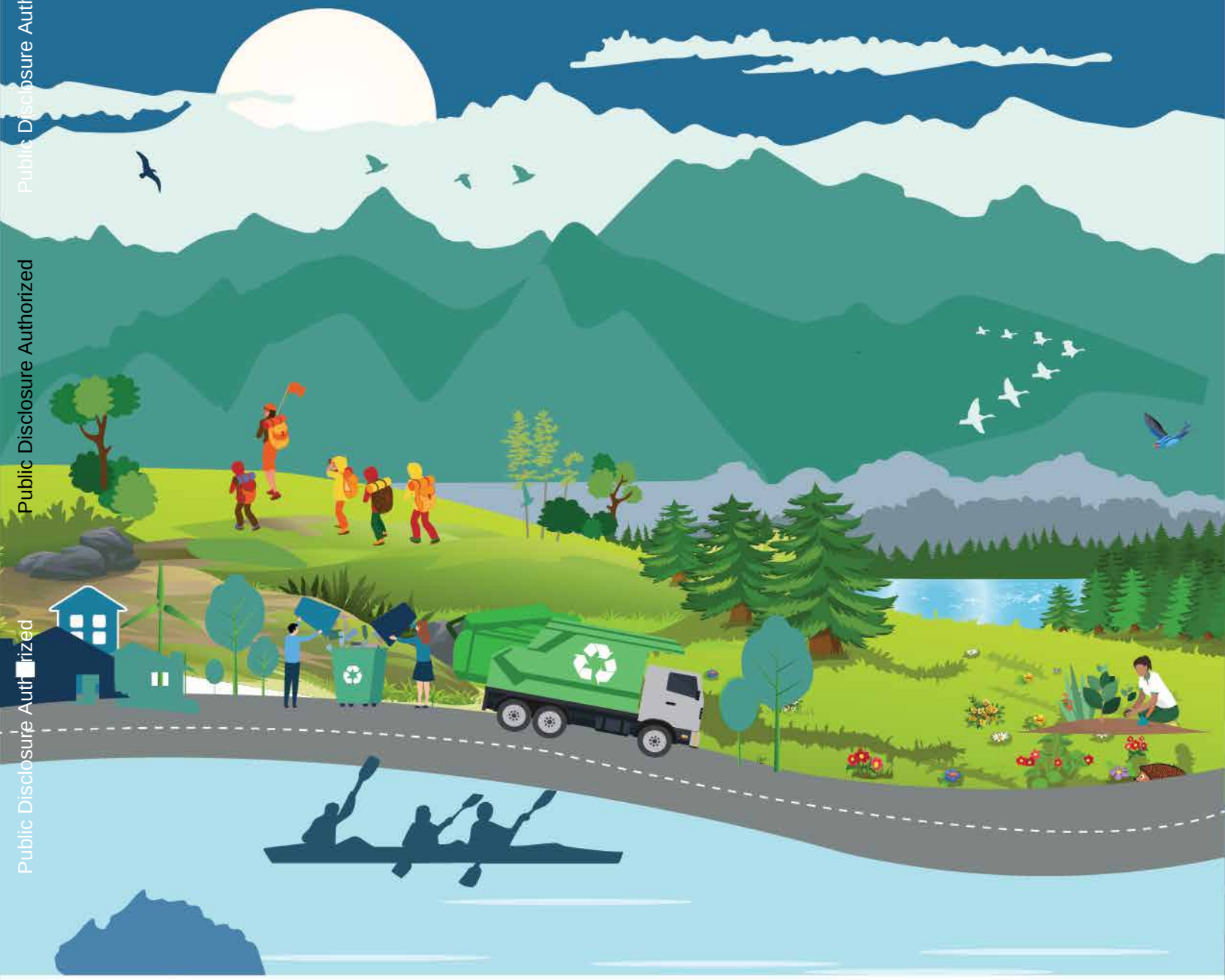
India:
Sustainable Solid Waste Management in Mountain Areas



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

India: Sustainable Solid Waste Management in Mountain Areas

January, 2021

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

India: Sustainable Solid Waste Management in Mountain Areas
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 India, 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, including ICLEI, during their field visit to India. 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 Swati Singh Sambyal, local resource person in India. Farahnaz Zahidi Moazzam provided valuable assistance in preparing the report for publication.

The team gratefully acknowledges feedback on the report from R.D. Dhiman, IAS *(Additional Chief Secretary, Government of Himachal Pradesh, Shimla),* D.C. Rana, IAS *(Director, Department of Environment, Science & Technology, Government of Himachal Pradesh, Shimla*) and his team, Parveen Gupta *(Additional Director),* and Suresh C. Attri *(Principal Scientific Officer (Environment).*

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

ASA	Advisory Services and Analytics
C&D	Construction and demolition
CBO	Community-based organization
CPCB	Central Pollution Control Board
CSR	Corporate social responsibility
ENB	Environment, Natural Resources, and Blue Economy
ENCORE	Enhancing Coastal Ocean Resource Efficiency
EPR	Extended producer responsibility
GBPIHED	G.B Pant Institute of Himalayan Environment and Development
GDP	Gross domestic product
GSDP	Gross state domestic product
HDPE	High-density polyethylene
ICIMOD	International Centre for Integrated Mountain Development
IHR	Indian Himalayan Region
ILM	Integrated landscape management
ISWM	Integrated solid waste management
K-eco	Korea Environment Corporation
kg	Kilogram
KGGTF	Korea Green Growth Trust Fund
LDPE	Low-density polyethylene
LNG	Liquefied natural gas
MCLLMP	Meghalaya Community Led Landscape Management Project
MDB	Multilateral development bank
MNRE	Ministry of New and Renewable Energy, Government of India
MoEF	Ministry of Environment and Forests, Government of India
MoEFCC	Ministry of Environment, Forest and Climate Change, Government of India
MoHUA	Ministry of Housing and Urban Affairs, Government of India
MoUD	Ministry of Urban Development, Government of India

MSW	Municipal solid waste
NAPCC	National Action Plan on Climate Change
NEERI	National Environment Engineering and Research Institute
NGO	Non-governmental organization
NGT	National Green Tribunal
PET	Polyethylene terephthalate
PforR	Program-for-results
PLEASE	Plastic Free Rivers and Seas for South Asia
PP	Polypropylene
PPP	Public-private partnership
PS	Polystyrene
PVC	Polyvinyl chloride
RDF	Refuse-derived fuel
SAR	South Asia Region
SAWI	South Asia Water Initiative
SBM	Swachh Bharat Mission
SBMU	Swachh Bharat Mission – Urban
SHG	Self-help group
SLB	Service level benchmarks
SPCB	State Pollution Control Board
sq. km.	Square kilometers
SRF	Solid recovered fuel
SWM	Solid waste management
ULB	Urban local body
UNFCCC	United Nations Framework Convention on Climate Change

Currency Units & Exchanges Rates

Currency Units	Exchange Rates (Effective as of December 27, 2020)	
Indian Rupee (Rs)	$1 = Rs 73.59	Rs 1 = $0.01
All dollar amounts are US dollars unless otherwise indicated.		

Executive Summary

India, the second largest country in the world in terms of population, has a solid waste generation per capita rate lower than the global average; however, solid waste generation is rising exponentially. A rapidly increasing population, coupled with economic growth and urbanization, has led to an uncontrolled increase in waste generation in the country. Current waste management systems are lacking due to poor levels of public awareness, inadequate technical capacity, outdated and inadequate infrastructure, and a shortage of financing.

Overview of Solid Waste Management in India

Solid waste management (SWM) is a crucial issue in India. While estimates of municipal solid waste (MSW) generation vary widely, the country generates millions of tonnes of MSW annually. Waste collection rates also vary considerably, depending on type of area (for example, urban areas have higher collection rates compared

to rural areas where collection is practically non-existent) and even within cities (for instance, wealthier neighborhoods have more efficient and frequent collection compared to poorer areas and slums).

The government recognizes these challenges and has created a number of laws, rules, and guidelines since the early 2000s; however, implementation remains a challenge. For instance, although source segregation of MSW is required, few local governments have implemented it. Moreover, although the government mandates that MSW be disposed of in sanitary landfills, open dumping and open burning are still common and make up the primary method of MSW disposal.

Solid Waste Management in Mountain Areas of India

India is one of a handful of countries that has created SWM rules specific to hilly and mountain areas, which is forward-thinking and important, given that over 29 percent of the country may be classified as hilly or mountainous. While there is little supporting data available on the population living in hilly and mountain areas in the country, it is clear that these areas support millions of people directly or indirectly, by contributing to the livelihood of millions and providing potable water for domestic, agricultural, and industrial activities. Twelve states and union territories in India make up the Indian Himalayan Region (IHR) itself, which together have a population of roughly 50 million people.

Mountain areas present numerous challenges for sustainable 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 all settlements—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 as well as mountainous regions 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 mountain areas and eco-sensitive 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.

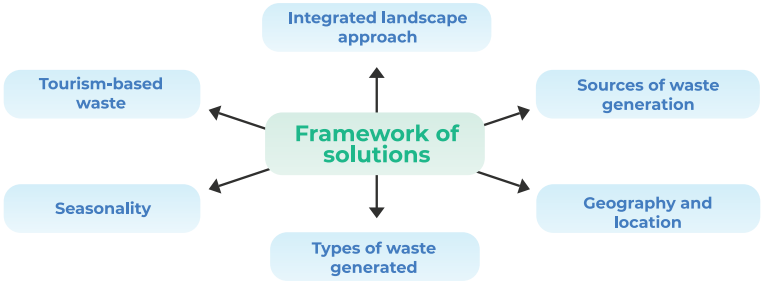
Table ES.1: Comparison of SWM challenges in mountain, non-mountain, and eco-sensitive areas

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	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	

Recommendations

This study recommends that solutions need to be steadily built on a framework in order to successfully and sustainably manage mountain waste. The framework consists of various, and related, factors shown in Figure ES.1.

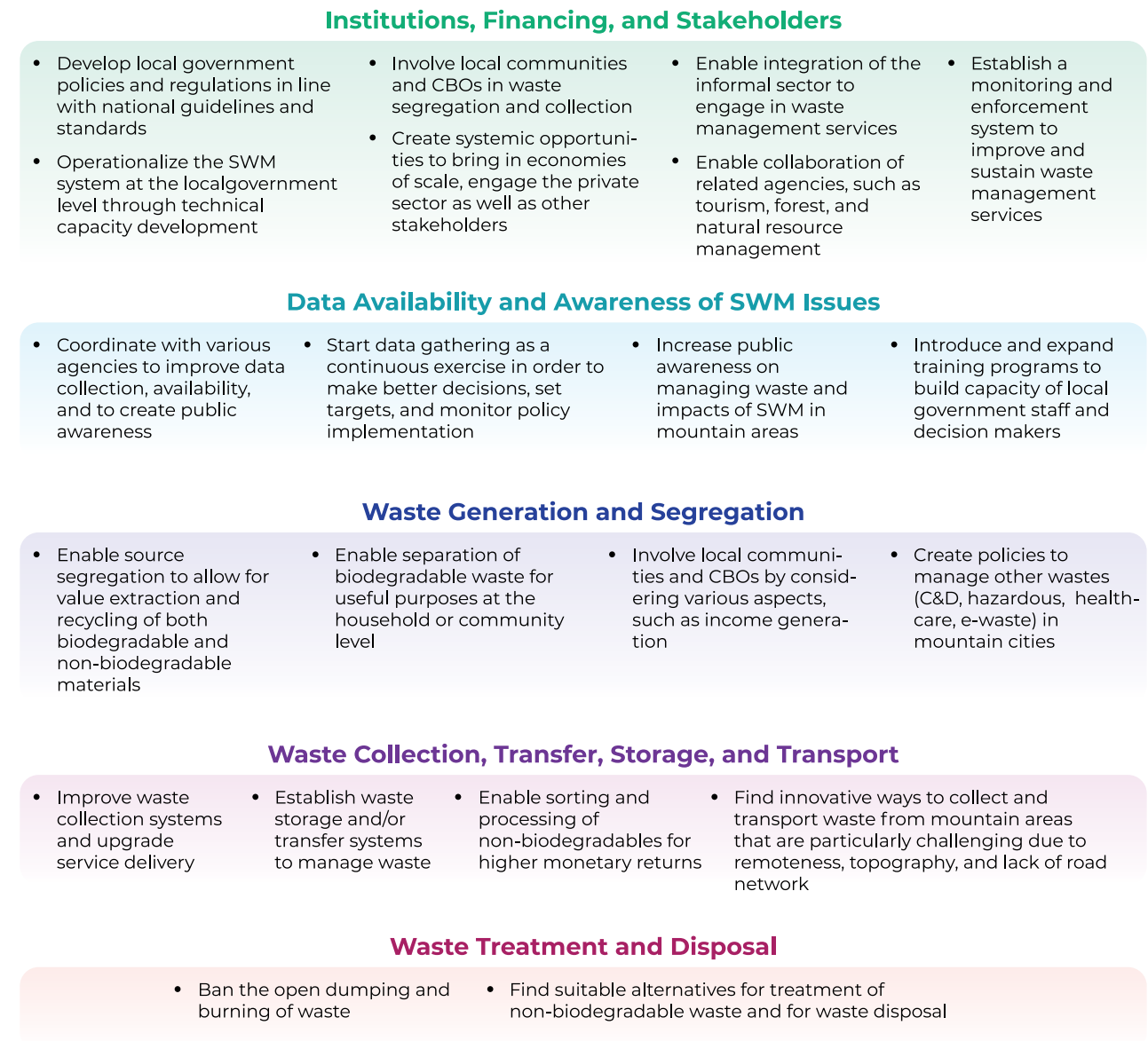
Figure ES.1: Framework of solutions on mountain waste management



This report presents various recommendations and implementable actions that may be adopted in a phased manner 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. Actions are applicable to all mountain settlement types, which includes mountain cities/towns, rural villages with road access, remote areas that are not connected by road, and high-altitude regions for trekking and mountaineering. Hence, actions would need to be selected based on the appropriate local scenario.

