
	• Promote opportunities to create awareness and the need for sustainable development • Promote indigenous, grassroots, locally-driven technologies to manage SWM • Provide training and awareness for solid waste workers (informal and formal) and officials
	• Promote more employment opportunities for women
	• Improve water quality by keeping waste out of water bodies • Dumping waste in water bodies, especially in mountain areas, should be banned in order to protect water-related ecosystems
	• Use biodegradable waste to provide cooking fuel and electricity from biomethanation/anaerobic digestion
	• Job creation along the SWM chain • Entrepreneurship opportunities from sorting, upcycling, and reuse of waste resources
	• SWM sector can create and use innovative technologies to improve the system • Developing resilient infrastructure for waste protects the environment and human health for decades
	• Recognize that the informal sector plays a hugely important role in resource efficiency and sanitation • The poor and underprivileged are most harmed by ineffective waste practices
	• Proper SWM reduces the adverse environmental impact of cities • Managing waste properly could provide more green and public spaces for urban residents

Table SS5.1: Relationship between SDGs and solid waste (contd.)

	• Sustainable production automatically "designs out" waste • Responsible consumption reduces waste generated by users • Reduces pollution caused by indiscriminate use of resources and products • Recognize that waste is a resource
	• Eliminate open dumping of waste • Segregate biodegradable waste for specific uses e.g., composting or anaerobic digestion • Avoid any biodegradable waste going to landfill, or if not possible, then ensure landfill gas capture systems in place
	• Prevent plastic pollution in the oceans by improving waste collection practices on land • Protect marine life from ingesting and dying from plastic debris • Prevent adverse effects of microplastics as they move through the food chain
	• Ecosystems can only be protected if they are not polluted by waste • Mountain ecosystems are particularly important because they provide freshwater resources to millions of people, not only in mountain areas but also downstream
	• Inclusive societies can be truly inclusive when vulnerable populations receive the same SWM services as wealthier counterparts • Environmental justice includes the opportunity for everyone to have a safe and healthy place to live and work in. This includes access to proper SWM services
	• Mobilize financing, including through international support to developing countries, to improve SWM infrastructure and services • Enhance capacity building for SWM institutions through north-south and south-south cooperation, including data monitoring and accountability • Enhance access to SWM technology and innovation for knowledge sharing

Sources: Lenkiewicz 2016; UNDESA n.d.

Appendix 1: India Field Study: Waste Sampling Data Summary

The data collected during the waste sampling and qualitative surveys in Himachal Pradesh state in India as part of this project are presented here. Tables A1.1 and A1.2 provide a summary of the waste collected and sampled, while Tables A1.3-A1.5 and Figures A1.1-A1.3 provide a detailed compositional analysis of the waste samples, including various types of plastic.

It should be noted here that due to the relatively small sample size, these data should be used with caution when making generalizations about the waste generation or composition in Himachal Pradesh, its districts, or, broadly, in mountain areas of India.

Table A1.1: Waste quantity sampled at households and hotels in the India field study

Total sample	Total waste generation per day	Total waste generation per unit	Waste generation per person
73 households	109.84 kg	1.156 kg per household per day	0.344 kg per person per day
5 hotels	17.64 kg	3.527 kg per hotel per day	

Table A1.2: Composition of waste sampled at various locations in the India field study

Clusters	Readily biodegradable waste (kg)	Biodegradable waste (kg)	Non-biodegradable waste (kg)	Total waste (kg)
6 households (Kullu)	7.89	3.54	4.99	16.42
27 households (Manali)	22.30	9.20	13.30	44.79
5 hotels (Manali)	3.19	3.56	10.89	17.64
1 commercial area (Manali)	17.44	8.29	10.95	36.67
1 tourist spot (Manali)	2.77	2.17	2.87	7.81
1 dump site (Manali)	18.27	4.81	9.40	32.47
40 households (Dharamshala)	15.50	2.90	3.09	21.48
1 hotel waste collection vehicle (Dharamshala)	29.70	4.05	11.98	45.73
1 commercial area (Dharamshala)	9.65	1.36	4.96	15.97
1 tourist spot (Dharamshala)	0.00	2.38	5.02	7.40
1 dump site (Dharamshala)	22.15	8.11	13.01	43.27

Table A1.3: Average composition of waste samples in the India field study (%)

