aviral
Reducing Plastic Waste in the Ganga

Haridwar

Baseline Assessment Report

November to December 2020

Powered by: ALLIANCE TO END PLASTIC WASTE

Implemented by: giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

In Cooperation with: SIA SUSTAINABILITY INNOVATIONS AND ADVISORIES PVT. LTD.

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In Cooperation with: SIA iFOREST INTERNATIONAL FORUM FOR ENVIRONMENT SUSTAINABILITY & TECHNOLOGY

Imprint

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Executive Summary

India's plastic consumption is increasingly outpacing the ability of urban waste management infrastructures to ensure a sustainvable processing of plastic waste. With approx. 9.4 million tons/year of plastic waste generated in India, rising urban populations and an increasing per-capita waste generation, sustainable solutions to prevent plastic waste leakage are imperative. In particular cities in the Indian state Uttarakhand, which experience large influxes of tourists every year, require immediate action to address the impacts of improper plastic waste management.

Within project *Aviral* - Reducing Plastic Waste in the Ganga, plastic waste entering the cities environments is reduced by strengthening an integrative and improved plastic waste management system in the two Ganga cities Haridwar and Rishikesh. The efforts also contribute to achieving the objectives of the flagship programs of the National Mission for Clean Ganga *(Namami Gange)* and the Clean India Mission *(Swachh Bharat Mission)*. In order to sustainably enhance existing capacities, improve selected elements of the plastic waste value chain, promote innovations and implement awareness activities, *Aviral* has addressed the existing plastic waste flow data in both cities by carrying out a detailed assessment study of plastic waste material flows and existing plastic waste management practices and trends in Haridwar and Rishikesh.

This city report focusses on the results obtained in Haridwar.

The objective of this assignment is to achieve a better understanding and identify gaps and barriers for sustainable plastic waste management and potential areas of intervention. In addition to this, the assessment study results feed into the development of a city specific Plastic Waste Management Action Plan for Haridwar. The availability of accurate data on waste quantities and qualities in Indian cities is commonly low. In cities such as Haridwar, where collected, transported and disposed waste amounts are barely recorded, the estimation of waste is challenging. The data on waste generation by different government agencies, waste contractors, municipalities and literature sources vary widely.

This assessment was conducted from November to December 2020 during the ongoing COVID-19 pandemic in India. In order to prevent infection risks for the personnel of this assessment and due to existing restrictions, this study had to be conducted with certain limitations and adjustments of the methodology. Due to the COVID-19 pandemic, deviations from the previous disposal behavior were observed globally, with a tendency to an increased share of inter alia sanitization and hygiene products, packaging waste as well as delivery and to-go food and beverage containers.

In Haridwar, Municipal Solid Waste (MSW) has a significantly higher share of wet waste (78%) compared to neighboring cities like Rishikesh. Due to the higher share of organic materials, the plastic waste share is at 7%. Within the plastic waste, a distribution is found, with a slightly higher LDPE share (57%) and lower PET (5%) and HDPE (9%) shares.

Identified waste quantities showed large discrepancies to literature values and collection vehicle data. Based on extrapolated per-capita waste data, 73.2 tons/day are estimated in Haridwar. Based on collection vehicle data and weight values of service providers, 229.5 tons/day are generated. A further investigation of waste generation is required within the course of project *Aviral*. Waste collection in Haridwar is realized by 50% through door-to-door collection and 50% through community bins. Besides, waste is generated from daily street sweeping and drain cleaning. Major waste leakage occurs at the locations of community bins within commercial wards as well as at the transfer of waste between primary and secondary collection. Out of the total generated plastic waste, approx. 19% are leaked into the environment. In comparison to neighboring cities like Rishikesh, waste leakage during collection and transportation has a larger contribution to the overall plastic leakage. Almost 19% of the total daily plastic waste generation is mismanaged, which means either leaked to the terrestrial environment, into water bodies or burnt. Until end of 2020, the city had one major waste contractor, responsible for collection, treatment and disposal of the city's waste. Currently, waste is collected by the municipality and disposed without further treatment on a dumpsite in the city's outskirts. Within the city's boundaries, recycling infrastructures are not available. Collected recyclables are transported to neighboring cities. Informal collectors extract valuable plastic waste on the store points between primary and secondary collection.

In Haridwar, almost 20% of the surveyed citizens and 17% of the commercial establishments use two dustbins for storing segregated waste. Segregated waste collected in Haridwar is mixed during primary collection and sent to the city's dumpsite. Awareness on waste management was found to be low. At an average, only one in four persons was aware of the waste hierarchy and sustainable waste management practices. However, almost all citizens perceived littered waste in the environment as a major challenge and are willing to act.

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Abbreviations

CFC	Central Finance Commission
CPCB	Central Pollution Control Board
EWS	Economically Weaker Section
GIS	Geographic Information System
HDPE	High-density polyethylene
HH	Household
HNN	Haridwar Nagar Nigam
INR	Indian Rupee
JnNURM	Jawaharlal Nehru National Urban Renewal Mission
LDPE	Low-density polyethylene
MLP	Multi-Layered Plastic
MRF	Material Recovery Facility
MSW	Municipal Solid Waste
PET	Polyethylene terephthalate
PP	Polypropylene
PPE	Personal Protection Equipment
PSU	Primary sampling units
PVC	Polyvinyl chloride
RCC	Reinforced cement concrete
SBM	*Swachh Bharat Mission* (Clean India Mission)
SFC	State Finance Commission
SSU	Secondary sampling units
SWM	Solid Waste Management

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1. Introduction

1.1. The Global Plastic Waste Concern

The continually increasing generation of plastic waste and its management pose one of the biggest challenges for countries across the globe. It is being estimated that 220 million tons of plastic waste were generated in 2016. Out of these, 129 million tons were either recycled (31 million tons), landfilled (69 million tons) or incinerated (28 million tons). The remaining 91 million tons were mismanaged and hence either openly burned (49 million tons), terrestrially leaked (31 million tons) or leaked into the ocean (11 million tons). The amount of mismanaged plastic waste is estimated to increase to 239 million tons by 2040 (Pew Charitable Trusts and SYSTEMIQ, 2020). These predictions create the pressing need for considerable action to address the growing plastic pollution and the herewith connected environmental challenge.

1.2. India's Plastic Waste Challenge

This plastic waste concern is especially true for emerging and fast-growing economies like India that are facing dynamic transformations which are characterized by a growing population, rising (average) incomes, increasing urbanization levels and a growing middle class. While cities continue to grow, they often lack adequate waste management systems. The plastic waste generation data for India ranges from 3.3 million tons/year to 9.4 million tons annually (Ministry of Housing and Urban Affairs, Government of India, 2019). This data from the Central Pollution Control Board (CPCB) and the Ministry of Housing and Urban Affairs respectively, underlines the fact that the existing plastic waste flow data in India is inconsistent. This data gap increases the challenges attached to addressing and tackling India's plastic waste concerns.

The growing generation of plastic waste and the management thereof are an increasing challenge particularly for urban local bodies, since the lack of financial means and capacities lead to a severely constrained infrastructure and limited solutions. According to the Ministry of Housing and Urban Affairs, about 60% of the 26,000 tons of plastic waste, which are generated per day, are currently being recycled, which leaves over 9,400 tons of plastic waste per day either landfilled or leaked into the environment.

1.3. Uttarakhand

Amongst the Indian states, Uttarakhand faces great challenges for sustainable plastic waste management: More than 80% of its geographic area are mountainous terrain and more than 60% are covered by forest, which calls for innovative and adaptable plastic waste management solutions along the value chain (Nainital Tourism, n.d.). The large number of tourists travelling to Uttarakhand annually, either on pilgrimage or to visit its diverse natural resources, increases the state's plastic waste challenge. According to the Uttarakhand Environment Protection

and Pollution Control Board, it is estimated that a total of 31,100 tons of plastic waste were generated in 2019 (Central Pollution Control Board, 2019). Low segregation rates and reduced recycling capability of plastic materials within the municipal solid waste collection impede the establishment of sustainable plastic material circles. Therefore, action needs to be taken to address the impacts of improper plastic waste management in the state.