The proposed recommendations to manage solid waste in mountain areas are generally aligned with the integrated solid waste management framework and are summarized in Figure ES.2.

Figure ES.2: Summary of recommendations for sustainable SWM in mountainous regions



Background of this Regional Study on Sustainable SWM in Mountain Areas

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—*Supporting the Development of Sustainable Solid Waste Management Strategies for the Mountainous Regions of India, Nepal and Pakistan*—with 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 conducted in the Himalayan state of Himachal Pradesh. Two sites were visited in particular, Kullu-Manali and Dharamshala-McLeod Ganj-Triund, in June 2019. The field study provides a snapshot of the current SWM scenario as well as confirmation of waste trends that one would expect to see in mountain areas.

The data collected during the course of the field study was collected via a two-pronged approach. Firstly, waste sampling was undertaken to identify the types of waste being generated, as well as quantity and other factors. Secondly, qualitative surveys were carried out to understand the mindset and awareness level of residents, commercial establishments, and tourists in these areas.

The key findings from the field study are summarized in Figure ES.3.

Figure ES.3: Key findings from the India field study

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.

Three country-specific reports on Nepal, Pakistan, and this one on India—***India: Sustainable Solid Waste Management in Mountain Areas***—provide overviews of the 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 ***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 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 ***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, Nepal, Pakistan, 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

India is the second largest country in the world in terms of population, and is rapidly catching up to the People's Republic of China. Around 2027, it is estimated that India will have the distinction of being the largest country in the world by population (UNDESA 2019). At present, India's waste generation per capita is lower than the global average, but as India continues its rapid economic growth and more people rise to the middle class, it is expected that waste generation will rise substantially (Kaza et al. 2018).

A rapidly increasing population, coupled with sustained economic growth and urbanization, has led to an uncontrolled increase in waste generation in the country. Current solid waste management (SWM) systems are lacking due to poor levels of public awareness, inadequate technical capacity, outdated and inadequate infrastructure, and a shortage of financing.

Solid waste service delivery varies considerably in India. Rural areas receive almost no solid waste services compared to urban areas. Large cities have better systems, transportation vehicles, and more labor compared to smaller cities. Even within cities, there is a variation in service provision with wealthier neighborhoods receiving more frequent municipal solid waste (MSW) collection services and street sweeping compared to poorer areas and slums that receive no services.

1.1 Key Solid Waste Management Challenges in India

The Government of India has created a number of laws and rules related to SWM since the early 2000s, but the implementation of solid waste rules—in mountainous regions as well as the plains—remains a huge challenge. Some of these issues, which span the solid waste management chain, are described below.

Awareness of environmental and human health problems arising from waste mismanagement and motivation to improve the cleanliness and aesthetics of surrounding areas are severely lacking. Correspondingly, waste segregation tends to be poor for two main reasons: Households either disregard the need to segregate waste or there is no separate mechanism to collect the segregated waste, which discourages communities from continuing to segregate.

Another major challenge is the lack of provision of collection and transportation services. In mountain areas, this is even more exacerbated due to the poor condition of roads arising from landslides, water-logging due to heavy rainfall, and even the lack of road networks, thus posing numerous logistical challenges for waste management in mountain areas. Remote mountain communities typically have small populations that generate waste somewhat seasonally. Investment in transportation equipment and labor is thus exorbitant and rarely undertaken. As a result, MSW is commonly disposed of and burned in open spaces, dump sites, or near waterbodies. Even in large urban mountain areas, where basic collection services exist, most cities dispose of their waste in dumps located outside their administrative boundaries. These dump sites result in excessive groundwater pollution, greenhouse gas emissions from the decomposition of biodegradable waste, fire hazards, and pests, to name a few.

Markets for processed waste and incentives for waste processing and recycling exist on paper, but are sometimes hard to put into practice. Excessive paperwork, coordination with various government departments, and lack of steady supply of segregated material make it burdensome for entrepreneurs to enter into the waste processing sector in India. This is prevalent throughout India, irrespective of the topography of the region.

Over the past few decades, the Indian Himalayan Region (IHR) has experienced continued tourism growth, leading it to become one of the fastest growing economic sectors in India. For instance, Uttarakhand state at the foothills of the Himalayas has seen an increase of almost 65 percent in the number of tourists between 2006 and 2016, and tourism contributes to over 50 percent of the state GDP (Uttarakhand, DoT 2018). This is in line with the tourism sector in India being predicted to grow at an average annual rate of 7.9 percent from 2013 to 2023 (Gaur and Kotru 2018). But the IHR is not the only popular hill/mountain region in India. The Western and Eastern Ghats are dotted with numerous hill stations that are popular tourist destinations, many of which are facing problems from mass tourism.[1] For instance, in Ootacamund, the "Queen of the Hills" in the Nilgiris, tourism increased by 50 percent between 2014 and 2017 (Ramamoorthi and Kumar 2019).

Resource depletion and environmental degradation are common aspects of long-term tourism. They are global issues but also have an impact on a local scale. Tourism has been known to overburden an already strained system, be it by way of infrastructure, the impact on waste management (especially in low-income countries), as well as its impact on impovrished communities.

1 Hill stations are towns located at elevations approximately 1,000-2,500 meters above sea level. They were established during colonial times first as sanitoriums and then as refuges from the hot Indian summers. They are now popular tourist destinations.

Poverty generally tends to be 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 1.1 presents a poverty profile of India, comparing population below the poverty line in the country as a whole to the population in the Indian Himalayan Region (IHR), which comprises 11 states and two union territories.[2] In India almost 22 percent of the total population in the country lives below the poverty line, compared to almost 19 percent in the Himalayan region.

Table 1.1: Poverty profile of India and the IHR (2011/12)

Total population (millions)		Population below the poverty line (millions)		Population below the poverty line (%)	
Countrywide	**IHR**	**Countrywide**	**IHR**	**Countrywide**	**IHR**
1,210.57	165.98	269.78	34.72	21.92	18.88

Source: India, MoHA 2011b, RBI 2020

1.2 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 solid waste management 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, treatment, and proper 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, commercial establishments, and hotels in order to understand waste generation and composition in mountain areas. Moreover, given the importance of public awareness and individual behavior to improve SWM, 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 the three country-specific reports in this study.

2 The 11 mountain states are Arunachal Pradesh, Assam, Himachal Pradesh, Manipur, Meghalay, Mizoram, Nagaland, Tripura, Sikkim, Uttarakhand, and West Bengal.

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

Figure 1.1: Overview of field study 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

1.3 Publications in this Study

Five reports make up the set of publications in this study, which together serve to inform positive change in the SWM sector in mountain areas in the South Asia Region. Three country-specific reports on Pakistan, Nepal, and this one on India—*India: Sustainable Solid Waste Management in Mountain Areas*—provide overviews of the municipal SWM 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 *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 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 *Good Practice Options for Sustainable Solid Waste Management in Mountain Areas of India, Nepal, and Pakistan* report offers examples of successful implementation and coordination of SWM plans that have led to a 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.

1.4 Overview of this Report

Chapter 2 of this report discusses the current landscape of the SWM sector in India. It explores key solid waste data in India, such as MSW generation rates, composition, collection efficiencies, and treatment and disposal options. This chapter also features comparisons of these key indicators between India and the South Asian region, as well as globally. Furthermore, it provides an overview of key policies and laws relating to SWM. Lastly, the chapter discusses the role of the informal sector in India and how SWM is currently funded in the country.

In Chapter 3, the report investigates the current situation regarding SWM in the mountain areas of India. Further information regarding the parameters of the field study, such as which areas were chosen and why, are also discussed. The analysis of the quantitative data gathered from the waste sampling and a summary of the qualitative information gained from the survey are presented for further analysis.

Chapter 4 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-mountain regions. The chapter concludes with the various SWM challenges common in India's mountain areas.

Based on the SWM challenges specific to mountain areas described in the previous chapter, 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 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.

2. Overview of the Solid Waste Management Sector in India

The South Asian region, of which India is a part, generated 334 million tonnes of waste in 2016, including both urban and rural waste (Kaza et al. 2018). India ranks first in terms of both land area and population compared to the other seven countries in the region. It also ranks first in terms of total waste generated in the region, and second in waste generation per capita, after the Maldives (Kaza et al. 2018).

The data presented in this chapter outline the municipal solid waste (MSW) scenario in India and the current approach to solid waste management (SWM). From generation to the collection, treatment, and disposal of MSW, it is apparent that more needs to be done to protect against severe environmental and health-related threats to the country, its economy, and its people from mismanagement of the solid waste sector.

2.1 Municipal Solid Waste Generation and Segregation

Estimates of MSW generation in India vary widely. The World Bank estimates that over 277 million tonnes of MSW are generated in India each year (2016), equivalent to more than 750,000 tonnes per day (Kaza et al. 2018). The Central Pollution Control Board (CPCB), which is part of the Indian Ministry of Environment, Forest and Climate Change (MoEFCC), estimates that total generation was 54 million tonnes annually (2015), or approximately 144,000 tonnes per day (CPHEEO 2016a). According to current World Bank estimates, MSW in India will increase to approximately 390 million tonnes in 2030 and over 540 million tonnes in 2050 based on current urbanization and population growth rates (Kaza et al. 2018).

India's waste generation of 0.57 kg per person per day is below the global (0.74 kg per person per day) and slightly higher than the South Asian regional (0.52 kg per person per day) averages (Kaza et al. 2018). Table 2.1 shows the MSW generation figures for India, compared to both the global as well as regional averages, along with forecasted MSW generation values for 2030 and 2050. The table also provides current and estimated population trends for the country.

Table 2.1: Comparison of India's MSW generation and population to global and regional averages

Indicator	Global	South Asia	India
Waste generation, 2016 (million tonnes/year)	2,010	334.23	277.14
Waste generation per capita, 2016 (kg/person/year)	0.74	0.52	0.57
Waste generation, 2030 projected (million tonnes/year)	2,590	466.24	388.77
Waste generation, 2050 projected (million tonnes/year)	3,400	661.18	543.28
Total population, 2016 (millions)	7,424	1,771	1,325
Urban population, 2016 (millions)	4,036	587.08	439.49
Urban population growth (annual rate %)	2.02	2.51	2.32
Rural population, 2016 (millions)	3,387	1,184	885.01
Rural population growth (annual rate %)	0.16	0.63	0.49
Total population, 2030 projected (millions)	8,548	285	1,504
Total population, 2050 projected (millions)	9,733	2,293	1,639

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

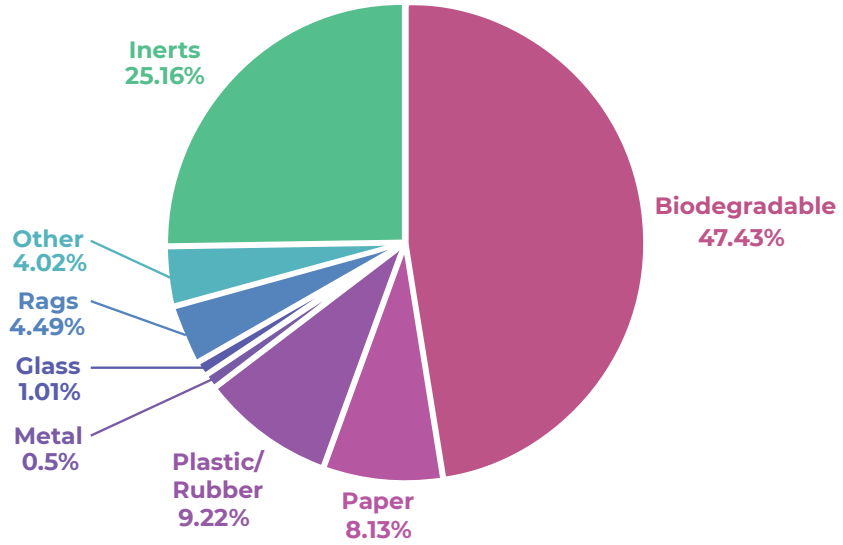
Large cities generate considerably larger quantities of MSW per person compared to smaller towns and villages. Hence, waste is growing at different rates across the country. According to *Not in My Backyard,* a book about SWM in India, MSW is increasing overall at a rate of five percent per year.

In general, waste segregation at source is not practiced by households. As per the *Swachh Survekshan*, an annual review of the state of SWM in urban areas in India, in 2019 about 40 percent of the administrative wards in Indian cities practiced source segregation (India, MoHUA 2019). Sorting of waste to remove the valuable recyclable fraction is often accomplished by the informal sector, both at community bins as well as at dump sites. Waste produced by households is usually transferred to community bins. Street sweepings and waste from nearby commercial enterprises are also left in these community bins (Kumar et al. 2009). The importance of the informal sector in segregating MSW for processing and recycling in India is discussed in Section 2.5.

2.2 Municipal Solid Waste Composition

The composition of MSW in India is shown in Figure 2.1. India is similar to other countries in the region in that MSW primarily constitutes biodegradable (organic) waste. Forty-seven percent of India's MSW comprises biodegradable waste (that is, kitchen and garden/green waste). The second largest category is inert waste, which consists of sand, rocks, rubble, ash, and so on. Plastic waste along with rubber makes up nine percent of the total waste generated (CPHEEO 2016b).

Figure 2.1: MSW composition in India (2005)



Source: CPHEEO 2016b

With changing lifestyles and food habits, and accessibility to markets, the composition of MSW in Indian cities has shown an increase not only in the consumption of paper, packaging, and plastics, but also in biodegradable waste. Driven by changing consumption patterns, per capita MSW generation has been growing by 1.3 percent annually in recent years (Joshi 2016). Table 2.2 shows the percentage changes in MSW composition in India between 1971 and 2005.

Table 2.2: Changes in MSW composition in India between 1971 and 2005 (%)

Waste type	1971	1995	2005
Paper	4.14	5.78	8.13
Plastics	0.69	3.90	9.22
Metals and Others	0.50	1.90	4.50
Glass	0.40	2.10	1.01
Rags	3.83	3.50	4.40
Ash and Fine Earth	49.20	40.30	25.16
Total Compostable Matter	41.24	41.80	47.40

Source: GHG Platform India, n.d.