Waste Type	Household	Commercial	Hotel	Commercial + hotel	Tourist spots	Dump sites	Average
Biodegradable	56.39	52.37	41.37	46.08	21.34	52.84	46.50
Paper	9.27	7.53	7.09	7.28	16.99	6.11	9.26
Cardboard	4.65	7.48	5.67	6.45	9.80	6.15	6.36
Plastic	13.84	13.15	12.65	12.87	32.04	13.39	16.28
Glass	4.81	7.70	19.71	14.56	11.39	6.01	9.63
Metal	1.05	0.50	3.30	2.10	0.59	0.51	1.28
Wood	0.00	0.43	0.00	0.18	0.00	0.00	0.07
Rags/clothes	4.25	2.49	2.06	2.24	3.24	5.20	3.50
Inert (Sweeping)	3.75	8.09	1.35	4.24	4.61	6.76	4.54
E-Waste	0.16	0.27	0.00	0.12	0.00	0.00	0.09
Domestic hazardous	1.81	0.00	6.79	3.88	0.00	3.04	2.48
Total	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***

Note: Red circle denotes highest value in column

Figure A1.1: Average composition of waste samples from all sites in India (%)

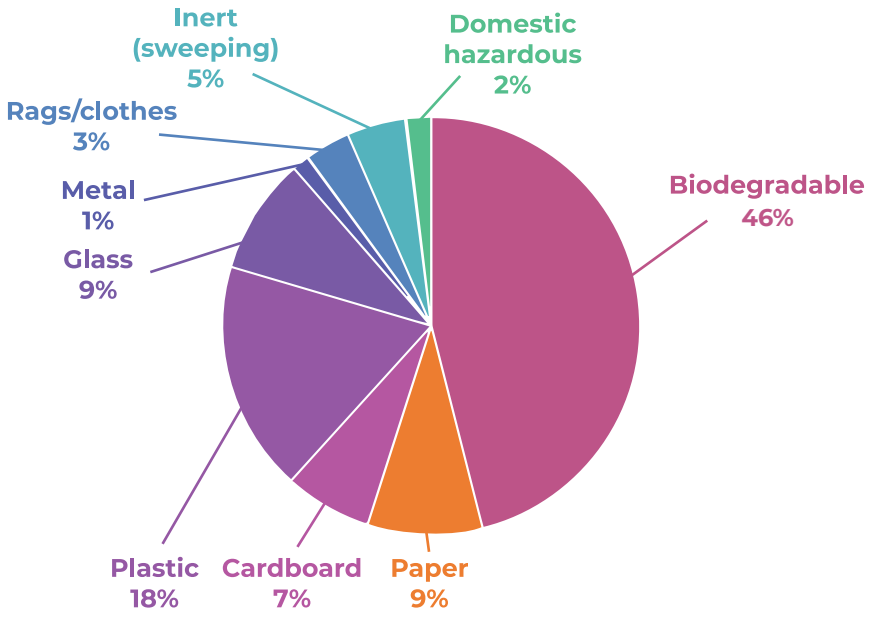


Table A1.4: Compositional analysis of plastic waste at sampled sites in the India field study (%)

Plastic Waste	Household	Commercial	Hotel	Commercial + hotel	Tourist spots	Dump sites	Average
PET	10.72	4.13	22.17	14.44	29.87	19.84	16.37
HDPE	15.07	2.36	10.42	6.96	20.35	6.32	11.83
PVC	1.59	0.00	0.00	0.00	0.11	0.00	0.55
LDPE	40.58	46.71	25.15	34.39	14.84	27.10	32.38
PP	2.84	7.89	2.85	5.01	3.85	10.95	4.76
PS	1.52	17.77	11.75	14.33	0.03	0.90	6.18
Multi-layered plastic	27.68	21.13	27.66	24.86	30.94	34.89	27.93
Total	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***

Note: Red circle denotes highest value in column

Figure A1.2: Composition of plastic waste at sampling sites in India (%)