1.4. *Aviral* - Reducing Plastic Waste in the Ganga

In July 2020, GIZ entered a strategic partnership with the Alliance to End Plastic Waste. Launched in January 2019, the Alliance is a CEO-led, cross-sector, not-for profit organization with a mission to develop, accelerate and deploy solutions, catalyze public and private investment and engage communities to help end plastic waste in the environment. Envisaging a series of projects globally, this partnership aims to contribute to the achievement of the Sustainable Development Goals, notably focusing on SDG 6, SDG 8, SDG 11, SDG 12, SDG 13 and SDG 17.

The first joint project to combat the negative impacts of the increasing amounts of plastic waste is being implemented in India since the end of 2019 (The Week , 2020). The objective of this project, *Aviral* - Reducing Plastic Waste in the Ganga, is to reduce the plastic waste entering the cities environments of Haridwar and Rishikesh by strengthening an integrative and improved plastic waste management system. The efforts also contribute to achieving the objectives of the flagship programs of the National Mission for Clean Ganga *(Namami Gange)* and the Clean India Mission *(Swachh Bharat Mission)*.

In Haridwar, *Aviral* works hand in hand with the municipal corporation, while it is embedded in the broader plastic waste management ecosystem, collaborating with inter alia the private sector, informal waste workers, schools and local NGOs.

In order to sustainably enhance existing capacities, improve selected elements of the plastic waste value chain, promote innovations and implement awareness activities, *Aviral* has addressed the existing plastic waste flow data in Haridwar by carrying out a detailed assessment study of plastic waste material flows and existing plastic waste management practices and trends in Haridwar. The objective of this assignment is to achieve a better understanding and identify gaps and barriers for sustainable plastic waste management and potential areas of intervention. In addition to this, the assessment study results feed into the development of city specific Plastic Waste Management Action Plans for Haridwar.

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2. Definitions

Ashram	*Ashram* is a Hindi term, describing a spiritual and/or religious place. In the area of investigation, Ashram's are also used for yoga.
Blackspot	Blackspots, also called litter spots, are open and illegal dumping locations for waste, mostly found in open spaces, on roadsides and on riverbanks. Depending on its size and concentration of plastic waste, blackspots can become plastic waste hotspots.
Commercial establishment	According to the Shops and Establishment Act in India, a commercial establishment is a premise where any trade, business, profession or any work related with it, is undertaken.
Dharamshala	*Dharamshala* is a Hindi term, which is used in the area of investigation for public resthouses or shelters, in particular for religious travelers at pilgrimage sites like Haridwar.
Dry waste	Dry waste according to the Indian SWM Rules 2016 means waste other than bio-degradable waste and inert street sweeping and includes recyclable and non-recyclable waste, combustible waste, sanitary napkins and diapers.
Ghat	*Ghat* is a Hindi term, which is used in the area of investigation and refers to a stairway or a downward path leading to a river.
Informal waste collector	An informal waste collector is defined as a person or a group of persons informally engaged in the collection and recovery of reusable and recyclable solid waste from households, streets, bins, Material Recovery Facilities (MRF) and processing and waste disposal facilities to earn their livelihood by selling - directly or through intermediates - the collected and recovered solid waste to recyclers.
Kabadi Walas	*Kabadi Walas* are scrap vendors, who trade recyclables and valuable waste items purchased from waste collectors and sell the aggregated valuables to recyclers. *Kabadi Walas* can be individuals, associations or waste traders, involved in the sorting, sale and purchase of recyclable materials.
Plastic waste hotspot	Plastic waste hotspots are uncontained locations with high plastic waste concentrations, generated by direct disposal or indirect accumulation. Plastic waste hotspots directly or indirectly contribute to plastic waste leakage into the environment.
Tipper / Auto Tipper	In Haridwar, small four-wheeled tipping trucks, called tipper, are used for waste collection. Tippers with a closed garbage box are used for door-to-door collection and transportation of municipal and other types of waste from the collection to the disposal point. The vehicles have a loading capacity of 2 m^3.
Wet waste	Wet waste is defined as biodegradable waste according to the Indian Solid Waste Management (SWM) Rules 2016. Further, biodegradable waste is defined as any organic material that can be degraded by micro-organisms into simpler stable compound.

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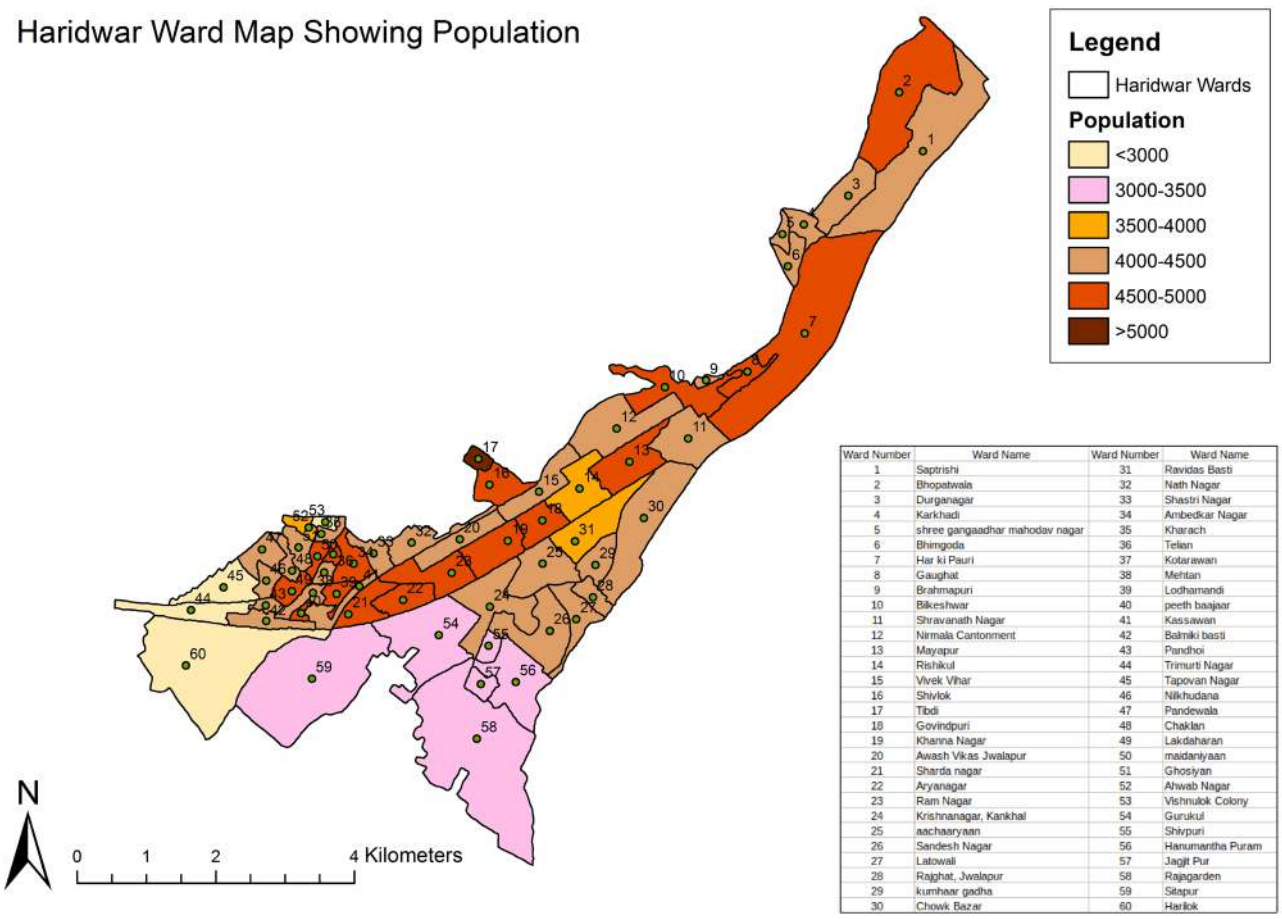
3. Area of Investigation

Haridwar is a city and municipal corporation in the Haridwar district of Uttarakhand. The city, which is situated on the western bank of the river Ganga, is regarded as a holy place for Hindus, hosting numerous religious events throughout the year and serving as a gateway to several places of worship. One of the most significant events is the *Kumbh Mela*, which is celebrated every twelve years in Haridwar. During the Haridwar *Kumbh Mela*, millions of pilgrims, devotees, and tourists congregate in Haridwar to perform ritualistic bathing on the banks of the river Ganges.