2.3 Municipal Solid Waste Collection and Transport

MSW collection data for India is limited. According to the World Bank's *What a Waste 2.0–A Global Snapshot of Solid Waste Management to 2050* report, the MSW collection rate in urban areas is close to 80 percent, which matches data from the CPCB (Kaza et al. 2018, CPHEEO 2016a). According to the Indian Ministry of Housing and Urban Affairs (MoHUA), after the implementation of the *Swatch Bharat Abhiyan* or Clean India Mission (SBM), door-to-door collection was achieved in 76,459 of 84,458 target wards (approximately

91 percent) in urban areas in 2019. Door-to-door collection efficiency increased from 54 percent in 2017 to 94 percent in 2019 (India, SBMU 2017 and India, SBMU 2019).

Larger cities tend to have lower collection rates than smaller cities. Cities with populations over 5 million have an average collection rate of 68.5 percent compared to small cities with populations less than 1 million that have an average waste collection rate of 96.7 percent. Source segregation follows a similar trend: It is practiced in 38 percent of large cities and 54 percent of small cities in India (Ahluwalia and Patel 2018).

Modes of transportation for MSW in India include carts, hand rickshaws, compactors, trucks, tractors, trailers, and dumpers. In smaller towns such as those in Himachal Pradesh where the field study was conducted, trucks with a capacity of 5–9 tonnes are used without adequate cover systems. Stationary compactors, trollies, tippers, tempos, and tarpaulin-covered vehicles are also used for MSW transportation.

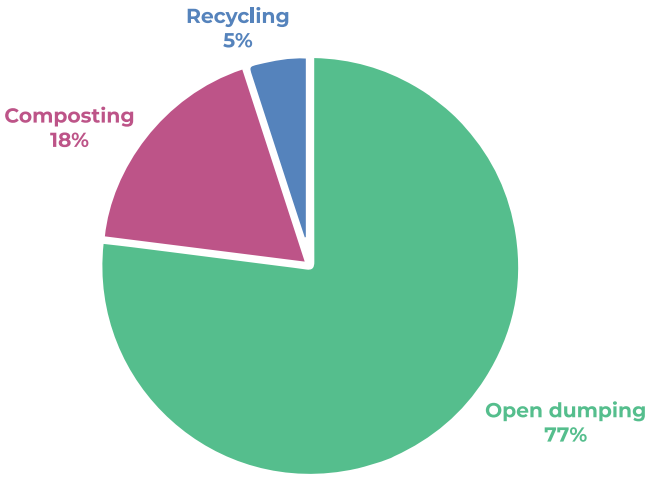
2.4 Municipal Solid Waste Treatment and Disposal

The amount of MSW processed or treated increased from 22.85 percent in 2017 to 60 percent in 2020 according to SBM assessments (India, SBMU 2017 and India, SBMU 2020). However, waste processing remains highly inadequate in a number of states, with less than 10 percent of the waste being processed in 10 states (CPCB 2017). The common treatment and disposal methods in India are shown in Figure 2.2 (Kaza et al. 2018).

According to recent data submitted by the states and union territories to the CPCB, in 2019 there were 3,159 dump sites spread across the country. Out of this, only 11 have been converted to sanitary landfills, which is equivalent to only 0.3 percent of the country having sanitary landfills (CPCB 2019).

Given that almost half of MSW generated in India comprises biodegradable waste, composting is a preferred treatment option in many small towns across the country, as it is relatively easy to operate and also inexpensive compared to other technologies. Refuse-derived fuel (RDF) and other incineration technologies are attempted by larger cities for the non-biodegradable and non-recyclable waste fraction. Smaller urban local bodies (ULBs) generally avoid these technologies due to lack of experience and capital investment. In 2014/15, 91 waste-to-energy technology projects had been initiated in India: 73 biogas, 12 RDF/pelletization, and six power plants (CPCB 2016b).

Figure 2.2: MSW treatment and disposal in India



Source: Kaza et al. 2018

Open dumping and the burning of waste pose long-term threats to the environment and to human health. Open dumping often results in odor issues as well as leachate leaking into, and thus contaminating, soil and groundwater. It also serves as a breeding ground for vector diseases such as malaria and dengue. Furthermore, unstable piles of waste material often result in landslides, not to mention the negative effect on surrounding property values.

Uncontrolled burning of waste in open areas is a significant source of carcinogens such as dioxins, furans, and black carbon, a short-lived climate pollutant that contributes to climate change (CCAC n.d.). Waste is often deliberately burned to recover recyclables or may start out on its own due to chemical reactions of combustible materials. As such, it contributes to air pollution and exacerbates health issues like respiratory diseases for nearby residents. Box 2.1 provides a brief description of municipal solid waste in the Indian Himalayan Region (IHR).

Box 2.1: SWM in the Indian Himalayan Region

MSW generation in the Indian Himalayan Region (IHR) is approximately 14,450 tonnes per day or over 5.2 million tonnes per year. Although mountain cities such as Shimla, Darjeeling, and Nainital have waste collection services, the majority of the waste is disposed of in open areas, including forests. According to the *Swachh Bharat Mission – Urban* (SBMU), in IHR states, 85 percent of door-to-door waste collection was achieved by early 2020 through the targeting of 7,985 wards. The states of Arunachal Pradesh, Mizoram, Sikkim, and Uttarakhand are the only Himalayan states that achieved 100 percent door-to-door waste collection by 2020. Thirty-eight percent of IHR states achieved 100 percent source segregation in the same time period. Relatively, the total waste processed is low across all IHR states, at 24 percent, as assessed under the *Swatch Bharat Abhiyan*.

MSW composition varies from place to place and is based on a number of local factors. Composition in IHR states shows a similar variation. Table B2.1.1 showcases the MSW composition of four IHR states in comparison to the national average (2016). Biodegradable waste ranges from 42 to 60 percent, paper ranges from 10 to 21 percent, and plastics from five to 21 percent.

Table B2.1.1: Comparison of MSW composition of four IHR states and national average, 2016 (%)

Composition	Meghalaya	Uttarakhand	Himachal Pradesh	Manipur	National Average
Biodegradable Waste	42.2	46.0	52.0	60.0	47.2
Garden/green waste	0.0	0.0	0.0	0.0	2.5
Wood	0.0	1.0	0.0	5.0	3.4
Paper and cardboard	21.0	3.0	24.0	10.0	8.9
Plastic	4.0	21.0	10.0	5.0	8.4
Glass	-	1.0	1.0	2.0	1.5
Metal	10.1	1.0	1.0	1.0	1.7
Rubber/leather	-	2.0	1.0	2.0	0.8
Rags/textile	10.0	4.0	4.0	5.0	3.7
Other	13.0	21.0	7.0	10.0	22.0

Sources: CPCB 2016a, CPCB 2018, calculations based on India, SBMU 2020

2.5 The Informal Sector in India

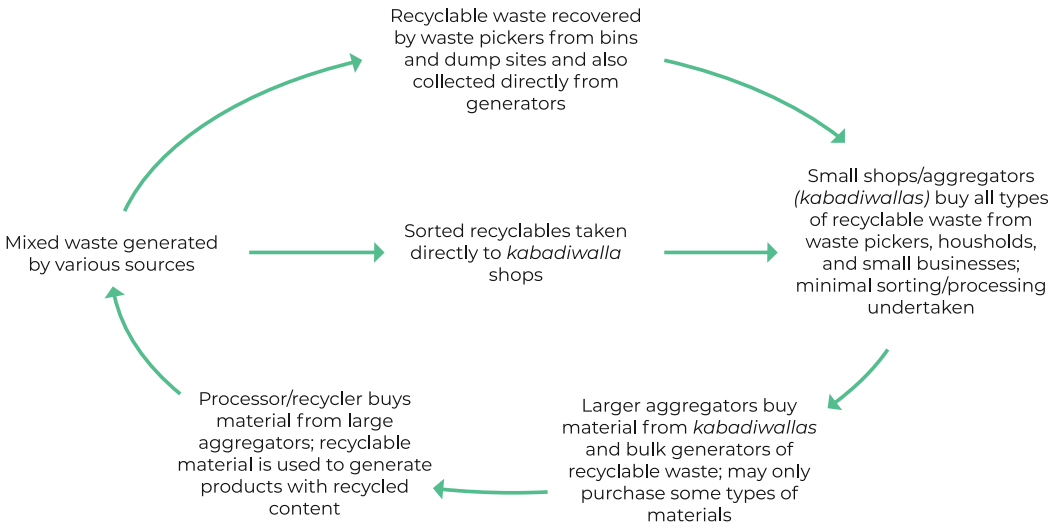
As is common in similar developing countries, the informal sector in India plays an important role in the collection and sorting of recyclable materials. While there is no official definition of an informal sector in waste management, it is broadly understood to be individuals or small businesses working in waste collection, trading, and recycling. These workers typically lack proper wages and benefits and work under poor conditions. Given the nature of their work, they are often considered unsanitary and are not respected for their roles in keeping cities free of trash, enabling recycling, and protecting the environment. This discrimination is prevalent in India as well. 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 workers are recognized by the public as playing a key role in keeping their cities clean and receive fixed salaries and benefits and have defined work hours.

Large numbers of people work in the informal sector scattered throughout India, particularly in urban areas. However, official and countrywide data on the informal sector in India does not exist. Given the nature of the work, it is hard to quantify how many workers are occupied in this sector, how much recyclable material they recover from waste, and how much the value of the recyclable material is. Nevertheless, it is estimated that thousands of people are informally employed in this sector in each city across India. For instance, in Pune, a city of 3.1 million people (2011), approximately 9,000 waste pickers work in the informal sector, almost double the number of employees formally employed in the sector (Gupta 2012).

Figure 2.3 illustrates the informal waste sector process in India. Waste pickers visit door-to-door and purchase reusable or recyclable material, which they then sell to nearby scrap shops or *kabadiwalas*. They also sort through waste dumped by the road side or at dump sites to find valuable recyclable material, which is then sold to small shops or aggregators known as *kabadiwallas*. Some waste pickers even have their own carts or tricycles which make it easier to collect large amounts of material from a particular neighborhood. Recyclable materials are also taken by generators (for example, households) directly to *kabadiwalla* shops. At dump sites, waste is sometimes intentionally ignited in order to recover recyclables. This is harmful not only to the workers and residents who work and live in the surrounding areas but also to the global climate.

Kabadiwalla 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: paper, cardboard, newspaper, plastic, metal, and glass. This is then sold to larger aggregators, who also typically buy waste from bulk generators of recyclable waste. 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 large processors or recyclers who then process the material into new products (Hande 2019).

Figure 2.3: Schematic representation of the informal sector in India



2.6 Governance and Policy

India has a long history of environmental laws, beginning in the 1970s. But it was not until the plague outbreak in Surat, Gujarat, in 1994, that waste management gained momentum. In response to the plague, Surat implemented a massive infrastructure overhaul and fines for littering in addition to transforming sanitation services, such that in just two years, it was judged the cleanest city in India. The policy and legislative framework for SWM in India is summarized in Table 2.3.

India is one of a few countries that has created SWM rules specific to hilly and mountain areas, which is important given that over 29 percent of the country may be classified as hilly or mountainous. Box 2.2 provides the text of the rules pertaining specifically to hilly and mountain areas as published by MoEFCC in the Gazette of India (India, MoEFCC 2016). In addition, the Indian Ministry of Urban Development (MoUD) also published guidelines relating to waste collection in hilly areas in its *Municipal Solid Waste Management Manual - Part II: The Manual* in 2016 (CPHEEO 2016b).

Table 2.3: Summary of national policies, programs, and legislation related to SWM in India

1986	**Environmental Protection Act** was the umbrella act as well as the primary legislation for environmental protection in India. It enabled the central government to take measures to protect and improve the environment and to prevent, control, and abate environmental pollution. Importantly, it also embraced the polluter pays principle.
1992	The **74th Constitutional Amendment** gave statutory provisions to local administrative bodies as the third level of administration (the first two being the central and state governments); responsibility for MSW collection, treatment, and disposal was transferred from the state to local government at this time.
1994	**Water (Prevention and Control of Pollution) Act** prohibited the discharge of pollutants into water bodies. Also prescribed penalties for non-compliance.
1995	**J.S. Bajaj Committee** was constituted by the Planning Commission, which proposed a range of recommendations including source segregation, primary collection, and user fees.

Table 2.3: Summary of national policies, programs, and legislation related to SWM in India (contd.)