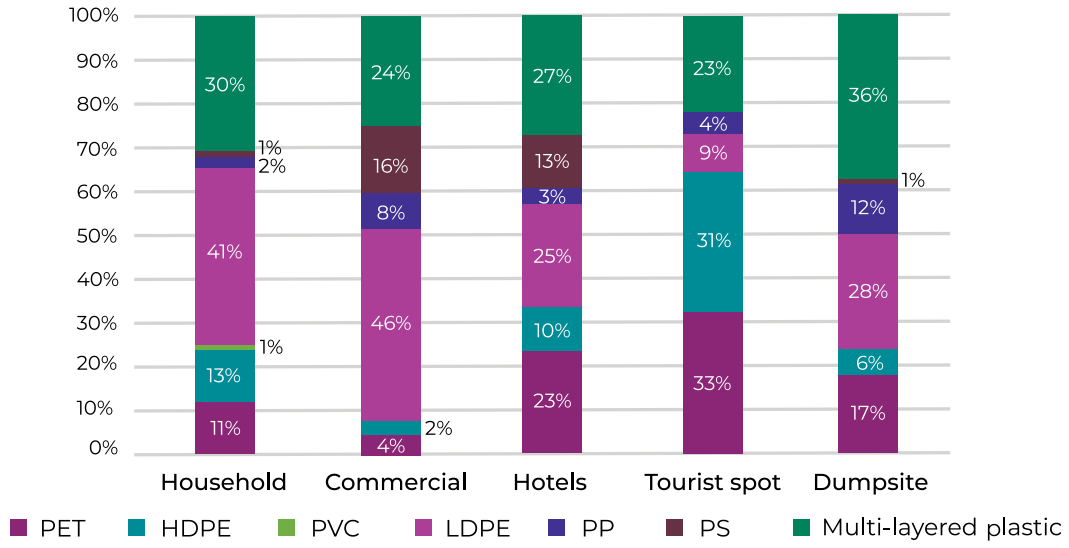


Figure A1.3: Average composition of plastic waste at all sampling sites in India (%)

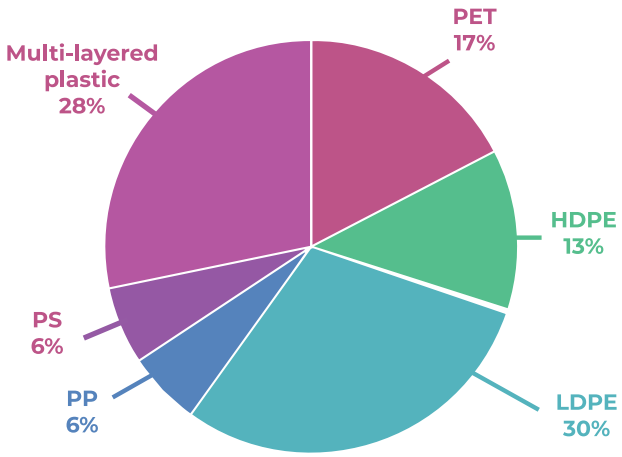


Table A1.5: Summary of plastic fractions collected at sampled sites in the India field study (%)

Plastics Fractions	Household (%)	Commercial (%)	Hotel (%)	Commercial + hotel (%)	Tourist spot (%)	Dump site (%)	Average (%)
Plastics (recyclable)	10.01	10.37	9.15	9.50	22.13	8.72	11.65
Plastics (non-recyclable)	3.83	2.78	3.50	3.15	9.92	4.67	4.64
Total	***13.84***	***13.15***	***12.65***	***12.65***	***32.04***	***13.39***	***13.39***

Appendix 2: Nepal Field Study: Waste Sampling Data Summary

The data collected during the waste sampling and qualitative surveys in the Annapurna Conservation Area (ACA) in Nepal as part of this project are presented here. Tables A2.1-A2.4 provide a summary of the waste collected and sampled, while Table A2.5 and Figures A2.1-A2.2 provide the compositional analysis of the waste samples.

It should be noted here that due to the relatively small sample size, these data should be used with caution when making generalizations about the waste generation or composition in ACA or, broadly, in mountain areas of Nepal.

Table A2.1: Waste quantity sampled at households and hotels for the Nepal field study (May 2019, off-peak tourist season)

Total sampled numbers	Total waste generation per day	Total waste generation per unit	Waste generation per person
275 households	84.75 kg	0.308 kg per household per day	0.160 kg per person per day
42 hotels	3.70 kg	0.088 kg per hotel per day	

Table A2.2: Composition of waste sampled at various locations for the Nepal field study (May 2019, off-peak tourist season)

Clusters	Readily biodegradable waste (kg/day)	Biodegradable waste (kg/day)	Non-biodegradable waste (kg/day)	Total waste (kg/day)
111 households (Chhomrong)	15.97	9.27	31.47	56.72
54 households (Ghandruk)	4.55	1.47	5.39	11.41
42 hotels (Ghandruk)	1.81	0.21	1.68	3.7
70 households (Kimche)	1.39	1.67	5.38	8.44
40 households (Syauli)	2.32	1.35	4.58	8.25