Haridwar Municipal Corporation (Haridwar *Nagar Nigam* (HNN)), consists of 60 wards with a total population of 251,197 in 2018, which makes Haridwar the second largest city in the state of Uttarakhand and the largest in the district. Figure 1 shows the ward map and the population of Haridwar.



Ward Number	Ward Name	Ward Number	Ward Name
1	Saptrishi	31	Ravidas Basti
2	Bhopatwala	32	Nath Nagar
3	Durganagar	33	Shastri Nagar
4	Karkhadi	34	Ambedkar Nagar
5	shree gangaadhar mahodav nagar	35	Kharach
6	Bhimgoda	36	Telian
7	Har ki Pauri	37	Kotarawan
8	Gaughat	38	Mehtan
9	Brahmapuri	39	Lodhamandi
10	Bilkeshwar	40	peeth baajwar
11	Shravanath Nagar	41	Kassawan
12	Nirmala Cantonment	42	Balmiki basti
13	Mayapur	43	Pandhoi
14	Rishikul	44	Trimurti Nagar
15	Vivek Vihar	45	Tapovan Nagar
16	Shivlok	46	Nilkhudana
17	Tibdi	47	Pandewala
18	Govindpuri	48	Chaklan
19	Khanna Nagar	49	Lakdaharan
20	Awash Vikas Jwalapur	50	maidaniyaan
21	Sharda nagar	51	Ghosiyan
22	Aryanagar	52	Ahwab Nagar
23	Ram Nagar	53	Vishnulok Colony
24	Krishnanagar, Kankhal	54	Gurukul
25	aachaaryaan	55	Shivpuri
26	Sandesh Nagar	56	Hanumantha Puram
27	Latowali	57	Jagjit Pur
28	Rajghat, Jwalapur	58	Rajagarden
29	kumhaar gadha	59	Sitapur
30	Chowk Bazar	60	Harilok

Figure 1: Haridwar ward map showing population.

The average daily influx of tourists was estimated to be 119,346 persons in 2019, see Table 1. The average daily tourist population influx contributed an additional 48% of the overall population of Haridwar.

Table 1: Demographic profile Haridwar.

Resident population in 2018 (HNN, 2018)	251,197
Number of households (approx.) (HNN, 2020)	41,335
Number of commercial establishments (approx.) (HNN, 2020)	6,000
Additional daily average tourist influx in 2019* (Uttarakhand Tourism Department, 2020)	119,346
Number of wards	60

*Calculated from data provided by the Uttarakhand Tourism Department, 2020.
The average daily tourist influx is estimated based on the total tourist bed nights.

The majority of tourists are Indian nationals. Foreign tourists only contribute 0.2%. The tourist number, however, also includes multiple night stays. In order to estimate the additional daily population number, the total number of bed nights is utilized.

Table 2: Month-wise tourist influx in Haridwar (Uttarakhand Tourism Department, 2020).

	Monthly number of tourists	Monthly number of bed nights			Daily bed nights
		Nationals	Internationals	Total	
January	914,205	1,825,500	4,365	1,829,865	59,028
February	1,152,578	2,301,000	6,234	2,307,234	82,401
March	1,248,065	2,491,500	6,945	2,498,445	80,595
April	1,981,837	3,960,450	4,836	3,965,286	132,176
May	1,876,552	3,751,000	3,156	3,754,156	121,102
June	1,897,141	3,791,000	4,923	3,795,923	126,531
July	3,877,115	7,751,300	4,395	7,755,695	250,184
August	2,877,016	5,751,500	3,798	5,755,298	185,655
September	1,637,771	3,273,000	3,813	3,276,813	109,227
October	1,979,346	3,954,900	5,688	3,960,588	127,761
November	1,373,847	2,742,700	7,491	2,750,191	91,673
December	954,759	1,905,000	6,777	1,911,777	61,670
Total	**21,770,232**	**43,498,850**	**62,421**	**43,561,271**	
Annual Average					**119,346**

During the year, the average daily tourist influx of 119,346 varies strongly in festive seasons and is generally higher on weekends due to short time tourist visits from the nearby cities of Delhi-NCR. In 2019, the Uttarakhand Tourism Department (2020) recorded a total number of 21,770,232 tourists with 43,561,271 bed nights.

4. Methodology

4.1. Overview

The objective of this baseline assessment is to identify the current status of the solid waste management systems in Haridwar to strengthen the city's plastic waste management. Besides an accurate data basis on solid waste quantities and qualities, an investigation of institutional and social roles and responsibilities as well as the interaction of stakeholders within the city and the current awareness level of citizens are an imperative for supporting the city in its management of plastic waste. This assessment describes the status-quo of the city's waste management system. The presented waste quantification and characterization was conducted within a seven-day time period. Seasonal effects on public disposal behavior and waste composition are not mapped in this assessment, however, they have been evaluated through secondary literature and will be addressed and added during the further course of the *Aviral* project implementation.

Generally, the availability of accurate data on waste quantities and qualities in Indian cities is commonly low. In cities like Haridwar, where collected, transported and disposed waste amounts are barely recorded, the estimation of waste is challenging. The data on waste generation by different government agencies, waste contractors, municipalities and literature sources vary widely. This is also the case in Haridwar, where strongly varying data on waste quantities and qualities are available. Following a standardized methodology reduces the uncertainty of values, however, cannot eliminate it. Especially the Indian waste sectors is based to a significant extend on informal activities, which poses a notable challenge for an appropriate and scientifically accurate methodology design.

This assessment was conducted from November to December 2020 during the ongoing COVID-19 pandemic in India. In order to prevent infection risks for the personnel of this assessment and due to existing restrictions, this study had to be conducted with certain limitations and adjustments of the methodology. Due to the COVID-19 pandemic, deviations from the previous disposal behavior were observed globally, with a tendency to an increased share of inter alia sanitization and hygiene products, packaging waste as well as delivery and to-go food and beverage containers.

As a baseline study, this assessment does not reflect seasonal variations of waste quantities and qualities. Seasonal waste data from previous assessment in the area of investigation are not available for data validation. The extent of seasonal variations on waste quantities and qualities have to be further investigated in the course of project *Aviral*. The assumed deviations of the disposal behavior and the pandemic-related limitations of this assessment are investigated through an evaluation of existing data and secondary literature from previous years. The assessments conducted in Haridwar contain three key components:

1. **Waste inventory analysis**
   - Composition;
   - Plastic typology;
   - Quantification.

2. **Analysis of current status of waste management in the city**
   - Population and source enumeration;
   - Existing waste management infrastructure;
   - Assessment of plastic leakage;
   - Assessment of the informal waste sector and the plastic waste value chain.

3. **Stakeholder perception, awareness, knowledge and capacity assessment**
   - Survey of households and commercial entities;
   - Assessment of capacity building needs of various stakeholders including ULBs, the informal sector and private entities.

The methodologies of the conducted assessments are presented in the following. For population and source enumeration, additional background information are required, which are elaborated in detail in the Annex, see Table 19, Table 20 and Table 21.

4.2. Waste Quantification and Characterization

Number of samples

The Guidelines for Solid Waste Management Assessment (baseline survey) developed by the United Nations Economic and Social Commission for Asia and the Pacific were adopted to collect and measure the waste from sampling units and assess the waste composition with regards to different waste generator types (UNESCAP, 2010). For waste quantification and characterization, the desired level of data accuracy must be balanced with the available resources and time. An analysis of all waste generators within one city, the parent population, commonly exceeds the feasibility of assessment studies, in particular in large cities. In order to ensure an adequate level of data reliability, the current status of the total urban area is assessed through the number of random samples, collected at different locations throughout the assessment area and representing the parent population through approximation. The required minimum number of samples is calculated to ensure the desired precision level.

The UNESCAP's Guidelines for Solid Waste Management Assessment do not provide a statistical equation for sampling in secondary cities and small towns (<1 million population) in Asia and the Pacific. The guidelines have recommended the following sampling approach:

- Define several residential areas, which represent different socio-economic population groups (low, middle- and upper-income groups);
- Select 60 to 100 households (HHs) for each of the residential areas;
- Identify a predominant business area, where a large number of shops and offices are located and select 50 shops and offices for the business area;

› Alternatively, business areas can be further divided into more specific categories such as hotels and restaurants, offices, shops and stores, and workshops. Select approximately 10 to 20 samples for each category;
› Collect the waste generated in the above areas once a day at a fixed time for eight successive days to allow variation over the week (the sample of the first day shall be discarded to avoid biased results due to waste accumulated from two or more days).