2000	The **Municipal Solid Wastes (Management and Handling) Rules** were released by the Ministry of Environment and Forests (MoEF) and made applicable to every municipal authority responsible for collection, segregation, storage, transportation, processing, and disposal of MSW.
2001	**Batteries (Management and Handling) Rules** regarding lead acid batteries laid out the responsibilities of manufacturers, importers, dealers, recyclers, and consumers.
2006	**National Environment Policy** proposed strengthening the capacities of local bodies for segregation, recycling, and reuse of MSW; giving legal recognition to the informal sector for collection and recycling, especially to enhance access to institutional finance and technology; and implementing viable PPPs for operating hazardous and non-hazardous waste facilities.
2008	**National Urban Sanitation Policy** launched by the Ministry of Urban Development (MoUD), emphasized the need for city-wide sanitation plans through institutional strengthening, awareness generation, behavioral changes, and pro-poor approaches.
2008	**Service Level Benchmarks** (SLBs) were standard performance parameters launched by the MoUD to increase accountability for service delivery. SLBs were created for four basic urban services: water supply, sewage, SWM, and storm water drainage.
2008	**National Mission on Sustainable Habitat** under the National Action Plan on Climate Change (NAPCC) was launched to create sustainable urban habitat with improved management of solid waste through increased recycling and focuses on developing waste-to-energy technologies.
2010	**National Green Tribunal Act** "for the effective and expeditious disposal of cases relating to environmental protection" (India, MoL&J 2010). It allowed for compensation for environmental damage.
2011	**Plastic Waste (Management and Handling) Rules** created by the MoEF, these were nullified in 2016 when new rules were adopted.
2011	**Bio-Medical Waste (Management and Handling) Rules** adopted in 2011 but were amended in 2016.
2011	**E-waste (Management & Handling) Rules** were superseded by new rules in 2016 by the MoEF, renamed the Ministry of Environment, Forest and Climate Change (MoEFCC).
2014	***Swachh Bharat Abhiyan*** or **Clean India Mission (SBM),** a countrywide campaign from 2014 to 2019, to eliminate open defecation and improve SWM. In rural areas *SBM-Gramin* was financed and monitored through the Ministry of Drinking Water and Sanitation, whereas *SBM-Urban* was overseen by the Ministry of Housing and Urban Affairs (MoHUA).
2015	**National Smart Cities Mission**, an urban renewal program run by the MoUD to develop smart cities across the country. The union ministry works in collaboration with state governments to complete this project by 2023.[3]
2016	**The Solid Waste Management Rules** adopted under the Environmental Protection Act 1986, were notified by the MoEFCC and replaced the ones from 2000; they were one of six categories of waste management rules brought out by the ministry.
2016	**Hazardous and Other Wastes (Management & Trans Boundary Movement) Rules,** adopted under the Environmental Protection Act 1986, distinguished between hazardous waste and other wastes for the first time. Other wastes, including tires, paper waste, metal scrap, and e-waste, were recognized as resources for recycling and reuse. In 2019, an amendment included the prohibition of solid plastic waste imports into the country.

3 Dharamshala, one of the sites selected for the field study for this project, is one of 100 cities selected for the Smart Cities Mission.

Table 2.3: Summary of national policies, programs, and legislation related to SWM in India (contd.)

2016	**Plastic Waste Management Rules** were expanded to include rural areas, provided specifications for EPR for certain types of plastic, and changes in recordkeeping, to name a few provisions.
2016	**Bio-Medical Waste Management Rules,** adopted under the Environmental Protection Act 1986, they included rules such as classifying waste into four categories from ten in order to improve segregation at source, more stringent standards for bio-medical waste incinerators, and the establishment of common waste treatment and disposal facilities.
2016	**E-Waste Management Rules,** adopted under the Environmental Protection Act 1986, included deposit refund schemes and EPR for e-waste, among other rules; amended in 2018.
2016	**Construction and Demolition (C&D) Waste Management Rules,** adopted under the Environmental Protection Act 1986 by MoEFCC, defined the responsibilities of waste generators, service providers, local governments, central/state pollution control boards, and central ministries.
2020	**Revised Guidelines of Waste-to-Energy**, included MSW-based projects eligible for financing and other benefits from the Ministry of New and Renewable Energy (MNRE).

Sources: CPHEEO 2016a, CPHEEO 2016b, India, MoL&J 2010, Kini and Nandeshwar 2020, Sanchitha n.d., Vikaspedia 2020a, Vikaspedia 2020b, Vikaspedia 2020c, Vikaspedia 2020d, Vikaspedia 2020e

2.7 Institutions Related to Solid Waste Management

While local governments are mainly responsible for MSW management, an institutional framework exists at all levels of government: central, state, and local. There are various ministries, authorities, and departments that contribute to SWM in some way or another.

At the central level, the key environmental regulatory authority is the Ministry of Environment, Forest and Climate Change (MoEFCC). The MoEFCC establishes policies, sets goals, and facilitates the implementation of policies. The Central Pollution Control Board (CPCB), a statutory organization under the MoEFCC, sets environmental standards, is responsible for coordinating the activities of state-level pollution control boards, and provides technical assistance and training, among other duties. At the state level, the state pollution control boards (SPCBs) are responsible for implementing legislation and comprehensive systems related to prevention and control of environmental pollution.

Examples of various institutions and how they work together in the SWM sector are presented below. This list, while not comprehensive, provides a look at how many ministries and departments at the central and state level work on the issue of SWM, demonstrating the need for multi-level governance and intra-ministerial cooperation. These examples also show the level of institutional coordination required at different stages of waste management (Reddy and Sree Ram 2019).

Box 2.2: India Solid Waste Management Rules 2016 specific to hilly 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

First, the Ministry of Urban Development published the Municipal Solid Waste Management Manual in 2016, directed towards urban local bodies (ULBs) to work towards sustainable SWM by implementing the 3 Rs and proper systems of segregation, collection, transportation, processing, treatment, and disposal.[4] Local authorities are responsible for providing MSW services, including waste collection from households, commercial and institutional entities, in addition to road sweeping, transportation, treatment, and disposal (CPHEEO 2016a).

Second, the Ministry of Chemicals and Fertilizers developed the Policy on Promotion of City Compost in 2016 as part of the SBM to ensure that all biodegradable waste from Indian cities is processed into compost. The Policy was aimed at providing market development assistance for compost produced from biodegradable waste in urban areas. As of 2019, not even five percent of biodegradable waste from cities was converted into compost. While this was an important part of the policy for various reasons, the design and implementation of the program failed to gain traction with the associated ministries, that is, MoHUA and Ministry of Agriculture and Farmers' Welfare, making it less of a priority (Agarwal 2019).

Finally, while the Ministry of New and Renewable Energy (MNRE) is responsible for waste-to-energy (in India this not only includes incineration, but also biomethanation, gasification, and pyrolysis) infrastructure development, subsidies, and incentives, it is the Ministry of Power that sets electricity rates generated from solid waste. This is done to ensure that electricity generated from these plants is purchased. The MNRE estimates that the total estimated energy generation potential from urban and industrial biodegradable waste in India is approximately 5,690 MW. So far, approximately one-fifth of that potential has been achieved (India, MNRE 2020).

Regulatory enforcement is seeing an upward trend with the help of the judiciary and National Green Tribunal (NGT), which are taking active roles in monitoring the implementation and enforcement of environmental laws (Kini and Nandeshwar 2020). The Indian judiciary has been an unlikely institutional ally for the environment. NGOs, think-tanks, and local citizen groups actively use the court system to raise environmental concerns in India. The Indian judiciary has historically been sympathetic to environmental concerns raised in the public interest. In fact, judges from the NGT, high courts, and even the Supreme Court are known to have taken up environmental cases *suo moto* (that is, on its own motion) based on media coverage of environmental issues (Kini and Nandeshwar 2020).

The NGT is a quasi-judicial authority established by the National Green Tribunal Act 2010. The NGT provides a forum to expediently hear cases regarding environment protection, conservation of forests, and to seek compensation for damages caused to people or property due to the violation of environmental laws. Each NGT bench comprises one judicial member and a technical expert member, ensuring that environmental decision-making is based on scientific knowledge. The Principal Bench of the NGT is based in New Delhi, with four regional benches in Pune (Western Zone Bench), Bhopal (Central Zone Bench), Chennai (Southern Bench), and Kolkata (Eastern Bench). Each bench covers a specific geographical area comprising multiple states. Non-compliance of NGT orders can result in imprisonment for three years, fines up to Rs 100 million, or both (Bhargav 2011). With regard to solid waste, the NGT has already heard numerous cases and passed judgment on state governments, private parties, and even the government's own regulatory bodies.

4 In India, ULBs were categorized into three types after the 74th Constitutional Amendment was enacted: (1) Municipal corporations (*mahanagar palika* or *mahanagar nigam*) in cities with populations over 1 million; (2) Municipalities (*nagar palika*) for populations between 100,000 but less than 1 million; and (3) notified area/city councils (*nagar panchayat*) for settlements in transition from rural to urban, comprising between 11,000 to 25,000 people. Municipalities or *nagar palikas* were previously constituted as urban centers with populations over 20,000; so even though some ULBs have populations under 100,000, they are still considered to be municipalities or *nagar palikas*.

2.8 Stakeholders Related to Solid Waste Management

Tables 2.4 and 2.5 outline the various stakeholders and service providers involved in SWM in India and their current roles and responsibilities. Table 2.4 focuses on direct waste management services provided by the government, quasi-government bodies (for example, NITI Aayog, a policy think-tank of the Government of India), the private sector, NGOs, and others (including self-help groups, community-based organizations, as well as the informal sector). Direct SWM services include collection, sorting, transportation, recycling/recovery, disposal of MSW, and financing SWM projects. Table 2.4 shows that, along with the public sector, the private sector, NGOs, and even other stakeholders are active in providing waste management services along the SWM chain, except for disposal.[5] Disposal still remains a service provided solely by the public sector. Recycling, on the other hand, is not handled by the government and is left to the informal and private sectors. NGOs promote recycling through awareness raising and training, helping form waste picker associations, and so on.

Table 2.5 shows the various stakeholders in India that provide ancillary services in the SWM sector. Services such as awareness campaigns and knowledge sharing, data collection and research, and technical expertise are provided by academia, consultants/experts, government and quasi-government bodies, and NGOs.

The media plays an active role in environmental issues in India, even if it cannot be considered a stakeholder in the usual sense. By creating awareness around these issues on public platforms, the media is simultaneously encouraging local governments to take action.

Table 2.4: Stakeholders providing direct waste management services

Waste Service	Government	Quasi-government	Private Sector	NGOs	Others (e.g., SHGs, CBOs, informal sector)
Collection	Yes	No	Yes	Yes	Yes
Transportation	Yes	No	Yes	Yes	Yes
Sorting	Yes	No data available	Yes	Yes	Yes
Recycling/Recovery	No	No	Yes	Yes	Yes
Disposal	Yes	No data available	No	No	No
Financing	Yes	Yes	Yes	No	No

5 The various steps involved in the management of solid waste—starting from generation to storage, collection, transport, transfer, treatment (including recycling), and finally disposal—are collectively referred to as the SWM chain.

Table 2.5: Stakeholders providing ancillary waste management services

Service	Government	Quasi-government	Consultants/ Expert Institutions	NGOs	Academia
Awareness campaigns, knowledge sharing	Yes	Yes	Yes	Yes	Yes
Data collection and research	Yes	Yes	Yes	Yes	Yes
Technical expertise	Yes	No	Yes	Yes	Yes

2.9 Solid Waste Management Financing in India

According to the Government of India's 2009 *Position Paper on the Solid Waste Management Sector in India*, ULBs spend about Rs 500-1,500 per tonne on solid waste collection, transportation, treatment, and disposal, but a negligible amount is spent on scientific disposal. The 2011 MoUD report, *Indian Urban Infrastructure and Services,* estimated that the annual per person cost of municipal solid waste management ranges from Rs 204-900 for capital investment and from Rs 113-269 for operation and maintenance.

In India, ULBs make provisions for financing waste management in their budgets (Narain and Sambyal 2016). Table 2.6 provides the various types of revenue categories and examples for each that generate municipal revenue, not only for waste management but other sectors as well. In addition, the Government of India provides financial assistance to ULBs, offers income tax relief to waste management agencies, and has permitted tax-free municipal bonds.

Table 2.6: Sources of municipal revenue in India

Revenue head/Category	Sources of revenue
Tax Revenue	Property tax, octroi, advertisemen tax, tax on animals, vacant land tax, taxes on carriages and carts
Non-tax revenue	User charges, municipal fees, sale and hire charges, lease amounts
Other receipts	Sundry reeeceipts, law charges, costs recovered, lapsed deposits, fees, fines, and forfeitures, rent on tools and plants, miscellaneous sales, etc.
Assigned (shared) revenue	Entertainment tax, surcharge on stamp duty, profession tax, motor vehicles tax
Grants-in-aid	(i) Plan grants made available through transfers from upper tier of government under various projects, programs, and schemes (ii) Non-plan grants made available to compensate for the loss of income and specific transfer
Loans	Loans borrowed by the local authorities for capital works etc. HUDCO, LIC, state and central governments, banks, and municipal bonds

Source: Mohanty et al. 2007, adopted from Narain and Sambyal 2016

Specifically related to waste management, the cost of MSW service delivery in India is generally offset by service charges levied on property through property taxes. Homeowners thus assume that they have paid for collection, transportation, and disposal of waste to the municipality; however, the real costs of these services are extraordinarily difficult to estimate. As the quantity of waste increases, the cost of SWM goes up and ultimately results in municipal services falling short. This is where private agencies step in.

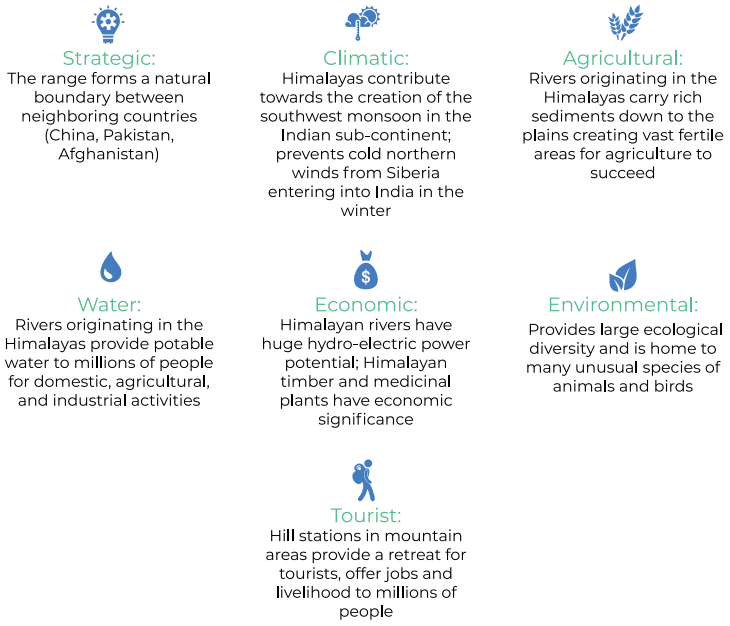
In most cities, households or residents' welfare associations in relatively affluent areas contract private agencies for door-to-door collection and pay a user charge for this collection. But invariably, the arrangement ends here. The collected waste is then deposited at a secondary facility—the *dhalao* as it is known in north India—which is managed by the relevant municipal agency. The municipal agency is responsible for transporting this waste or paying for its transportation to the dump site or other facility, in addition to disposal.