Table A2.3: Waste quantity sampled at households and hotels for the Nepal field study (September 2019, peak tourist season)

Total sampled numbers	Total waste generation per day	Total waste generation per unit	Waste generation per person
35 households	23.57 kg	0.673 kg per household per day	0.178 kg per person
36 hotels	154.71 kg	4.29 kg per hotel per day	

Table A2.4: Composition of waste sampled at various locations for the Nepal field study (September 2019, peak tourist season)

Clusters	Readily biodegradable waste (kg/day)	Biodegradable waste (kg/day)	Non-biodegradable waste (kg/day)	Total waste (kg/day)
35 households (Ghandruk)	15.86	1.75	5.96	23.57
36 hotels (Ghandruk)	81.88	5.45	67.38	154.71

Figure A2.1: Average composition of waste samples from households in Nepal (%)

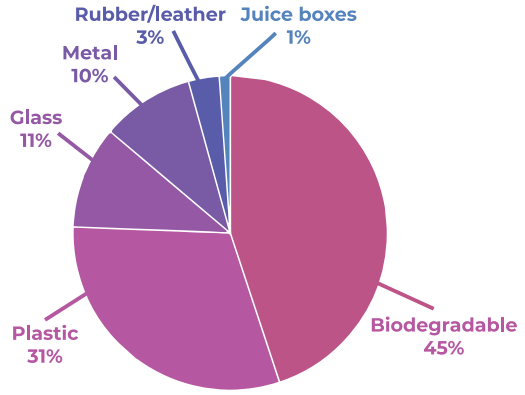


Figure A2.2: Average composition of waste samples from hotels in Nepal (%)

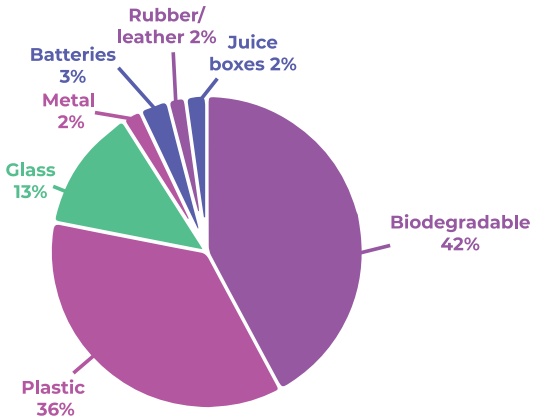


Table A2.5: Average composition of waste samples from Nepal (%)

Waste classification	Waste component	Household average	Hotel average	Total average
Readily-biodegradable waste	Kitchen waste	26	24	25
	Plant residue and fine organics	2	0	1
	Total: Readily-biodegradable waste	***28***	***24***	***26***
Biodegradable waste	Paper and cardboard	7	7	7
	Clothes, fabric, shoes	9	3	6
	Wood and straw	0	0	0
	Fur/hair, miscellaneous	0	0	0
	Total: Biodegradable waste	***16***	***10***	***13***
Non-biodegradable waste	Plastic bottles	7	4	6
	Plastic bags	6	17	11
	Glass	11	13	12
	Aluminum	10	2	6
	Cigarette butts	0	0	0
	Rubber/leather	3	2	3
	Batteries	0	3	2
	Bones/eggshells	0	8	4
	Plastic food wrappers	17	15	16
	Juice boxes	1	2	2
	Total: Non-biodegradable waste	***56***	***65***	***60***
Total		***100***	***100***	***100***

Note: Red circle denotes highest value in column

Appendix 3: Pakistan Field Study: Waste Sampling Data Summary

The data collected during the waste sampling and qualitative surveys in the Khyber Pakhtunkhwa province in Pakistan as part of this project are presented here. Tables A3.1 and A3.2 provide a summary of the waste collected and sampled, while Tables A3.3 and A3.4 and Figures A3.1-A3.2 provide the compositional analysis of the waste samples.

It should be noted here that due to the relatively small sample size, these data should be used with caution when making generalizations about the waste generation or composition in Khyber Pakhtunkhwa, its districts, or, broadly, in mountain areas of Pakistan.