According to the methodology, the total number of samples in Haridwar needs to be 180-300 household samples and 50 commercial and institutional samples. The total sample size is required to be 230-350.

Another recent methodology for determining waste quantities and compositions is the Waste Wise Cities Tool developed by UN-Habitat (UN Habitat, 2021). To ensure data comparability of this assessment in Haridwar with international data of the Waste Wise Cities Tool, the statistical parameters are evaluated. According to the Waste Wise Cities Tool, in order to achieve a confidence level of 95% and a 5% error, at least 370 to 384 households need to be sampled over a period of seven days for a city with 10,000 to 10 million inhabitants. In order to verify this approach, the statistically required minimum number of samples was determined. The sample size was estimated based on a 95% confidence level and a 5% error. This reflects a reasonable balance between resources and statistical integrity.

$$\text{Sample size} = \frac{\frac{z^2 \cdot p\,(1-p)}{e^2}}{1 + \frac{z^2 \cdot p\,(1-p)}{e^2 N}}$$

Where:

› N population size
› e Margin of error (percentage in decimal form)
› z z-score based on the confidence level (for 95% confidence level, z-score is 1.96)

In practice, households and commercial establishments are not used to the sample requirements during the sampling period (i.e. seven days for this assessment). To meet the theoretical requirement, the actual sample size is recommended to be 25% higher than the theoretical calculation. This ensures that on all sampling days, the sample collected is on the higher side and not on the lower side of the theoretical requirement.

With a total number of households (approx.) of 41,335 and a total number of commercial establishments (approx.) 6,000, the number of waste generators amounts to 47,335. Following the equation above, the required minimum number of samples amounts to 382. In the assessment of Haridwar, 383 households and 91 commercial establishments participated in the perception survey and 187 households and 51 commercial establishments were included in the waste characterization.

In Haridwar, approx. 50% of the generated solid waste is collected through door-to-door collection, while the remaining 50% is disposed in community bins. To reflect this practice in the

sampling, half of all the waste was collected from the community bins and half through door-to-door collection. The number of door-to-door samples was therefore halved from the total required minimum sample amount of 382. The resulting minimum required number of samples for door-to-door collection amounted to 191. In order to ensure an adequate data reliability and address the non-availability of the actual door-to-door collection share, the number of samples was increased by 25% to 238. In addition to residential and commercial waste generators, community bins in Haridwar were sampled to reflect the existing waste management system. A total amount of 14 community bins were randomly selected, of which seven were located in predominantly residential areas and seven in predominantly commercial areas.

The sample number considered for Haridwar is higher than recommended by the UNESCAP guidelines and in line with the recent Waste Wise City Tool by UN-Habitat. Hence, the presented assessment ensures a high level of data precision and data comparability with international waste system data.

Sampling methodology

This assessment was conducted from November to December 2020 during the ongoing COVID-19 pandemic in India. Commonly, samples are collected without contacting the waste generators in advance to avoid biased disposal behavior. Without any interventions, however, this would result in waste generators also disposing medical waste potentially contaminated with COVID-19, posing a significant risk to the subsequent sorting personnel. In order to avoid any potential health impact, the waste generators were approached prior to the assessment and asked to collect their medical waste in a separate bag. Firstly, the selected waste generators were surveyed regarding their waste management awareness and perception. Secondly, the same generators were requested to store their waste for measurement.

In Haridwar, the initial survey showed that almost 50% of the total waste is collected through community bins. Hence, in addition to the waste collected from the selected waste generators, waste from common disposal sites, like community bins, were also collected and analyzed to reflect the actual disposal pattern in the city. A stratified two-stage sampling design was adopted to capture the diversity in economic status and economic activities in the city. The city area was divided according to two stratification criteria:

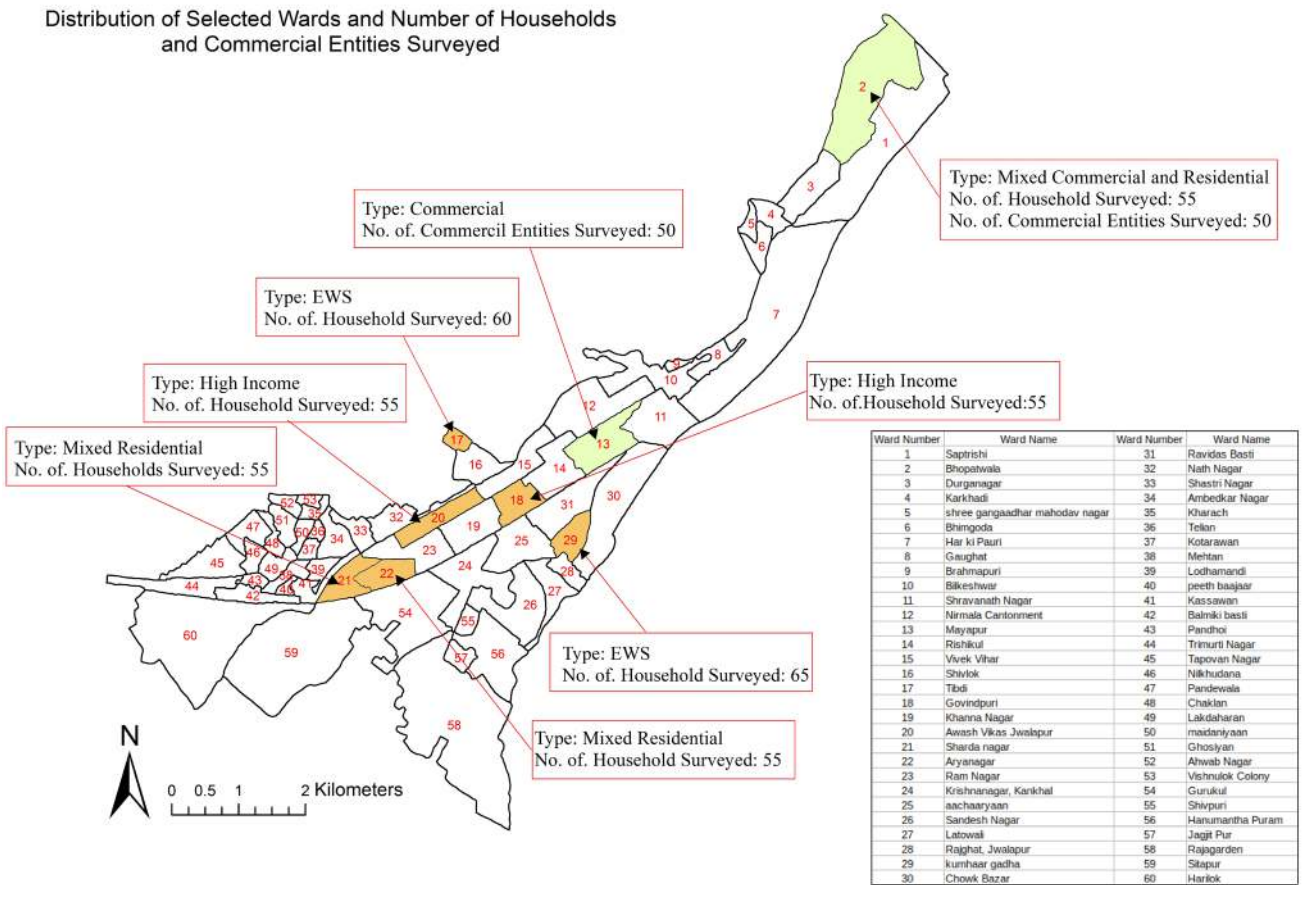
- Economic status of wards as primary sampling units (PSU);
- Waste generator type as secondary sampling units (SSU).

As a first step for PSU, the wards were divided into five groups based on the property tax rates and the proportion of taxes collected from different economic sectors:

- High-income residential wards;
- Mixed income residential wards;
- Economically Weaker Section (EWS) of residential wards;
- Commercial wards;
- Mixed residential and commercial wards.

The tax rate is based on the width of the road and type of construction. For 24 m wide roads, the rate for a high-income is 2.52 INR per square foot. For both mixed land and low-income, it is 2.21 INR per square foot. Similar rates have been specified for 12 to 24 m wide roads and roads with less than 12 m width. The tax data was complemented with the support of the municipality. HNN listed areas as high-income, low-income and mixed land use as per their own categorization.