Despite the number of rules and amendments to laws regarding SWM in India over the years, as provided in Table 2.3, the government is seemingly poorly equipped to implement these laws in every strata of society, be it urban or rural. This has forced many to live alongside waste or has incentivized the informal sector to take action. It is interesting to note that in the business of waste in India, private agencies are engaged at different points of the SWM chain in different cities from collection, to segregation, transportation, treatment, and disposal or a combination of these activities, as opposed to managing the process singularly, from start to finish.

3. Solid Waste Management in Mountain Areas of India

Over 29 percent of India may be classified as hill and/or mountain areas (Easy Tutorial n.d.). While there is little supporting data available on the population living in hilly and mountain areas in the country, it is clear that these areas support millions of people directly or indirectly. Twelve states and two union territories in India make up the Indian Himalayan Region (IHR), which together have a population of 50 million people (NITI Aayog n.d.). But the Himalayas are not the only significant mountain region in India—the Western and Eastern Ghats are also culturally, environmentally, and economically significant. That said, the Himalayas are the most well-known and the largest mountain range in the region. It is important to note that the Himalayas support 450 million people in the plains, a staggering number (Chengappa 2013). Figure 3.1 summaries why the Himalayas are significant for multiple reasons (Easy Tutorial n.d.).

Figure 3.1: Significance of the Himalayas to India



Source: Kuang 2010

India has a robust and thriving tourism market; however, despite its value to the economy, the tourism sector puts pressure on environmental resources and increases all forms of pollution. The government recognizes these issues and the need to promote eco-tourism. For instance, with respect to the IHR, a government report cites that an increase in tourism, urbanization, and population growth have all impacted the area in terms of "pollution, overexploitation of natural resources, food insecurity, poorly planned urbanization, traffic congestion, loss of indigenous culture, natural disasters, and so on" (Gaur and Kotru 2018). Box 3.1 summarizes the contribution of the tourism sector to the Indian economy and focuses on the impact of tourism in the IHR in particular.

Box 3.1: Tourism in India: Snapshot on solid waste from tourism in the Indian Himalayan Region

The 11th Five-Year Plan of India's Planning Commission stated that "Tourism is the largest service industry in the country. Its importance lies in being an instrument for economic development and employment generation, particularly in remote and backward areas (for example, in IHR)." (Gaur and Kotru 2018) Some key statistics on tourism in India include:

Tourism sector: Tourism in India contributed to 9.6 percent of the country's GDP, creating over 40 million jobs and 9.3 percent of total employment in the country (2016).

International tourists: There were 1.2 billion international tourist arrivals in India in 2017, which translated into $27.7 billion in foreign exchange earnings. This was almost 21 percent more compared to 2016.

Domestic tourists: Between 2000 and 2018, the number of domestic tourist visits in India grew from 220 million to 1.85 billion. The domestic tourism sector is one of the fastest growing sectors in the country, expected to grow at an average annual rate of 7.9 percent from 2013 to 2023.

Impact of Tourism on Solid Waste in the Indian Himalayan Region

Tourist arrivals in the Indian Himalayan region (IHR) increased from 84.2 million in 2011 to 136.1 million in 2015, an increase of over 60 percent in four years. In comparison, the population of the IHR is approximately 60 million. In Himachal Pradesh, the state where the field study was conducted, saw an increase of 16 percent in tourists between 2011 and 2015.

With the growth of the domestic tourism industry being led by a growing middle class, improved standard of living, and more disposable income, tourists are becoming increasingly frequent in the IHR, regardless of the season. This has resulted in increased traffic congestion, air and noise pollution, and strain on local water and energy supplies, even in smaller towns. Based on available data, IHR states generate 22,372 tonnes of MSW per day, equivalent to over 8.1 million tonnes annually.

A visitor satisfaction survey in Dharamshala, a small town and one of the sites for the field study conducted for this World Bank-led project in India, revealed that some aspects of the town were rated very negatively, namely, hygiene, waste, a lack of safe drinking water, poor transportation, and communication. Even in more urbanized cities in the IHR, such as Shimla, Darjeeling, Srinagar, Nainital, and Kohima, while waste collection services exist, the collected waste is dumped in open areas, including forests, thus exacerbating the solid waste problem.

An assessment by the Ladakh Ecological Development Group reveals important lessons on the impact of tourism on limited natural resources. It found that, on average, local residents use 25 liters of water per day, whereas each tourist consumes 75 liters per day. In addition, some hotels consume up to 5,000 liters of water per day. Each year, the number of hotels in the Ladakh region increases by 20-25 hotels.

The government piloted trials to restrict the number of visitors to fragile areas such as the high-altitude Rohtang Pass (Himachal Pradesh). However, these pilots have not resulted in a decrease in tourism as people use alternative routes and means to reach these sites. The government recognizes the concerns and risks associated with tourism development. For instance, NITI Aayog, has set up the Action Agenda for “Sustainable Development of Mountains of Indian Himalayan Region (IHR)”.

The government is already aware of the concerns and risks associated with tourism development. For instance, in 2018 the Himachal Pradesh state government introduced a ban on Styrofoam cutlery and in 2019 on single-use plastic items such as carry bags and cutlery under an amendment to the Himachal Pradesh Non-Biodegradable Garbage (Control) Act 1995. However, this has only been partially successful due to high tourist inflows and lack of effort by the administration in implementing the ban. In Dharamshala, Waste Warriors, an NGO, organizes periodic community clean-up campaigns, has started door-to-door collection, and set up waste bins.

Sources: Gaur and Kotru 2018, Himachal Pradesh, DoEST 2018, Himachal Pradesh, DoEST 2019, ICLEI 2019, NITI Aayog n.d., Statista 2020

3.1 Solid Waste Management in Himachal Pradesh State

Himachal Pradesh is an ecologically-sensitive state in the IHR, having an immense wealth of natural resources and biodiversity while at the same time facing the pressures of development and urbanization, one of which is solid waste management (SWM). Despite having a large staff appointed for and a substantial portion of the annual budget allocated to SWM, the difficult terrain and scattered nature of settlements pose major challenges to the collection of municipal solid waste (MSW) in the state. Additionally, the combined effects of the monsoon season from July to September and snowfall in the winter months limits the availability of disposal facilities.

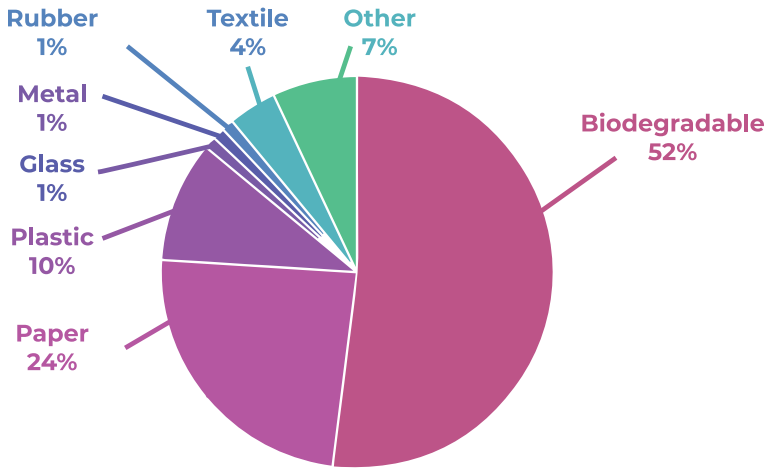
3.1.1 Municipal Solid Waste Generation and Segregation

In 2017, the state generated around 1,100 tonnes of MSW per day in both urban and rural areas (CPCB 2017). MSW generation from cities in Himachal Pradesh was estimated to be 377 tonnes per day (India, SBMU 2020). Being a favored tourist destination, the state receives a huge influx of tourists during peak season. Therefore, the quality and quantity of waste generated in the state varies. According to information provided by the state to the Swachh Bharat Mission – Urban, 78 percent of the total waste generated is processed (that is, 294 tonnes per day). In addition, 98 percent of the administrative wards in the state have both 100 percent door-to-door collection as well as 100 percent source segregation (India, SBMU 2020).

3.1.2 Municipal Solid Waste Composition

Biodegradable waste, plastic, and paper make up the majority of MSW composition in the state, while other materials such as glass, metal, and rubber are found in negligible quantities. Figure 3.2 shows the composition of MSW in Himachal Pradesh.

Figure 3.2: MSW composition in Himachal Pradesh



Source: Himachal Pradesh, DoUD 2017

3.1.3 Municipal Solid Waste Treatment and Disposal

As of 2017, there were only a handful of waste processing facilities installed by ULBs in the state (Shimla, Solan, Kullu/Bhuntar, Manali, Una, Kangra/Nagrota and Hamirpur). None of the municipalities in the state have proper waste disposal facilities for the disposal of non-biodegradable waste. It is estimated that only 20 percent of the collected waste is treated, primarily through composting (Himachal Pradesh, DoUD 2017).

3.2 Field Study Overview

A key element of the World Bank's *Supporting the Development of Sustainable Solid Waste Management Strategies for the Mountainous Regions of India, Nepal and Pakistan* project, funded by the Korea Green Growth Trust Fund (KGGTF), was to enhance the quality of data, given its insufficient availability in mountain areas of the three countries.

The field study had two components: waste sampling and a qualitative survey. The aim of this study was to present current trends, identify challenges, and make recommendations that may be applied widely to mountain areas in all three countries under this study.

Due to time limitations and other constraints, the sample size for the field study was small, so the results (provided in Appendix 1) should not be considered statistically significant and caution must be used when citing this data. The analysis of the data is provided in Section 3.7 of this chapter, which is verified through observation and experience. The field study can thus be considered to provide a snapshot of the current solid waste scenario as well as confirmation of waste trends that one would expect to see in mountain areas in these three countries.

In India, a field study for this project was undertaken in the Himalayan state of Himachal Pradesh in June 2019. The technical team selected these areas based on the interest expressed by state officials. This project benefited from previous work carried out by the G.B. Pant Institute of Himalayan Environment and Development (GBPIHED), the International Centre for Integrated Mountain Development (ICIMOD), and other organizations actively working in the region.

3.3 Location and Geography

Himachal Pradesh state was chosen for the field study in India, focusing on the areas of Kullu and Manali in Kullu District and Dharamshala, McLeod Ganj, and Triund in Kangra District.

Himachal Pradesh is a north Indian state situated in the Western Himalayas, boasting an extreme landscape featuring high peaks and extensive river systems. It is one of the states that comprises the IHR. Almost 90 percent of the state's 6.9 million population (2011) lives in rural areas. Administratively, Himachal Pradesh comprises 54 urban local bodies (two municipal corporations, 31 municipal councils, and 21 *nagar panchayats*) (India, MoHA 2011a). Table 3.1 provides some key facts about Himachal Pradesh.

Table 3.1: Important facts about Himachal Pradesh

Area: 55,673 sq. km.
Elevation range: 450-6,826 meters
Population (2011): 6.9 million
Urban population: 10% of total
Key sectors: Agriculture, pharmaceuticals, tourism
Number of Tourists (2016): 18.45 million (18 million domestic + 0.45 million foreign)

Sources: Himachal Pradesh, DoIPR n.d., India, MoHA 2011a, IBEF 2018, IBEF 2020

The tourism sector of Himachal Pradesh contributes seven percent to the gross state domestic product (GSDP). Between 2004 and 2017, tourism in Himachal Pradesh increased by almost 200 percent. The state receives more than double the residents it supports, as shown in Table 3.1. Tourism in Himachal Pradesh is suited to a wide range of themes: eco-tourism, agro-tourism (for example, organic farming, orchards), adventure tourism, pilgrimage, health and wellness tourism (for example, hot springs, yoga), film (for example, natural landscapes), and MICE (meetings, incentives, conferences and exhibitions) tourism (Himachal Pradesh, DTCA 2019).

3.4 Field Study Site Descriptions

Site locations: Kullu-Manali and Dharamshala-McLeod Ganj-Triund
Districts: Kullu and Kangra
State: Himachal Pradesh

Both the sites chosen for the field study are important in terms of tourism. Kullu-Manali is the main tourist attraction in the state for both domestic and international tourists throughout the year. Kullu is a municipal council and the administrative headquarters of the Kullu district in Himachal Pradesh. It is located in the Kullu Valley on the banks of the Beas River, a major access route to Ladakh. Manali is a resort town at one end of the Kullu Valley. A tourist town itself, it serves as a gateway to numerous popular destinations.

Dharamshala is the district headquarters of the Kangra district. It is a municipal corporation and became the second capital of Himachal Pradesh (the first being Shimla) in 2017. Dharamshala covers almost 50 percent of the total urban population in the district. McLeodGanj, a suburb of Dharamshala, is where the Dalai Lama and his followers have settled. Triund, where some waste sampling was conducted, is a four-hour trek from the village of Dharamkot, 5 km away from Dharamshala, and is only accessible by foot. Table 3.2 provides some general information regarding the sites chosen for the field study.

Table 3.2: Key facts about site locations

Key information	Kullu	Manali	Dharamshala	Triund
District	Kullu	Kullu	Kangra	Kangra
Total population (2011)	18,536	8,096	53,543 (2015)	NA
Elevation (meters)	1,279	2,050	1,457	2,850

Sources: Census 2011 2020a, Census 2011 2020b, Census 2011 2020c

Kullu, Manali, and Dharamshala Municipal Corporation are three of the top ten cities generating the highest amount of solid waste in the state.

Triund is a major tourist attraction in the state for both foreign as well as domestic tourists. On average, 7,460 tourists visited Triund in 2018. In the peak tourist month of June, Triund had over 15,000 tourists (Himachal Pradesh, Forest Range Officer 2019).