Table A3.1: Waste quantity sampled at households and hotels for the Pakistan field study

Total sampled numbers	Total waste generation per day	Total waste generation per unit	Waste generation per person
60 households	251.64 kg	4.19 kg per household per day	0.775 kg per person per day
15 commercial entities	209.67 kg	13.98 kg per commercial entity per day	

Table A3.2: Composition of waste sampled at various locations for the Pakistan field study

Clusters	Readily biodegradable waste (kg)	Biodegradable waste (kg)	Non-biodegradable waste (kg)	Total waste (kg)
30 households for 8 days (Mingora)	977.11	113.66	434.14	1524.91
5 commercial entities for 8 days (Mingora)	743.36	47.25	158.67	949.28
30 households for 5 days (Abbottabad)	100.81	64.75	139.59	305.15
5 commercial entities for 5 days (Abbottabad)	44.50	22.81	54.80	122.11
5 commercial entities for 8 days (Nathia Gali)	381.27	102.44	48.99	532.71

Table A3.3: Composition of waste samples from sites in Abbottabad city and Nathia Gali in Abbottabad District (%)

Waste classification	Abbottabad						Nathia Gali
	Households (%)			Household average (%)	Commercial average (%)	Household + commercial average (%)	Commercial (%)
	Low-income	Middle-income	High-income				
Readily-biodegradable waste	25.05	34.41	31.28	30.24	37.77	34.01	71.63
Biodegradable waste	22.43	18.69	33.25	24.79	17.82	21.31	19.14
Non-biodegradable, non-recyclable waste	5.15	4.03	10.79	6.66	10.06	8.36	3.21
Non-biodegradable, recyclable waste	47.38	42.87	24.68	38.31	34.35	36.33	6.02
Total	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***

Note: Red circle denotes highest value in column

Table A3.4: Composition of waste samples from Mingora in Swat District (%)

Waste classification	Waste component	Households (%)			Household average (%)	Commercial (%)	Household + commercial average (%)
		Low-income	Middle-income	High-income			
Readily-biodegradable waste	Kitchen waste	64.37	60.14	59.16	61.22	68.02	64.62
	Grass and wood	0.70	1.92	6.04	2.89	7.75	5.32
	Total: Readily-biodegradable waste	***65.07***	***62.07***	***65.20***	***64.11***	***75.77***	***69.94***
Biodegradable waste	Paper (recyclable)	1.86	3.26	4.87	3.33	1.19	2.26
	Hair	0.00	0.00	0.00	0.00	0.00	0.00
	Textile	4.14	3.78	3.16	3.70	3.33	3.51
	Leather and rubber	0.15	0.45	0.15	0.25	0.34	0.30
	Total: Biodegradable waste	***6.16***	***7.49***	***8.19***	***7.28***	***4.86***	***6.07***

Table A3.4: Composition of waste samples from Mingora in Swat District (%) (contd.)

Waste classification	Waste component	Households (%)			Household average (%)	Commercial (%)	Household + commercial average (%)
		Low-income	Middle-income	High-income			
Non-biodegradable, non-recyclable waste	Plastic (non-recyclable)	8.09	8.01	9.40	8.50	8.40	8.45
	Paper (non-recyclable)	4.79	3.63	3.42	3.95	2.70	3.32
	Metal (non-recyclable)	0.00	0.35	0.03	0.13	0.40	0.27
	Glass (non-recyclable)	0.59	0.12	0.74	0.48	0.26	0.37
	Domestic hazardous wastes	1.02	0.96	0.47	0.82	0.06	0.44
	Tetra Pak	1.70	0.55	1.69	1.31	0.78	1.05
	Diapers	5.24	6.30	4.99	5.51	0.90	3.21
	Bones	0.37	0.45	0.47	0.43	2.84	1.63
	Inert (e.g., soil, ceramics)	1.77	0.41	0.25	0.81	1.52	1.17
	Sieve (particles)	3.20	3.94	3.09	3.41	0.41	1.91
	Sieve (fine)	0.63	3.12	0.05	1.27	0.35	0.81
	Total: Non-biodegradable, non-recyclable waste	***27.39***	***27.85***	***24.59***	***26.61***	***18.62***	***22.62***
Non-biodegradable, recyclable waste	Plastic (recyclable)	0.92	1.60	1.27	1.26	0.49	0.88
	Metal (recyclable)	0.13	0.42	0.33	0.29	0.21	0.25
	Glass (recyclable)	0.33	0.58	0.41	0.44	0.04	0.24
	Total: Non-biodegradable, recyclable waste	***1.38***	***2.59***	***2.02***	***1.99***	***0.74***	***1.37***
Total		***100.00***	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***