The SSU were primarily households and commercial entities. In normal times, hotels, schools, colleges and offices would have also been included as part of the SSU. However, during the study period, education institutions were mostly closed and tourism barely existent in the city. These waste generators could therefore not be analyzed. To determine the share of these waste generator types in the total urban waste generation, the extrapolated waste generation values were validated with the data available from the waste collection. Within the selected PSU, the SSU (i.e. households and commercial establishments) were selected through a stratified random sampling method, using a skip interval and random start method. The selected wards in Haridwar are presented in Figure 2. The distribution of the SSU within the selected PSU are presented in Table 3. The SSU values represent the intended sampling amount. The actual values are slightly lower due to the waste generators' actual participation in this assessment.



Ward Number	Ward Name	Ward Number	Ward Name
1	Saptrishi	31	Ravidas Basti
2	Bhopatwala	32	Nath Nagar
3	Durganagar	33	Shastri Nagar
4	Karkhadi	34	Ambedkar Nagar
5	shree gangaadhar mahodav nagar	35	Kharach
6	Bhimgoda	36	Telian
7	Har ki Pauri	37	Kotarawan
8	Gaughat	38	Mehtan
9	Brahmapuri	39	Lodhamandi
10	Bilkeshwar	40	peeth baajaar
11	Shravanath Nagar	41	Kassawan
12	Nirmala Cantonment	42	Balmiki basti
13	Mayapur	43	Pandhoi
14	Rishikul	44	Trimurti Nagar
15	Vivek Vihar	45	Tapovan Nagar
16	Shivlok	46	Nilkhudana
17	Tibdi	47	Pandewala
18	Govindpuri	48	Chaklan
19	Khanna Nagar	49	Lakdaharan
20	Awash Vikas Jwalapur	50	madaniyaan
21	Sharda nagar	51	Ghosiyan
22	Aryanagar	52	Ahwab Nagar
23	Ram Nagar	53	Vishnulok Colony
24	Krishnanagar, Kankhal	54	Gurukul
25	aachaaryaan	55	Shivpuri
26	Sandesh Nagar	56	Hanumantha Puram
27	Latowali	57	Jagjit Pur
28	Rajghat, Jwalapur	58	Rajagarden
29	kumhaar gadha	59	Sitapur
30	Chowk Bazar	60	Harilok

Figure 2: Distribution of selected wards and number of Households and commercial entities surveyed in Haridwar.

Table 3: Sampling in Haridwar.

Name of selected ward	Type of selected ward	Number of SSUs
Sharda Nagar	Mixed Residential	55
Arya Nagar	Mixed Residential	55
Tibdi	EWS	60
Kumargarha	EWS	65
Bhupatwala	Mixed Commercial & Residential	105
Mayapur (Railway Road)	Commercial	50
Govindpuri	High-Income	55
Awash Vikas	High-Income	55

In Haridwar, 1,308 household samples with a total of 1.3 tons of waste were collected over a seven-day period. An additional amount of 1.4 tons of waste were collected from community bins placed at different locations in the city and from commercial establishments.

Sorting methodology

Due to the COVID-19 restrictions, the sampling of certain sectors such as hospitality, offices and institutions was not possible. Waste generation from these sectors was estimated based on secondary sources. The waste inventory was conducted in two parts.

1. Estimation of waste based on physical sampling from households, commercial establishments and community bins; and,
2. Estimation of waste from hotels, institutions, religious places, road sweeping and *Ghat* cleaning based on the secondary data.

The overall process flow scheme of the quantification and characterization process is presented in Figure 3.

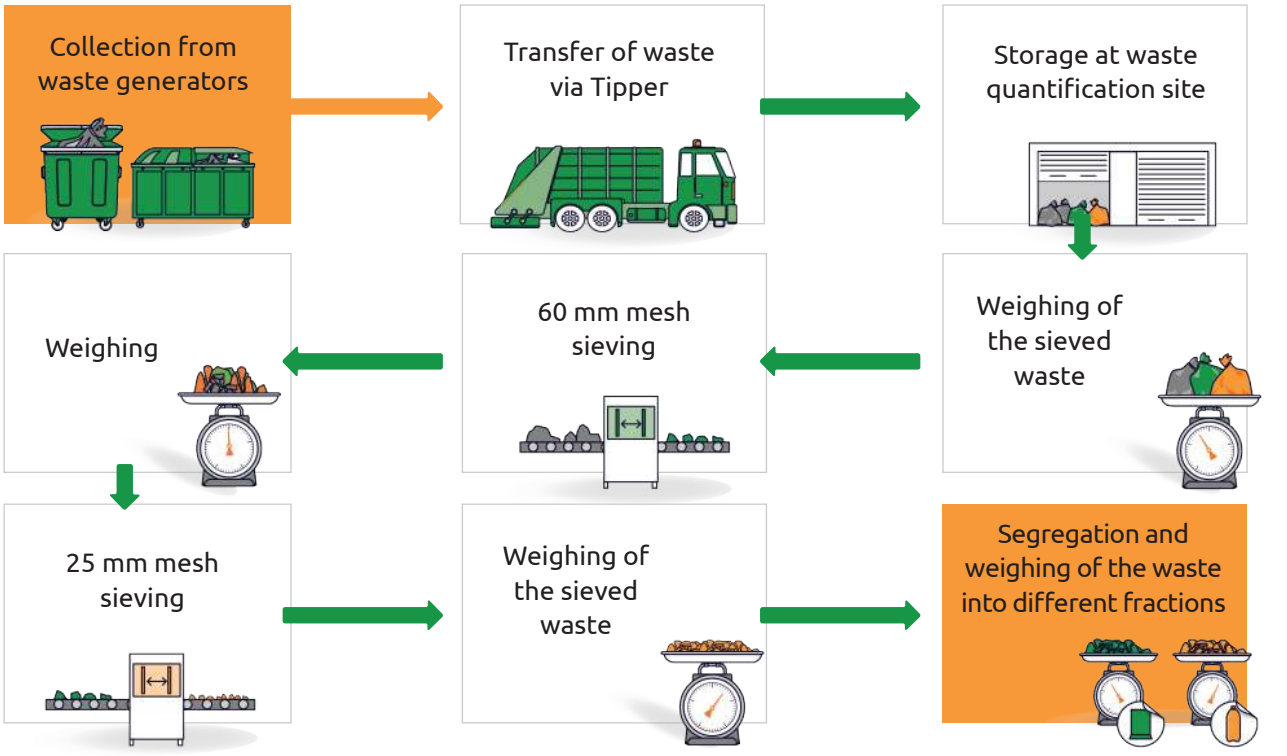


Figure 3: Flowchart for waste quantification.

Step 1: Collection of waste

In each selected ward, a volunteer was made responsible for coordinating the sample collection alongside the municipal waste collector. The survey staff was trained for the perception study and for coordinating the waste collection. A three-day hands-on training was provided in Haridwar. The main responsibility of the volunteer was to ensure that the samples were collected and recorded correctly. To identify the selected households and commercial establishment, a sticker with the ward number and the household/establishment number was fixed at the gate of the waste generators. For each ward, a checklist was handed out to the volunteers, which included the sample code and date to record the waste collection from the sampling units.

The waste generators were provided with plastic bags to store their generated waste. 15-liter black bags were distributed to collect daily mixed waste. Additionally, a single 35-40-liter red garbage bag was provided for domestic hazardous waste to reduce the infection risks for the survey and sorting personnel. To raise awareness about domestic hazardous waste, a pictorial pamphlet in English and Hindi was handed out and explained to the participating waste generators. The households were asked to store their daily waste in the provided bags over a period of eight days, while the commercial establishments were asked to store their two-day waste. The waste collected on the first day was discarded to avoid biased results from previous days. The waste samples were collected in the morning according to the sampling checklist illustrated in Table 4.

Table 4: Sampling checklist for marking waste collection.

Sample code	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
AVHH01								
AVHH02								
AVHH03								
…								

As mentioned above, the existing waste collection systems are reflected in this assessment. In an initial investigation it was identified that approx. 50% of Haridwar's daily waste is collected through community bins. Hence, in addition to the households and commercial establishments, waste was collected from different community bins in Haridwar every day and analyzed separately. In Haridwar, a minimum required sample number of 382 was estimated as described above. Since 50% of the waste is collection through door-to-door collection, the total number of 382 was divided into two halves. 191 samples were obtained from households, and 191 from community bins. Before taking the samples, larger waste portions of community bins were extracted and reduced to individual samples by the quartering method. In total, 14 community bins were sampled in Haridwar, two per day.