3.5 Methodology of the Field Study

The data assimilated during the course of the field study was collected via a two-pronged approach: the use of waste sampling in order to identify the kinds of waste being generated as well as quantity and other factors, and a qualitative survey undertaken in specific key areas in order to understand the mindset and awareness level of residents in these areas. Further details on the components of the study include:

- *Waste sampling:* This was done at source to determine the amount and composition of generated and discarded waste by different sources. Sources included households, commercial establishments, hotels, tourist spots, and dump sites.
- *Qualitative survey:* Interviews were conducted with residents and domestic and foreign tourists in order to better understand their behavior and habits with respect to SWM, as well as their level of awareness of waste management in mountainous regions.

In general, the targets of the qualitative surveys were local residents, domestic and foreign tourists, and hotel staff. For the qualitative survey in India, only households and tourists were interviewed; commercial establishments were excluded. The data gathered from the qualitative survey are summarized in Table 3.3.

Table 3.3: Qualitative survey summary

Household 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	• Visit type and purpose of visit • Awareness of environmental problems in the area • Waste generation by tourists • Prioritization of waste management in mountainous regions

3.6 Respondents and Sample Size

The field study in India was conducted by Korean consultants, Korea Environment Corporation (K-eco), in cooperation with local partner, ICLEI. Tables 3.4 and 3.5 provide summaries of the waste sampling and qualitative surveys, respectively, in terms of types of respondents and sample size.

Table 3.4: India field study: Waste sampling summary

District	Kullu		Kangra
Field study site	Kullu	Manali	Dharmshala/McLeod Ganj/Triund
Waste sampling conducted	6 households	25 households	40 households
		2 commercial	1 commercial
		5 hotels	2 hotels
		2 tourist spots	1 tourist spot
		1 dump site	1 dump site
Total number of samples by location	6	35	45
Types of information gathered in waste samples	Waste generation	Waste generation	Waste generation
	Composition	Composition	Composition
Survey period (number of days)	2	4	3

Table 3.5: India field study: Qualitative survey summary

District	Kullu	Kangra
Field study site	Kullu-Manali	Dharmshala/ McLeod Ganj/Triund
Waste surveys conducted	27 households	21 households
	24 tourists (3 foreign; 21 Indian)	25 tourists (9 foreign; 15 Indian; 1 unknown)
Number of interviews by location	51	46

3.7 Key Findings from the Field Study

The key findings from the waste sampling and qualitative surveys and observations from the study are summarized in this section. Please note that due to small sample sizes, as shown in Tables 3.4 and 3.5, 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 study are summarized in Appendix 1.

3.7.1 Waste Sampling

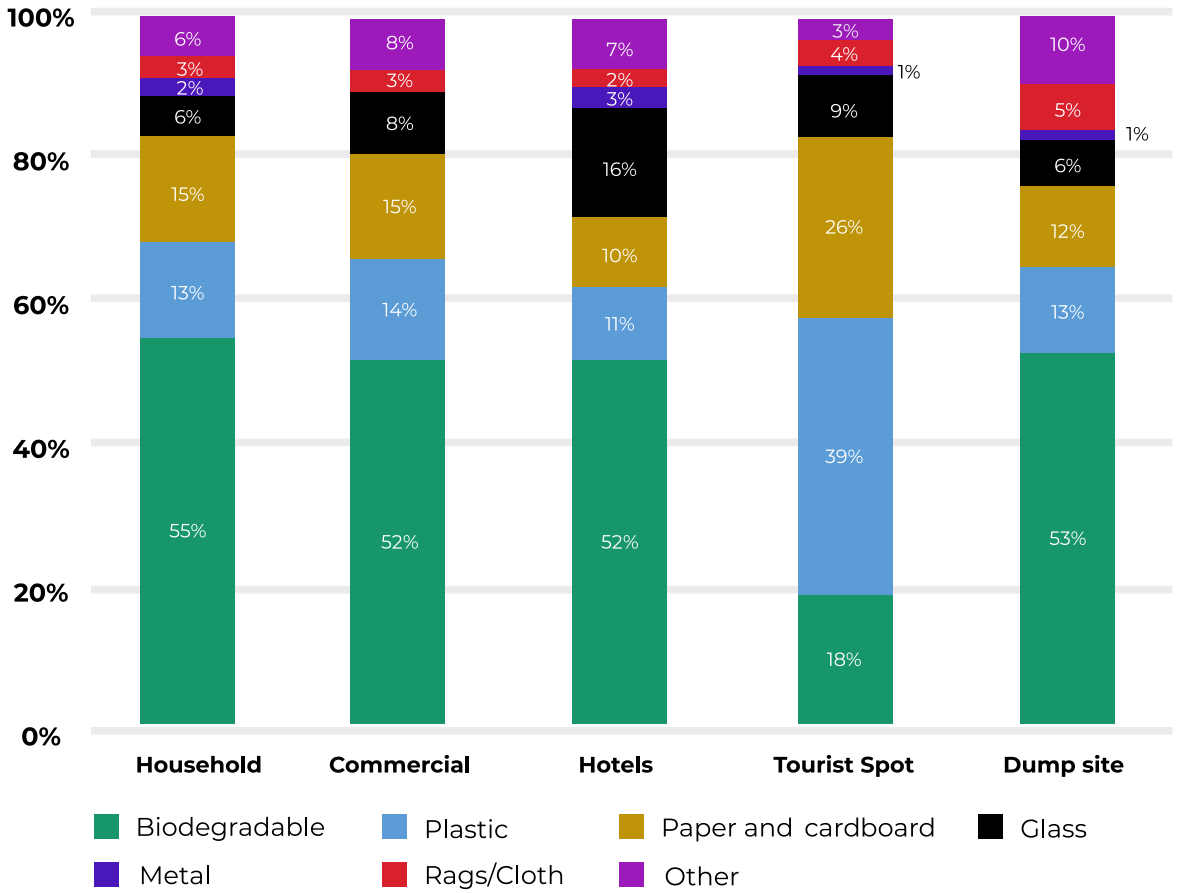
Waste Generation and Composition:

- The volume of waste generated in remote mountain communities is considerably less than in mountain cities.
- Plastic is the main constituent of mixed waste in tourist hotspots, while biodegradable waste is the

main constituent of mixed waste from other sources (that is, households, commercial establishments, hotels, and dump sites), as shown in Figure 3.3.

- The primary components of household and commercial waste are biodegradable waste (including wood), paper and cardboard, and plastic.
- The composition found in the waste sampling matches a study conducted by NEERI in 2015, which found the main components to be biodegradable waste, paper, and plastic.
- Hotels have the most glass waste compared to other sources, which is expected, as the amount of glass used in the form of bottles, crockery, and serving ware is higher compared to other sources.
- At tourist spots, the primary waste type is plastic. Tourist spots also have the least amount of biodegradable waste compared to other sources. This is expected given the amount of plastic packaging used by tourists.
- Waste from commercial areas has more paper and cardboard, plastic, and glass compared to household waste.
- Further information about waste composition at various sampling locations can be found in Table A1.3 in Appendix 1.

Figure 3.3: Waste composition at various sampling locations

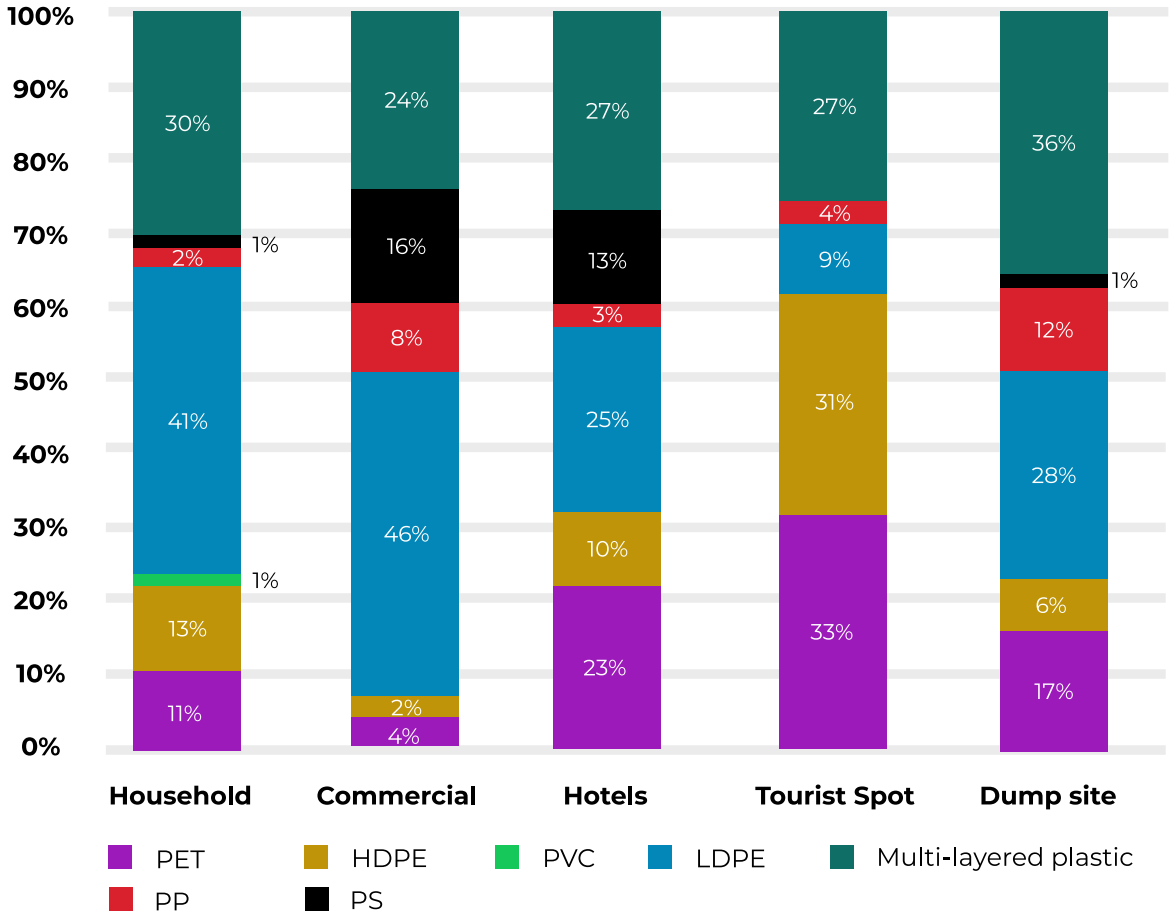


Plastics Composition:

- The waste sampling in India also included separating plastics into their different types, identified by their recycling number as shown in Figure 3.4.
- Different types of plastics are used by different sources, summarized in Figure 3.5. For instance:
  - Low-density polyethylene (LDPE) is the most common type of plastic used in households and commercial establishments. Single-use plastic bags are a common type of LDPE.
  - At hotels, multi-layered packaging is most commonly found, closely followed by LDPE and polyethylene terephthalate (PET). PET is the plastic most commonly used in single-use plastic water bottles.
  - At tourist spots, PET and high-density polyethylene (HDPE) are found in larger proportions compared to other sources.
  - At dump sites, multi-layered packaging are more commonly found than other types of plastics. This is to be expected, as multi-layered plastic is commonly used for packaging snacks (for example, chips, biscuits, chocolates) and is hard to recycle.
- From most to least, the common types of plastics found by source are (fractions lower than 10 percent are not included here, but are provided in Appendix 1):
  - Households: LDPE, multi-layered, HDPE, and PET
  - Commercial: LDPE, multi-layered, and polystyrene (PS)
  - Hotels: Multi-layered, LDPE, PET, PS, and HDPE
  - Tourist spots: Multi-layered, PET, HDPE, LDPE
  - Dump sites: Multi-layered, LDPE, PET, polypropylene (PP).
- The largest fraction of PP plastic is found at dump sites, which is expected as this type of plastic is hard to recycle.

Figure 3.4: Types of plastics and their common uses

Figure 3.5: Composition of plastics from various sources sampled



3.7.2 Qualitative Survey

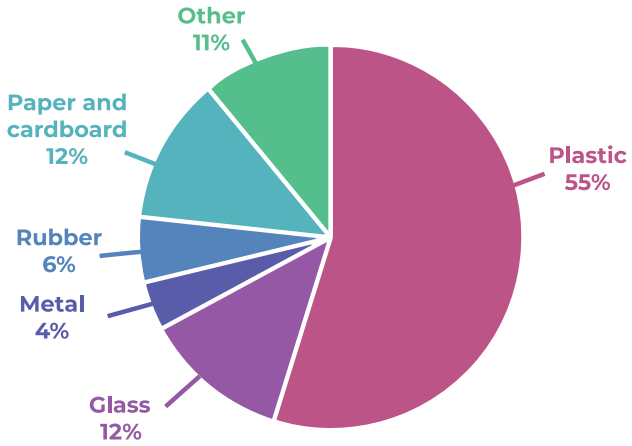
Households

More than half of the households surveyed were employed in the tourism sector in some way, followed by the private sector, government, and self-employment. Below is a summary of their responses by topic.

Types of Waste:

- When asked what kinds of non-biodegradable waste are generated, plastic makes up an overwhelming majority of non-biodegradable waste generated in households, as shown in Figure 3.6.
- According to the residents surveyed, besides plastic the other non-biodegradable waste types generated, from most to least, include paper and cardboard, glass, other waste, rubber, and metal.

Figure 3.6: Types of non-biodegradable waste generated by households



Waste Collection:

- About half of the households responded that regular waste collection services are provided, and the majority of those households confirm that they used it.
- Many households do not use waste collection services and dispose of their waste by dumping, burning, or throwing the waste into drains.
- Collection services are mainly provided by the public sector.
- Almost all who responded that their collection service was provided by the public sector replied that they are satisfied with the service provided.
- It was observed that regular waste collection services are not available in low- and middle-income residential areas. Collection coverage is a major challenge for SWM.
- The lack of adequate transportation vehicles is also a challenge.
- From most to least common, the methods of biodegradable waste disposal adopted by households are to provide waste to service provider, use as animal feed, throw away, and compost, as shown in Figure 3.7.
- From most to least common, the methods of non-biodegradable waste disposal adopted by households are to provide waste to service provider, sell the recyclable fraction, and burn it, as shown in Figure 3.8.