Note: Red circle denotes highest value in column

Figure A3.1: Composition of waste from households sampled in Abbottabad and Swat Districts (%)

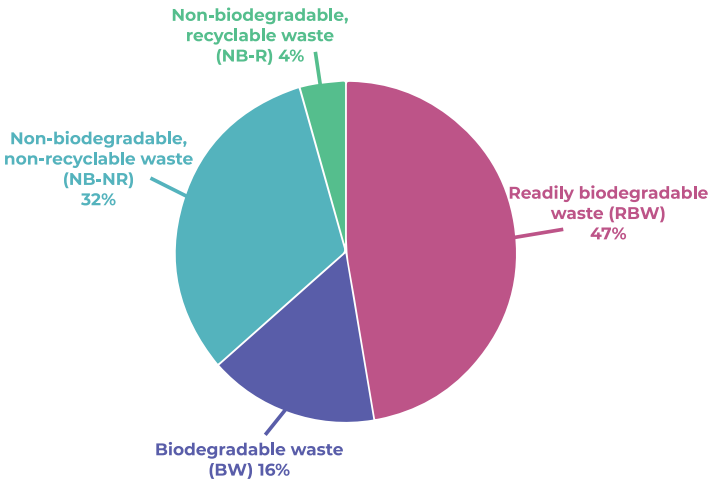
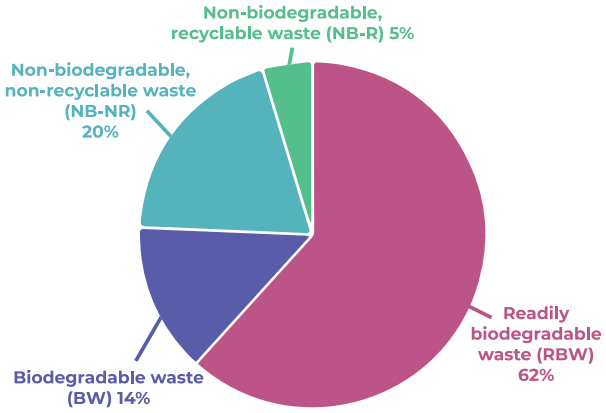


Figure A3.2: Composition of waste from commercial establishments sampled in Abbottabad and Swat Districts (%)



Appendix 4: India Solid Waste Management Rules 2016

The following text is an excerpt of the Solid Waste Management Rules 2016 in India that are applicable to all local authorities, whether in the plains or hilly/mountain areas of the country. The rules relate to creating solid waste management plans, setting user fees, integrating the informal sector, waste disposal, training, and so on. The emphasis in bold has been added, but the text is verbatim.

15. Duties and responsibilities of local authorities and village Panchayats of census towns and urban agglomerations.- The local authorities and Panchayats shall,-

(a) **prepare a solid waste management plan** as per state policy and strategy on solid waste management within six months from the date of notification of state policy and strategy and submit a copy to respective departments of State Government or Union territory Administration or agency authorised by the State Government or Union territory Administration;

(b) arrange for **door to door collection of segregated solid waste** from all households including slums and informal settlements, commercial, institutional and other non residential premises. From multi-storage buildings, large commercial complexes, malls, housing complexes, etc., this may be collected from the entry gate or any other designated location;

(c) establish a system to **recognise organisations of waste pickers** or informal waste collectors and promote and establish a system for integration of these authorised waste-pickers and waste collectors to facilitate their participation in solid waste management including door to door collection of waste;

(d) facilitate **formation of Self Help Groups**, provide identity cards and thereafter encourage integration in solid waste management including door to door collection of waste;

(e) **frame bye-laws** incorporating the provisions of these rules within one year from the date of notification of these rules and ensure timely implementation;

(f) prescribe from time to time **user fee** as deemed appropriate and collect the fee from the waste generators on its own or through authorised agency;

(g) direct waste generators **not to litter** i.e throw or dispose of any waste such as paper, water bottles, liquor bottles, soft drink canes, tetra packs, fruit peel, wrappers, etc., or burn or burry waste on streets, open public spaces, drains, waste bodies and to segregate the waste at source as prescribed under these rules and hand over the segregated waste to authorised the waste pickers or waste collectors authorised by the local body;