Step 2: Transfer of the collected waste

The waste samples from each ward and community bin were collected separately in jumbo bags with a volume range of 500-1,000 liter and carefully marked with the name of the ward and the total number of households that had given away their waste on the respective day. For commercial establishments, a separate jumbo bag was provided. The collected waste was transferred to the sorting station with the help of an auto tipper. Jumbo bags from different wards and categories were stored separately and brought to the waste quantification site.

Step 3: Weighing the waste from different wards

The weighing and sorting of the samples was carried out, in accordance with the municipality, at a temporary sorting station for this assessment located at an open space which is commonly used by the informal sector for waste segregation. The waste from each jumbo bag was analyzed separately. The waste from the jumbo bags was emptied in a bucket and the garbage bags were discarded. The empty weight was noted and subsequently subtracted from the total waste. A digital iron platform weight scale with a capacity of 250 kg and an accuracy of ±10 g was used. The scale was caliberated and the error margin checked with a weight of 10 kg before it was used for quantification.

Step 4: Particle size distribution

The weighed waste was subsequently screened into three different size fractions using rectangular meshes with an edge length of 25x25 mm and 60x60 mm.

- Firstly, the weighed waste was emptied over the 60 mm mesh and sieved properly to extract the waste with less than 60 mm size. The reject remaining on the sieve was collected and weighed.
- The second stage was the 25 mm screening. The 60 mm extract was sieved with the 25 mm mesh. Both extract (<25 mm) and reject (25-60 mm) were separately collected and weighed.

Step 5: Sorting and quantifying

After the particle size analysis, the sample waste was sorted. A temporary platform with High-density polyethylene (HDPE) liner was made for the waste quantification at the sorting station. Two helpers and five sorters were engaged in carrying out the quantification exercise. The helpers and sorters were provided with appropriate personal protection equipment (PPE) for their safety. The sorting was conducted with the help of trained workers, who were first trained in sorting different types of wastes, including different types of plastics. A pictorial banner for the training purpose was developed and used. Firstly, the waste was quantified and separated into dry and wet waste. The dry waste was further sorted into seven primary sorting categories:

- Papers,
- Textiles,
- Rubbers & leathers,
- Metals,
- Glass,
- Plastics,
- and others.

Against the background of the objective of this assessment, the primary category plastics was further sorted into seven secondary sorting categories according to the BIS standard for plastic codification (IS 14534:1998) and adopted by the CPCB for plastic segregation (see Table 5).

Table 5: Different category of plastic as per BIS standards.

Category Type	Short Name	Uses
1	PET	Soft drink bottles, furniture, carpet, paneling, etc.
2	HDPE	Bottles, carry bags, recycling bins, agricultural pipe, base cups, playground equipment, etc.
3	PVC	Pipe, Window profile, fencing, flooring, shower curtains, lawn chairs, non-food bottles and children's toys, etc.
4	LDPE	Plastic bags, various containers, dispensing bottles, wash bottles, tubing, etc.
5	PP	Auto parts, industrial fibers, food containers, dishware, etc.
6	PS	Cafeteria trays, plastic utensils, toys, video cassettes and cases, clamshell containers, insulation board, etc.
7	Others	Multilayer Packaging and Laminates, Bakelite, Polycarbonate, Nylon SMC, FRP, etc.

Step 6: Waste quantification

The waste quantification was conducted following two approaches for cross-validation of the results, an extrapolation of per-capita generation data and an assessment of available collection and processing data.

1. For the waste quantification based on extrapolation of per-capita data, the survey data of the waste inventory was utilized. During the assessment and notification of waste generators prior to the survey and waste sampling, the number of inhabitants per household was noted. Waste samples from different households within one ward (PSU) were collected and weighed at the temporary sorting center. The total weight of the daily collected samples was divided by the total number of persons connected to the respective households. Based on this, a daily waste generation per person value was calculated for different wards.
2. For the verification of the extrapolated data, actual waste management data can be used. In case of Haridwar, weighing data at the landfill level were not available. However, the number of trips required for waste transportation was recorded over a period of seven days. Based on the vehicles' individual collection capacity, the maximum potentially transported waste amounts were estimated. The community bins with capacity of 4 m^3 can hold a maximum of 1.0 to 1.3 tons of waste.

To record the data on daily basis coming from different wards and community bins, a record sheet was developed in a tabular format and illustrated in the Annex, Table 22.

4.3. Analysis of Current Status of Waste Management

Assessment of the existing waste management infrastructure

For the analysis of the waste management infrastructure, available data from the municipality and the former local waste contractor were used. Parallelly, discussions were held with waste management officials and stakeholders in order to support the understanding of the city's waste management system. The existing waste management infrastructure was additional investigated through on-ground assessments and field surveys as shown in the Annex, Table 23.

The following categories help in capturing the existing infrastructure data at ward level and city level. The detailed surveys format for each category are listed in the Annex.

- City Level Information (Table 24 and Table 25)
- Assessment of municipality (Table 26)
- Finance data from the municipality (Table 27 and Table 28)
- Assessment of Private agency for waste collection and management (Table 29)
- Hotels (Table 30)
- Schools and Colleges (Table 31)
- Religious places (Table 32)

Assessment of plastic leakage

This assessment aims to set the basis for developing a sustainable and integrated plastic waste management system for Haridwar. Strategies to prevent or reduce plastic waste leakage into the environment play an essential role when it comes to plastic waste management solutions. Plastic waste leakage can occur through diffuse emissions (e.g. waste littering on household/ citizen level) or accumulation along point, line or area sources. In multiple urban areas of India, open littering of waste can be observed across the city. Although littering is prohibited by law, it follows an inherent structure. Waste that is not collected or covered under the municipal collection system is disposed on certain points along roadsides or in open spaces. While these locations are not specifically marked or intended by authorities, they are usually known to the waste generators for disposal and the waste collectors for their clean-ups. These locations are usually open dumping points for waste, prone to dispersion by wind and attraction of vermin and larger animals. In particular, plastic waste items are commonly dispersed more easily by wind and other factors in the surrounding environment. Litter spots at or close to riverbanks additionally are a potential source for riverine plastic waste. Capturing or avoiding these point sources can have significant impacts on the reduction of urban plastic waste leakage. Due to the dynamic nature of these hotspots, an accurate quantification within the scope of this analysis was not conducted. In this assessment, these point sources are identified and mapped. The identification of major leakage spots supports the design of targeted management solutions for plastic waste diversion.

In this assessment, plastic waste hotspots are defined as major leakage points of plastic waste in the environment. The hotspots were identified through field surveys and interviews with municipal officials, citizens and community leaders. Field surveys and interviews were also used to determine the annual intensity of plastic waste leakage. The identification of plastic waste hotspots supports the design of adapted solutions to reduce plastic waste emissions into the environment. However, this assessment only allows for a qualitative evaluation of hotspots and does not incorporate diffuse plastic waste leakage along the collection and processing chain. To quantify these emissions, another methodology has to be applied. Due to the diffuse nature of waste emissions, an on-ground quantification for one entire city would require an immense financial, personnel and time effort. Besides data collection, the implementation of an on-ground quantification was considered as not feasible from an institutional perspective. As a result, a leakage quantification based on extrapolated data following a uniform methodology was applied. For this assessment, the Waste Flow Diagram recently developed by GIZ, University of Leeds, Eawag-Sandec and Wasteaware (2020) was applied.

Assessment of the informal waste sector and the plastic waste value chain

The informal waste sector has a fundamental role in managing and recycling the city's waste. Not being a part of the official waste collection system and waste management funding, informal waste workers and recyclers play a crucial role within the waste management system and operate only based on the financial value of collected waste materials. Informal workers are commonly marginalized groups with low income and education levels but drive an elaborated value chain for recyclables within the city and beyond its boundaries.