Figure 3.7: Methods for biodegradable waste disposal by surveyed households

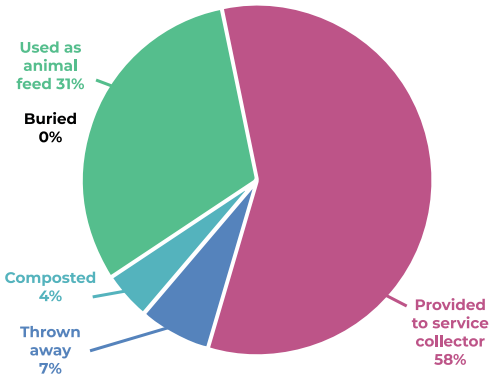
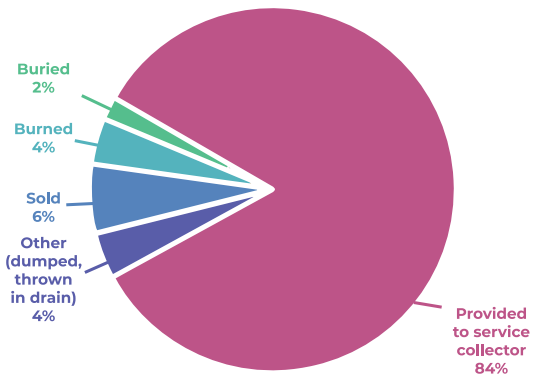


Figure 3.8: Methods for non-biodegradable waste disposal by surveyed households



Segregation and Disposal:

- The majority of respondents segregate their waste into wet and dry fractions, although the survey team observed only partial segregation of waste.
- When asked how non-segregated waste was disposed of, most households responded that it is collected by the service provider.
- When households were asked if they would segregate their waste if asked to by the service provider, most respondents did not answer. Those that did answer said they would segregate if asked.
- Although some mountain communities segregate waste at source, end-to-end segregation is not facilitated due to the lack of compartmentalized collection and transportation systems. As a result, the proportion of waste disposed of in valleys or near rivers is still very high in the two mountain cities of Dharamshala and Manali. Open burning of solid waste in remote areas is also a frequent occurrence.
- There are no sanitary landfill sites, and dump sites are spread across the area and have no sanitary structures.
- Problems associated with the SWM system in the area are location and accessibility of waste bins (for example, narrow lanes) followed by irregular collection.

Environmental Awareness:

- Approximately half of the respondents had participated in community clean-up activities or other voluntary clean-ups in the past year.
- Just over half of the respondents say that waste management is an environmental problem, while the remaining say it is not.
- Most surveyed households are not aware of how the service provider disposes of waste, neither are they concerned about the methods used, as shown in Figure 3.9.
- The most effective way of raising awareness according to surveyed households, from most to least preferred, include door-to-door campaigning, followed by social media. Newspapers, radio, and television were selected by only a very small fraction, as summarized in Figure 3.10.

Figure 3.9: Summary of environmental awareness of surveyed households

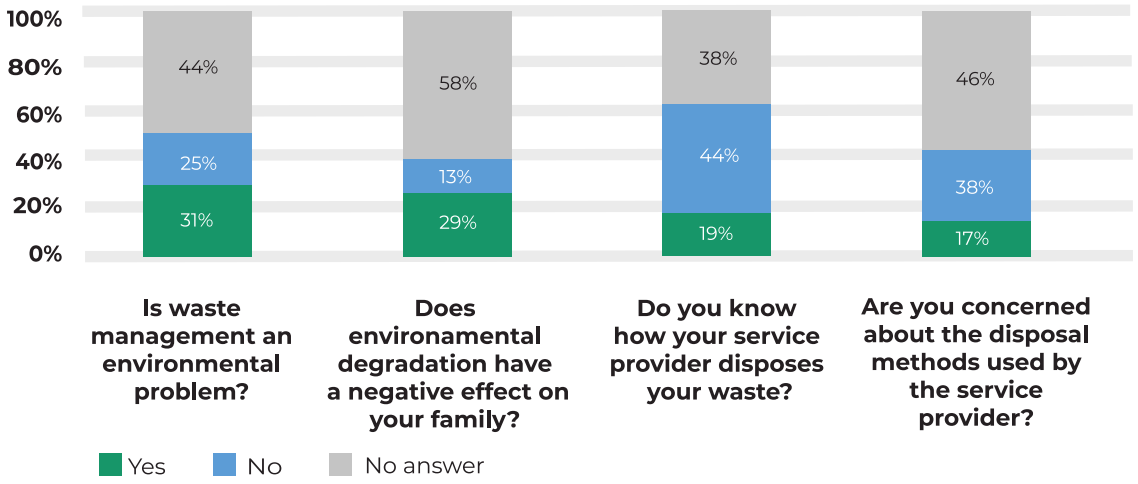
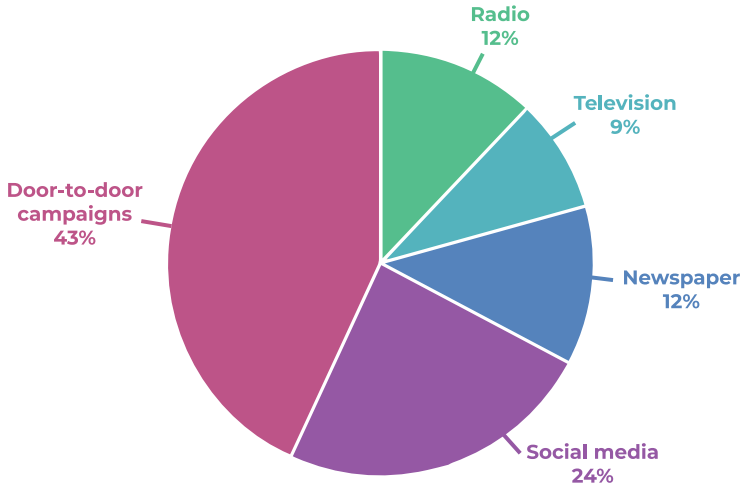


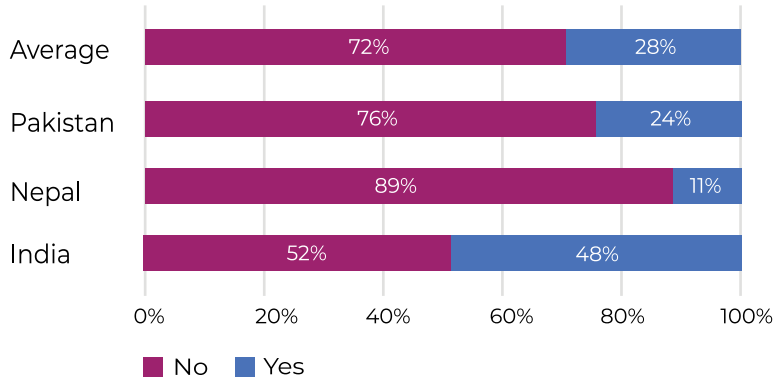
Figure 3.10: Awareness-raising methods according to sampled households



Willingness to Pay:

- Among households sampled in all three countries, India has the lowest number that are willing to pay for SWM services, as shown in Figure 3.11. Nevertheless, a majority of respondents show a willingness to pay for services than those who do not. This is not unusual, as is the case in many other low-income country cities around the world. Households are willing to pay for services if they perceive that the standard of service is efficient.
- The majority are willing to pay Rs 10-50 per month, with a small fraction willing to pay more than Rs 50 and above.

Figure 3.11: Willingness to pay for SWM services among surveyed households



Tourists

- The majority of tourists surveyed were Indian. Tourists were in the area to engage in backpacking, trekking, sightseeing, and for expeditions.
- The predominant environmental issues cited by tourists, from most to least, are litter and garbage on the trails, lack of sanitary facilities, water pollution, openly dumped waste, odor, fine dust, and deforestation, as shown in Figure 3.12.
- Common types of waste seen by tourists include plastic packaging, plastic bottles, and to a lesser extent, glass, as summarized in Figure 3.13.
- With respect to goods purchased locally, the common types of waste generated are plastic bottles, plastic food and other packaging, and glass.
- Most tourists surveyed say that waste generated by them is disposed of in bins, some carry it in their luggage, and a few said they littered.
- The top priority for mountain waste management according to respondents, from most to least, include more bins available on trails, campaigns on SWM, stricter policies and regulations, road construction, and facilities for waste management, as shown in Figure 3.14.

Figure 3.12: Surveyed tourists' rankings of predominant environmental issues faced in the area

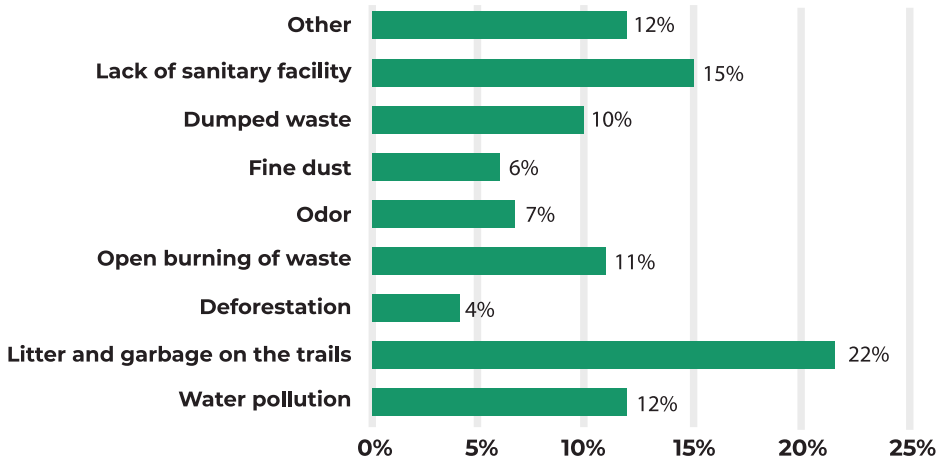


Figure 3.13: Type of garbage most commonly seen by surveyed tourists

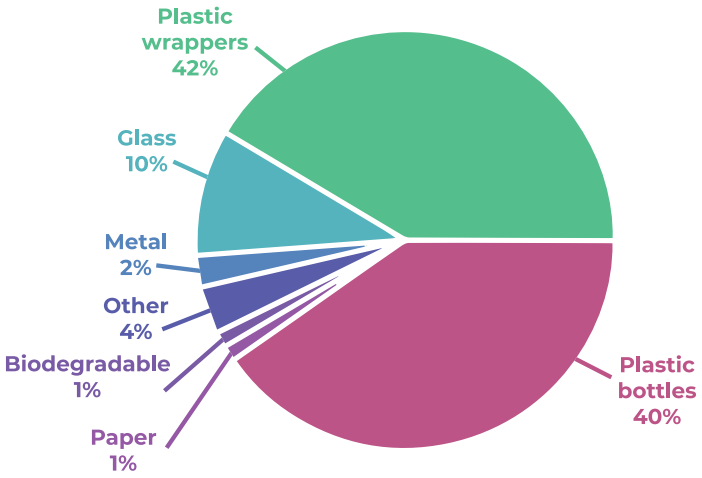
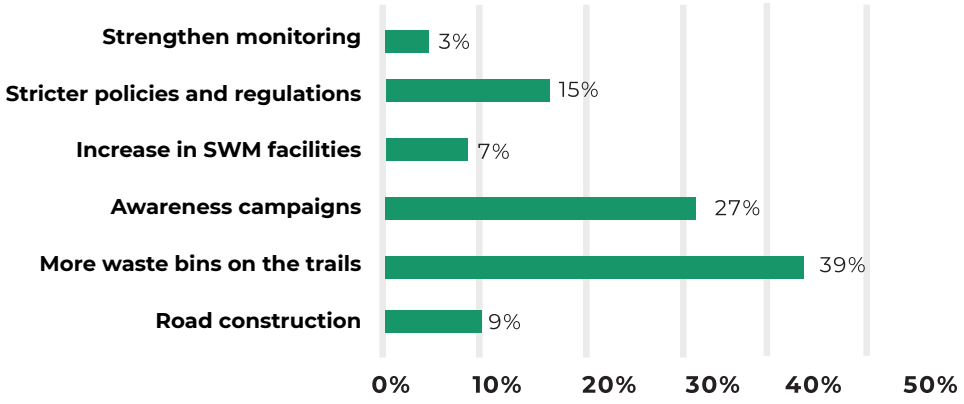


Figure 3.14: Summary of surveyed tourists' rankings of priority SWM-related actions

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4. Solid Waste Management Challenges in Mountain Areas of India

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 such as 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 relate to 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.

4.1 What Makes Mountain Areas Unique?

Mountain areas are unique for the following reasons: type of settlement, 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 that 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 concentrations 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 sources of freshwater not only for mountain communities but also for settlements downstream that support millions of people.

- *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 larger towns nearby and to 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.

4.2 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 4.1 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 4.1: Comparison of SWM challenges in mountain and non-mountain areas

SWM in all Areas	SWM 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 and ecological conditions • Vulnerability from seismic activity • Lack of road networks making access difficult • Special types of waste generated (e.g., mountaineering waste), which require treatment and disposal • Waste transport requires vehicles suitable to mountainous regions • Limitations of space for waste treatment and disposal • Poor socio-economic conditions in general • High variability of waste generation due to tourist seasons

4.3 Shared Challenges with Other Eco-Sensitive Areas

Mountain areas face many SWM challenges that are similar to other eco-sensitive areas, such as protected areas (e.g., conservation parks, sanctuaries), small island states, remote villages in Arctic regions, and so on. These 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 of 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.

4.4 Challenges Specific to Mountain Areas of India

Mountain areas are, therefore, quite complex and require considerable coordination, planning, and financing. One cannot address mountain waste in India 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 4.1 summarizes the various SWM challenges in India's mountain areas.