(h) **setup material recovery facilities or secondary storage facilities** with sufficient space for sorting of recyclable materials to enable informal or authorised waste pickers and waste collectors to separate recyclables from the waste and provide easy access to waste pickers and recyclers for collection of segregated recyclable waste such as paper, plastic, metal, glass, textile from the source of generation or from material recovery

facilities; Bins for storage of bio-degradable wastes shall be painted green, those for storage of recyclable wastes shall be printed white and those for storage of other wastes shall be printed black;

(i) establish waste deposition centres for **domestic hazardous waste** and give direction for waste generators to deposit domestic hazardous wastes at this centre for its safe disposal. Such facility shall be established in a city or town in a manner that one centre is set up for the area of twenty square kilometers or part thereof and notify the timings of receiving domestic hazardous waste at such centres;

(j) ensure safe **storage and transportation of the domestic hazardous waste** to the hazardous waste disposal facility or as may be directed by the State Pollution Control Board or the Pollution Control Committee;

(k) **direct street sweepers not to burn tree leaves** collected from street sweeping and store them separately and handover to the waste collectors or agency authorised by local body;

(l) **provide training on solid waste management** to waste-pickers and waste collectors;

(m) collect waste from vegetable, fruit, flower, meat, poultry and fish market on day to day basis and promote setting up of **decentralised compost plant or bio-methanation plant** at suitable locations in the markets or in the vicinity of markets ensuring hygienic conditions;

(n) collect separately **waste from sweeping of streets,** lanes and by-lanes daily, or on alternate days or twice a week depending on the density of population, commercial activity and local situation;

(o) set up **covered secondary storage facility for temporary storage of street sweepings** and silt removed from surface drains in cases where direct collection of such waste into transport vehicles is not convenient. Waste so collected shall be collected and disposed of at regular intervals as decided by the local body;

(p) **collect horticulture, parks and garden waste separately** and process in the parks and gardens, as far as possible;

(q) **transport segregated bio-degradable waste to the processing facilities** like compost plant, bio-methanation plant or any such facility. Preference shall be given for on site processing of such waste;

(r) **transport non-bio-degradable waste to the respective processing facility** or material recovery facilities or secondary storage facility;

(s) **transport construction and demolition waste** as per the provisions of the Construction and Demolition Waste management Rules, 2016;

(t) **involve communities** in waste management and promotion of home composting, bio-gas generation, decentralised processing of waste at community level subject to control of odour and maintenance of hygienic conditions around the facility;

(u) **phase out the use of chemical fertilizer** in two years and use compost in all parks, gardens maintained by the local body and wherever possible in other places under its jurisdiction. Incentives may be provided to recycling initiatives by informal waste recycling sector.

(v) facilitate construction, operation and maintenance of **solid waste processing facilities** and associated infrastructure on their own or with private sector participation or through any agency for optimum utilisation of various components of solid waste adopting suitable technology including the following technologies and adhering to the guidelines issued by the Ministry of Urban Development from time to time and standards prescribed by the Central Pollution Control Board. Preference shall be given to decentralised processing to minimize transportation cost and environmental impacts such as-

- a) Bio-methanation, microbial composting, vermi-composting, anaerobic digestion or any other appropriate **processing for bio-stabilisation of biodegradable wastes**;
- b) **Waste to energy processes** including refused derived fuel for combustible fraction of waste or supply as feedstock to solid waste based power plants or cement kilns;

(w) undertake on their own or through any other agency construction, operation and maintenance of **sanitary landfill** and associated infrastructure as per Schedule 1 for disposal of residual wastes in a manner prescribed under these rules;

(x) make adequate **provision of funds for capital investments** as well as operation and maintenance of solid waste management services in the annual budget ensuring that funds for discretionary functions of the local body have been allocated only after meeting the requirement of necessary funds for solid waste management and other obligatory functions of the local body as per these rules;

(y) make an application in Form-I for grant of **authorisation for setting up waste processing, treatment or disposal facility**, if the volume of waste is exceeding five metric tones per day including sanitary landfills from the State Pollution Control Board or the Pollution Control Committee, as the case may be;

(z) submit application for renewal of authorisation at least sixty days before the expiry of the validity of authorisation;

(za) prepare and submit annual report in Form IV on or before the 30th April of the succeeding year to the Commissioner or Director, Municipal Administration or designated Officer;

(zb) the annual report shall then be sent to the Secretary -in-Charge of the State Urban Development Department or village panchayat or rural development department and to the respective State Pollution Control Board or Pollution Control Committee by the 31st May of every year;