For any new plastic waste management system, the existing recycling networks of the informal sector form an important basis for understanding market demands and mechanisms and identifying potential opportunities for plastic waste management business cases. Due to the relevance of this sector, in particular for plastic waste collection and recycling, a detailed assessment has been conducted for the informal waste sector. Firstly, the existing informal waste collection structures and networks were identified based on interviews with municipal officials, community leaders and informal workers. Secondly, a survey was conducted for the informal waste sector, see Annex Table 33 and Table 34. The objective of the survey was to obtain detailed information on types of collected waste items, trading and markets of recyclables, income of waste aggregators, numbers of waste collectors employed and the overall plastic waste chain.

4.4. Stakeholder Perception, Knowledge and Capacity Assessment

Computer-Assisted Personal Interviewing was used for the perception study, in which the interviewer uses an electronic device to record the answer to the questions from the respondent, or the respondent uses an electronic device to answer the questions. The number of samples was calculated following the equation presented above in this chapter. In Haridwar, 383 households and 91 commercial establishments were surveyed.

The perception questionnaire – in Hindi and English - was uploaded in an online form and was used by the enumerators on the ground. The questionnaire was designed to capture information on the knowledge and awareness levels of the respondents, their waste disposal habits and their perception regarding the existing waste management systems in the city. Two different forms of questionnaires were developed and used for households and commercial establishments respectively.

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5. Waste Inventory

5.1. Size Distribution

The overall size distribution of solid waste in Haridwar is presented in the following. The overall size distribution of waste items in the city is 46% above 60 mm and 34% below 25 mm. The particle size distribution of the waste from households shows that more than 43% of the total waste are >60 mm in size, while and 37% are <25 mm in size. Similar to the observations made in neighboring cities like Rishikesh, most of Haridwar's dry waste, including plastic, paper and textiles, is larger than >60 mm in size. Below 25 mm, mostly wet waste can be found. The size distribution assessment of waste from community bins shows that nearly 49% of the total waste are >60 mm in size, while around 30% are <25 mm. The size distribution from commercial establishments shows that more than 54% of the total waste are >60 mm in size, which is a bigger share compared to the same segment in the household waste, caused by a higher share of dry waste.

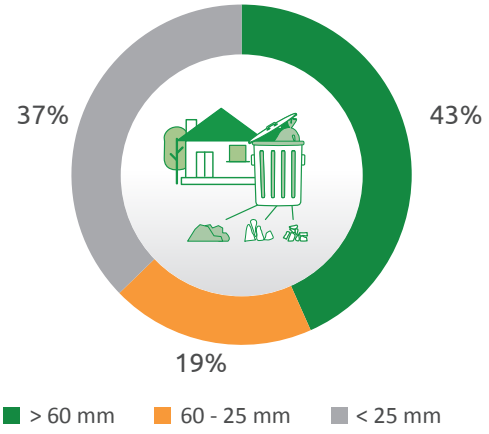


Figure 4: Household waste - Particle size distribution, Haridwar.

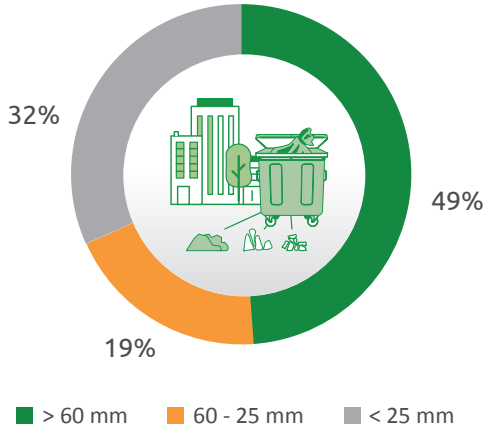


Figure 5: Community bins waste – Particle size distribution, Haridwar.

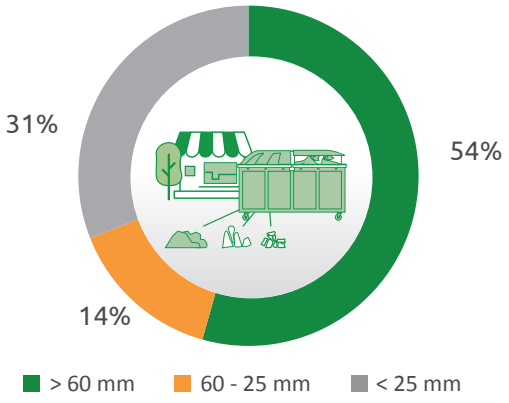


Figure 6: Commercial establishment waste - Particle size distribution, Haridwar.

5.2. Waste Composition

The overall composition of waste generated in Haridwar shows that a large component of the waste is wet waste (78%). Figure 7 corresponds with the fact that the proportion of wet organic waste is usually the highest in low- and middle-income countries' MSW composition (Hoornweg and Bhada-Tata, 2012). In the remaining dry waste stream (22%), the share of plastic waste amounts to 31%, while the remaining major waste components are comprised of paper (22%), textile (14%) and other, non-listed items (25%). Approx. 77% of household waste are comprised of wet organic waste, while 23% are dry waste. The composition analysis of dry waste from households shows that 31% of it is plastic waste. Waste from commercial establishments contains 73% wet waste. The composition of dry waste is, with a share of 34% plastic and 31% paper, similar to the household's dry waste composition. Commercial establishments, however, have a significantly higher share of paper waste (31%) compared to the paper waste share in the household dry waste (23%). The composition of waste from community bins shows that wet waste constitutes around 78%. The respective dry waste composition has a significantly higher share of textiles (18%) compared to households (11%) and commercial establishments (6%).

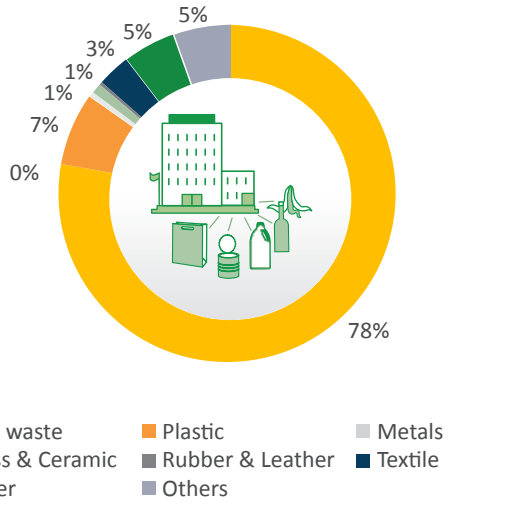


Figure 7: Overall composition of municipal solid waste, Haridwar.

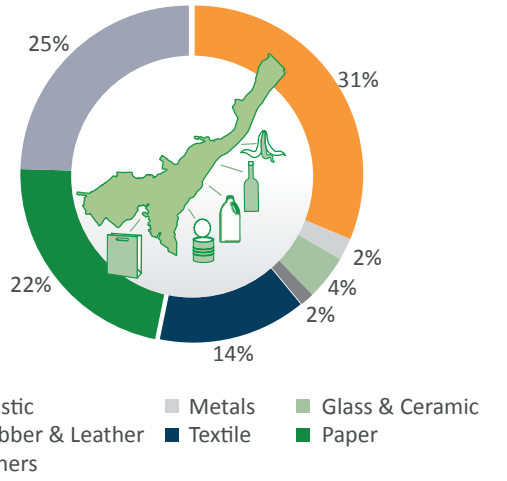


Figure 8: Overall composition of dry waste, Haridwar.

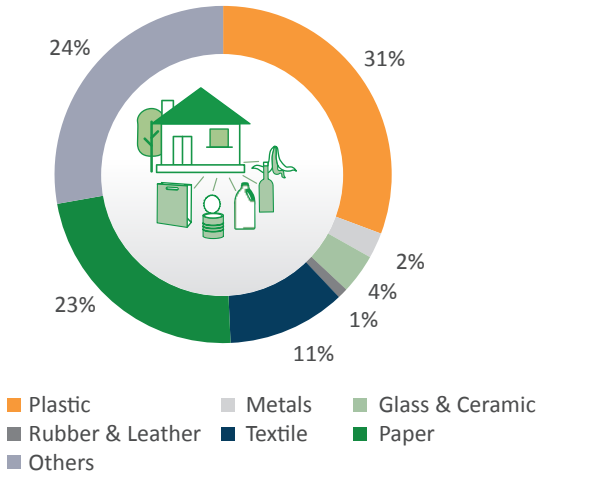


Figure 9: Dry waste composition of household waste, Haridwar.