Figure 4.1: Summary of SWM challenges specific to mountain areas of India

Institutional coordination and financing	Availability of data and Awareness	Waste generation and segregation	Waste collection and transport	Waste treatment and disposal
• SWM is a priority at the national level but implementation is lacking • Given the lack of monitoring and enforcement, wastes are dumped illegally and hazardous wastes such as healthcare and industrial wastes are often mixed with other general waste • While local governments have the legal authority to define necessary regulations related to SWM, there is limited technical and financial capacity to deal with these issues • Lack of adequate infrastructure, equipment, and skilled technical human resources • Most tourist revenue does not reach local authorities, whereas the responsibility of providing service rests with them	• 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 its management • Low environmental awareness of both residents and tourists • Citizens' lack of respect and disregard for the law	• Waste segregation is a major challenge in large cities as well as in smaller towns • No formal system of waste segregation exists • Waste quantities and characteristics vary significantly between places that are tourist hotspots and those that are not and also by season • 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 • Lack of systems established to support segregation • No (proper) storage bins/areas provided • Collection is challenging due to remoteness and topography • 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 • High level of coordination, technical know-how, funding, and regular waste supply required to establish 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., ravines, waterways) • Siting of disposal facilities is a challenge

5. Recommendations and Actions for Solid Waste Management in Mountain Areas of India

Based on the solid waste management (SWM) challenges specific to mountain areas described in Chapter 4 and the issues identified in the course of analysis of the field study as provided in Chapter 3, 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 or foundation on which solutions can steadily be 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 2021). See Box 5.1 for more information on the landscape management 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 (1) mountain cities or urban areas, (2) mountain villages or rural areas that are generally connected by some form of road network, and (3) remote areas that are not connected by road and can only be reached by foot. 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 of waste generation in these areas is from tourism. Tourists contribute significantly to the amount of municipal solid waste (MSW) 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.

Box 5.1: 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.

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.

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.

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.

Sources: World Bank 2018, World Bank 2021

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 certain types of 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 waste before the waste is shipped to a large processor or recycler. On the contrary, waste transport vehicles would not be able to reach remote locations, and 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 types of waste generated by these sources. Based on the type of settlement or by activity (in this case, tourism), 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 (C&D) waste, healthcare waste, electronic waste, and inert/non-recyclable 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 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 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 and adventure tourism—both domestic as well as international—are bringing growing numbers of visitors to mountain areas in the three countries in this study. 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 and awareness on prevalent waste practices
3. Comparisons to other tourists' behavior
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 solid waste, 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).[6]

It has been observed that when areas become popular with tourists, the non-biodegradable waste fraction such as 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.

6 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.

An action plan or policy would detail the current waste situation in mountainous regions in the country, set targets for the sector (on collection, treatment, recycling, and disposal), and create guidelines 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 presented in this section are suggested taking into account an integrated approach of solid waste management. The concept of integrated solid waste management (ISWM) is described in Box 5.2. Box 5.3 provides a note on how to use Tables 5.1-5.5 presenting the suggested actions.

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 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 4.1). 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, and hence 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 can it be scaled-up or expanded in a way that benefits the rest of the region or even the 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 future 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.

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Box 5.3: A note on how to use the recommended actions tables

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.

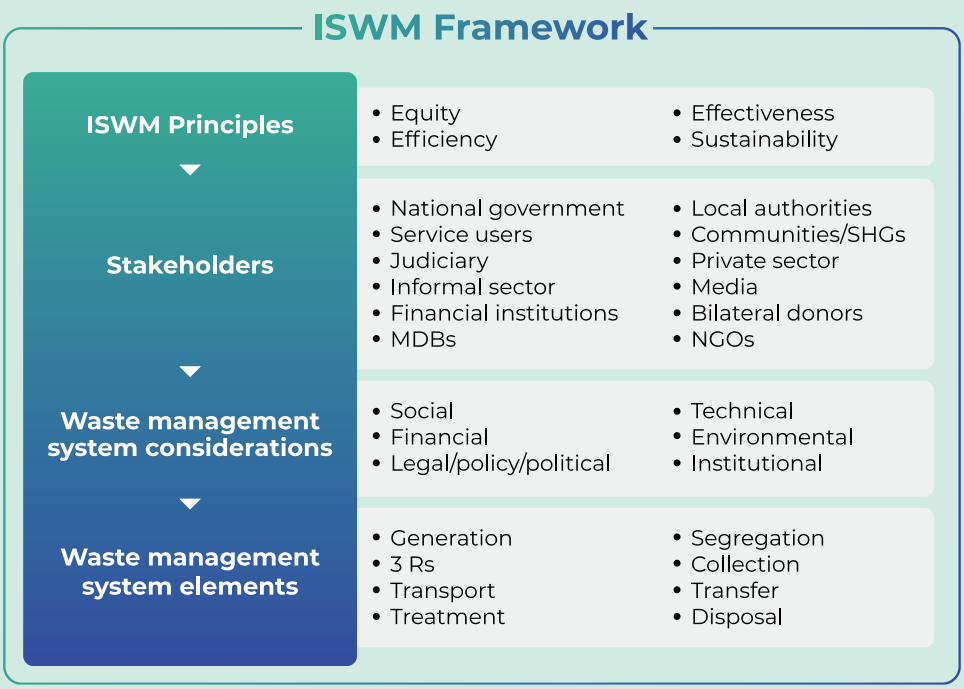
ISWM is based on four basic principles:

- 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: Integrated solid waste management

- Recommendations are grouped based on an integrated solid waste management framework.
- Each table focuses on a set of recommendations and related implementable actions.
- The SWM challenges identified in the course of this study 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 be modified depending on the local situation or change over time.

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 and to 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, forestry, and natural resource management
- Establish a monitoring and enforcement system to improve and sustain waste management services.

Based on these recommendations, suggested actions for implementation 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 waste and impacts of SWM in mountain areas
- Introduce and expand training programs to build capacity of local government staff and decision makers.

Based on these recommendations, suggested actions for implementation 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, hazardous, healthcare, e-waste) in mountain cities.

Based on these recommendations, suggested actions for implementation 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 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.

Based on these recommendations, suggested actions for implementation 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.

Based on these recommendations, suggested actions for implementation 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 for these SWM services 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; however, the 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[8]			✓	✓ (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)

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

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

Biodegradable waste: Medium- to large-scale composting	✓	✓		
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	✓	✓	✓	

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

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, 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.

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, 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, Program-for-Results (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.

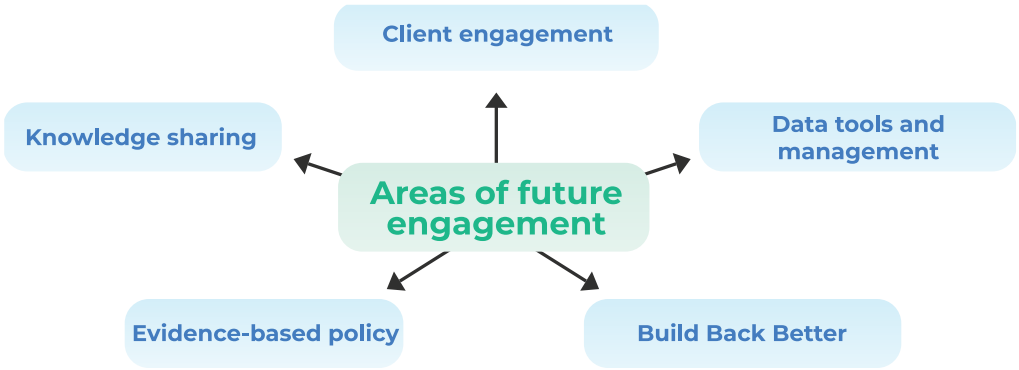
Build Back Better: Like many other countries, India, Nepal, and Pakistan face unprecedented challenges of managing the consequences of the COVID-19 pandemic. While all three countries have initiated stimulus packages to include investments and drive the creation of jobs, not all stimulus spending has 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 6.1 summarizes related ongoing World Bank studies in the region.

Box 6.1: 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.

Appendix 1: India Field Study: Waste Sampling Data Summary

The data collected during the waste sampling in Himachal Pradesh state in India as part of this study 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 and A1.2 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 waste generation or composition in Himachal Pradesh, its districts, or, broadly, in the 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

	Household		Commercial		Hotels		Tourist spot		Dump site	
Waste type	**Waste sampled (kg)**	**%**	**Waste sampled (kg)**	**%**	**Waste sampled (kg)**	**%**	**Waste sampled (kg)**	**%**	**Waste sampled (kg)**	**%**
Biodegradable	45.68	55%	27.09	51%	32.89	52%	2.77	18%	40.415	53%
Paper	8.445	10%	3.815	7%	3.575	6%	2.385	16%	4.335	6%
Cardboard	4.325	5%	4.16	8%	2.985	5%	1.51	10%	4.64	6%
Plastic	10.4	13%	7.418	14%	6.77	11%	5.951	39%	9.645	13%
Glass	5.015	6%	4.075	8%	9.885	16%	1.41	9%	4.875	6%
Metal	1.315	2%	0.18	0%	2	3%	0.13	1%	0.445	1%
Wood	0	0%	0.155	0%	0	0%	0	0%	0	0%
Rags/cloth	2.86	3%	1.515	3%	1.045	2%	0.655	4%	3.945	5%
Inert (sweeping)	2.545	3%	4.03	8%	1.34	2%	0.395	3%	5.47	7%
E-waste	0.16	0%	0.2	0%	0	0%	0	0%	0	0%
Domestic hazardous	1.935	2%	0	0%	2.88	5%	0	0%	1.97	3%
Total	***82.68***	***100%***	***52.638***	***100%***	***63.37***	***100%***	***15.206***	***100%***	***75.74***	***100%***

Note: Red circle denotes highest value in column

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

	Household		Commercial		Hotels		Tourist spot		Dump site	
Plastic waste type	**Waste sampled (kg)**	**%**	**Waste sampled (kg)**	**%**	**Waste sampled (kg)**	**%**	**Waste sampled (kg)**	**%**	**Waste sampled (kg)**	**%**
PET	1.12	11%	0.28	4%	1.54	23%	1.95	33%	1.145	17%
HDPE	1.38	13%	0.14	2%	0.69	10%	1.865	31%	0.41	6%
PVC	0.14	1%	0	0%	0	0%	0.015	0%	0	0%
LDPE	4.265	41%	3.418	46%	1.681	25%	0.51	9%	1.9	28%
PP	0.235	2%	0.615	8%	0.185	3%	0.225	4%	0.81	12%
PS	0.11	1%	1.17	16%	0.848	13%	0.001	0%	0.065	1%
Multi-layered plastic	3.15	30%	1.795	24%	1.826	27%	1.385	23%	2.485	36%
Total	***10.4***	***100%***	***7.418***	***100%***	***6.77***	***100%***	***5.951***	***100%***	***6.815***	***100%***

Note: Red circle denotes highest value in column

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***

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

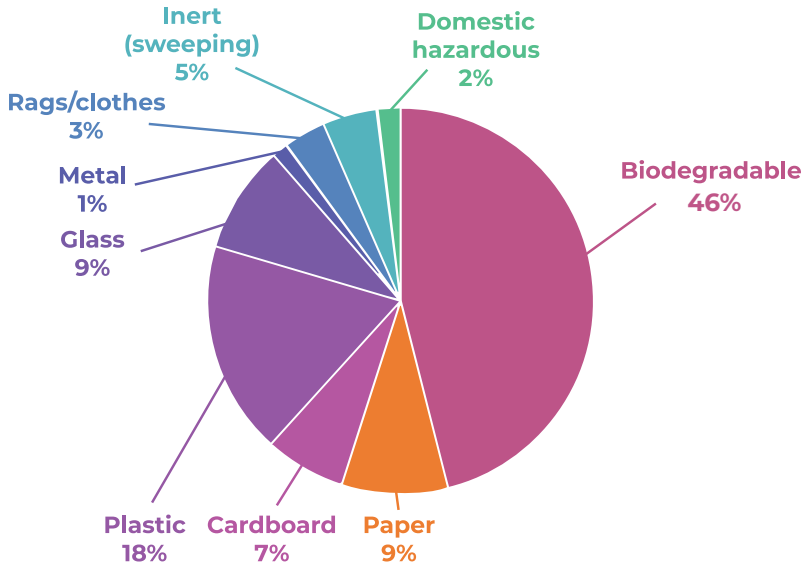
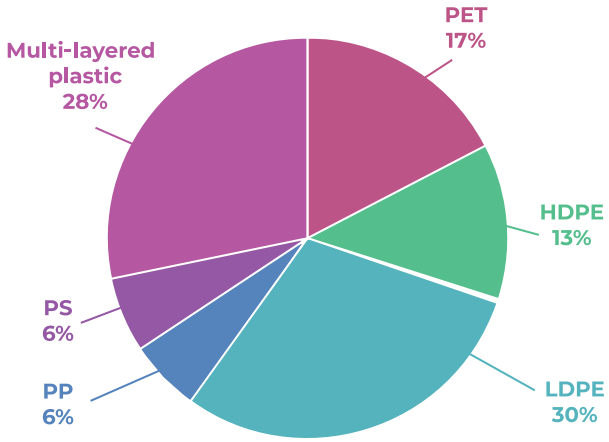


Figure A1.2: Composition of plastic waste at sampling sites in India (%)

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Appendix 2: India Solid Waste Management Rules 2016 Applicable to Hilly Areas

The following text is an excerpt of the *Solid Waste Management Rules 2016* in India that are applicable to SWM in all areas, including the plains as well as in hilly areas. The rules relate to creating SWM plans, setting user fees, integrating the informal sector, waste disposal, training, etc. The emphasis in bold has been added, but the text is unchanged.

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 *India: Sustainable Solid Waste Management in Mountain Areas* report provides an overview of the municipal solid waste management scenario in the country. Furthermore, the report investigates the impacts and challenges of mountain waste, including a detailed analysis of the data collected from the field study undertaken for this project. The report presents 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.

Other Publications in this Study:

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

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