(zc) **educate workers** including contract workers and supervisors for door to door collection of segregated waste and transporting the unmixed waste during primary and secondary transportation to processing or disposal facility;

(zd) ensure that the operator of a facility provides **personal protection equipment** including uniform, fluorescent jacket, hand gloves, raincoats, appropriate foot wear and masks to all workers handling solid waste and the same are used by the workforce;

(ze) ensure that provisions for setting up of **centers for collection, segregation and storage of segregated wastes, are incorporated in building plan** while granting approval of building plan of a group housing society or market complex; and

(zf) frame bye-laws and prescribe criteria for levying of **spot fine for persons who litters** or fails to comply with the provisions of these rules and delegate powers to officers or local bodies to levy spot fines as per the bye laws framed; and

(zg) **create public awareness through information, education and communication campaign** and educate the waste generators on the following; namely:-

- (i) not to litter;
- (ii) minimise generation of waste;
- (iii) reuse the waste to the extent possible;
- (iv) practice segregation of waste into bio-degradable, non-biodegradable (recyclable and combustible), sanitary waste and domestic hazardous wastes at source;
- (v) practice home composting, vermi-composting, bio-gas generation or community level composting;
- (vi) wrap securely used sanitary waste as and when generated in the pouches provided by the brand owners or a suitable wrapping as prescribed by the local body and place the same in the bin meant for non- biodegradable waste;
- (vii)storage of segregated waste at source in different bins;
- (viii) handover segregated waste to waste pickers, waste collectors, recyclers or waste collection agencies; and
- (ix) pay monthly user fee or charges to waste collectors or local bodies or any other person authorised by the local body for sustainability of solid waste management.

(zh) **stop land filling or dumping of mixed waste** soon after the timeline as specified in rule 23 for setting up and operationalisation of sanitary landfill is over;

(zi) **allow only the non-usable, non-recyclable, non-biodegradable, non-combustible and non-reactive inert waste and pre-processing rejects and residues from waste processing facilities to go to sanitary landfill** and the sanitary landfill sites shall meet the specifications as given in Schedule-I, however, every effort shall be made to recycle or reuse the rejects to achieve the desired objective of zero waste going to landfill;

(zj) **investigate and analyse all old open dumpsites and existing operational dumpsites** for their potential of bio- mining and bio-remediation and wheresoever feasible, take necessary actions to bio-mine or bio-remediate the sites;

(zk) in absence of the potential of bio-mining and bio-remediation of **dumpsite, it shall be scientifically capped** as per landfill capping norms to prevent further damage to the environment.

Source: India, MoEFCC 2016

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Korea Green Growth Trust Fund

The Korea Green Growth Trust Fund is a partnership between the World Bank Group and the Republic of Korea, established in 2011 to support client countries as they shift to green development path. Both partners share a common goal to reduce poverty and promote shared economic prosperity in an environmentally responsible and socially inclusive way.

The Trust Fund finances on-the-ground programs as well as knowledge exchange activities, and to date has approved 144 programs in the urban, transport, information and communication technology, energy, environment, water, climate and agriculture sectors. Based on strong performance as well as increasing demand for collaborative development implementation programs, the fund has grown from $40 million to $138 million to support World Bank Group programs through 2026.

Supporting the Development of Sustainable Solid Waste Management Strategies for the Mountainous Regions of India, Nepal and Pakistan

The *Technical Guidance Report: Sustainable Solid Waste Management in Mountain Areas of India, Nepal, and Pakistan* summarizes the key findings and current understanding of mountain waste in the three countries. It provides an overview of the unique issues faced in the Himalayan region through a comparative analysis of solid waste management issues faced by each country. Based on the field study conducted for this project, as well as on experience and observations, recommendations are presented as a framework of overarching approaches with specific, implementable actions not only to improve current SWM practices, but also to mitigate the negative impact of solid waste in mountain regions. The actions are presented in a phased manner, considering that implementation of a mountain waste plan or policy may progress according to different time frames in different countries. The report concludes with suggested areas of World Bank and donor engagement to promote sustainable SWM in mountain regions.

Other Publications in this Study:

India: Sustainable Solid Waste Management in Mountain Areas

Nepal: Sustainable Solid Waste Management in Mountain Areas

Pakistan: Sustainable Solid Waste Management in Mountain Areas

Good Practice Options for Sustainable Solid Waste Management in Mountain Areas of India, Nepal, and Pakistan

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