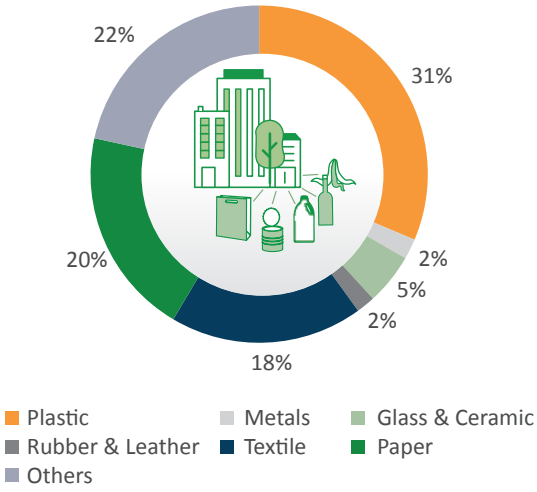


Figure 10: Dry waste composition of community bin waste, Haridwar.

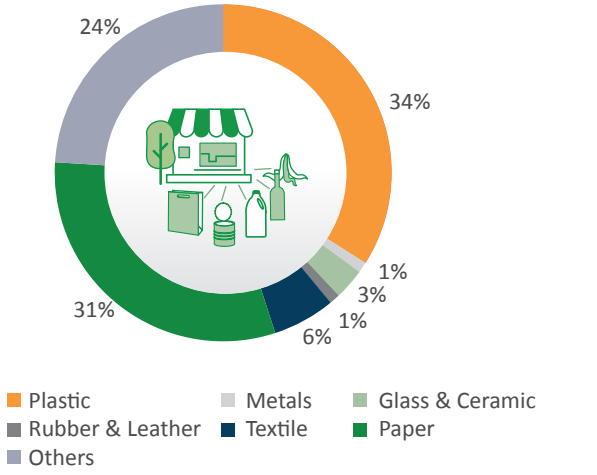


Figure 11: Dry waste composition of commercial waste, Haridwar.

5.3. Plastic Typology

A further characterization of the primary sorting category "plastic" was conducted into seven categories. The results show that LDPE (57%) and MLP (23%) are major parts. The plastic waste composition from households and community bins is found to be similar. However, the shares of valuable items like PET, HDPE and PP are, compared to the household waste, lower in the community bin waste. Community bins are expected to have a major share of waste from residential generators and should be similar to household waste. However, while the majority of households do not store valuable plastics separately and dispose also valuable items into the waste, community bins are largely used by the slum population and residents of economic weaker wards. Here, a separate storage of valuable items and regular material sales to local

Kabadi Walas is common. Additionally, informal waste collectors are likely to have had access to the waste stored within community bins prior to the sample collection, which results in a lower share of valuable plastic items.

Plastic waste from commercial establishments shows a similar composition to household and community bin waste. The overall composition of high-value waste materials in the mixed municipal solid waste of Haridwar remains below 20%. The share of light LDPE plastics such as shopping bags are predominant within the waste. However, it must be added that the level of pollution and recyclability of the LDPE waste has not been assessed. It can be assumed that LDPE materials are partly not recyclable due to contamination with other materials.

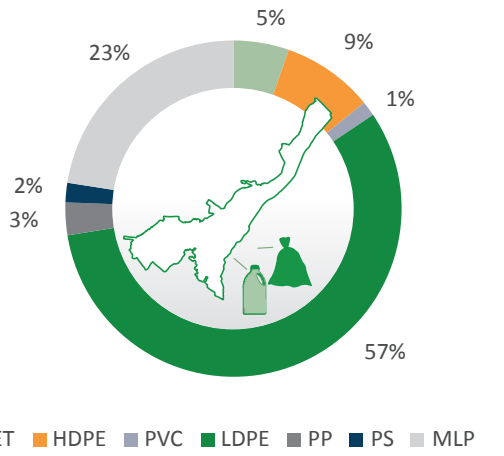


Figure 12: Plastic waste analysis, Haridwar.

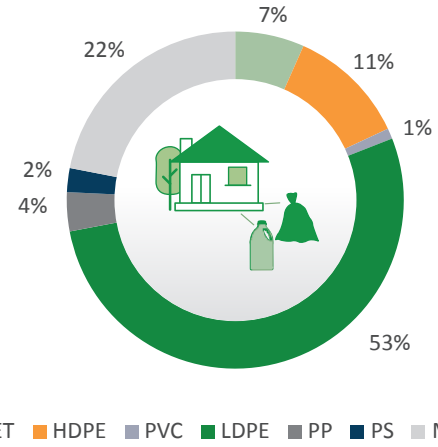


Figure 13: Plastic waste analysis of household waste, Haridwar.

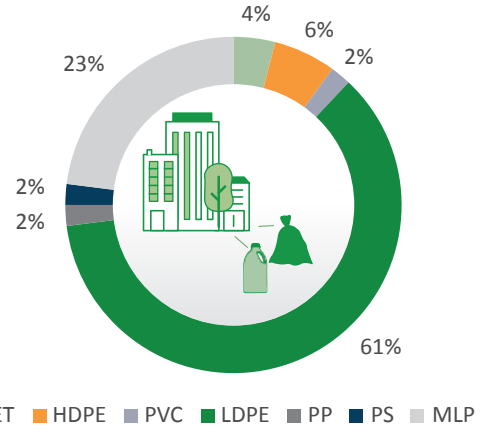


Figure 14: Plastic waste analysis of community bin waste, Haridwar.

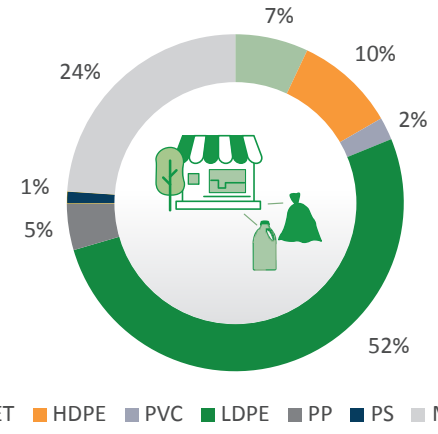


Figure 15: Plastic waste analysis of commercial waste, Haridwar.

The percentages of each type of plastic waste for Haridwar were calculated. With a total waste generation in Haridwar of 229.5 tons/day and a plastic waste share of 7%, the amount of plastic waste generated results in 16.1 tons/day. Consequently, the total material flows and inherent material values are obtained and presented in Table 6.

Table 6: Material streams of plastic waste, Haridwar.

Type of plastic waste	Share in total plastic waste (%)	Total mass flow (kg/day)
PET	5	805
HDPE	9	1,449
LDPE	57	9,177
MLP	23	3,703

5.4. Estimated Waste Generation

Waste quantification based on literature values

Pilgrimage cities like Haridwar show a significant difference between generated and disposed waste amounts. Households and religious places in Haridwar ritually feed organic waste to animals. By this, a significant part of organic waste is not collected in the urban waste collection system. Generally, the availability of accurate data on waste quantities and qualities in Indian cities is low. In cities like Haridwar, where collected, transported and disposed waste amounts are barely recorded, the estimation of waste is challenging. The data on waste generation by different government agencies and literature sources vary widely. As per the Comptroller and Auditor General of India (CAG) report (Government of Uttarakhand, 2018), Haridwar generates 237 tons/day of solid waste. Another report claims that during peak months, the city generates around 250 tons/day of waste and is expected to increase to 278 tons/day by 2025 and 353 tons/day by 2040 (eHealth Network , 2018). In 2019, the municipal commissioner stated that the city generates around 260 tons/day solid waste (The Pioneer , 2019).

Waste quantification based on per-capita generation data

For the assessment of Haridwar's daily per capita waste generation, waste samples with a total sample mass of 1.3 tons were weighed and sorted. As a result, an overall daily waste generation per capita of 0.16 kg/capita/day was identified. Considering an urban population of 251,197 (2018), waste from residential sources amounts to 40.8 tons/day. Additionally, waste samples of 356 commercial establishments have been weighed and analyzed, resulting in an overall waste generation per establishment of 0.64 kg/day. With approx. 6,000 commercial establishments in Haridwar, the total amount of commercial waste amounts to 3.8 tons/day. In 2019, the Uttarakhand Tourism Department (2020) recorded a total number of 21,770,232 tourists with 43,561,271 bed nights, equaling to 119,346 bed nights per day. Considering a daily waste generation by tourists of 0.24 kg/capita/day, a total daily tourism waste generation

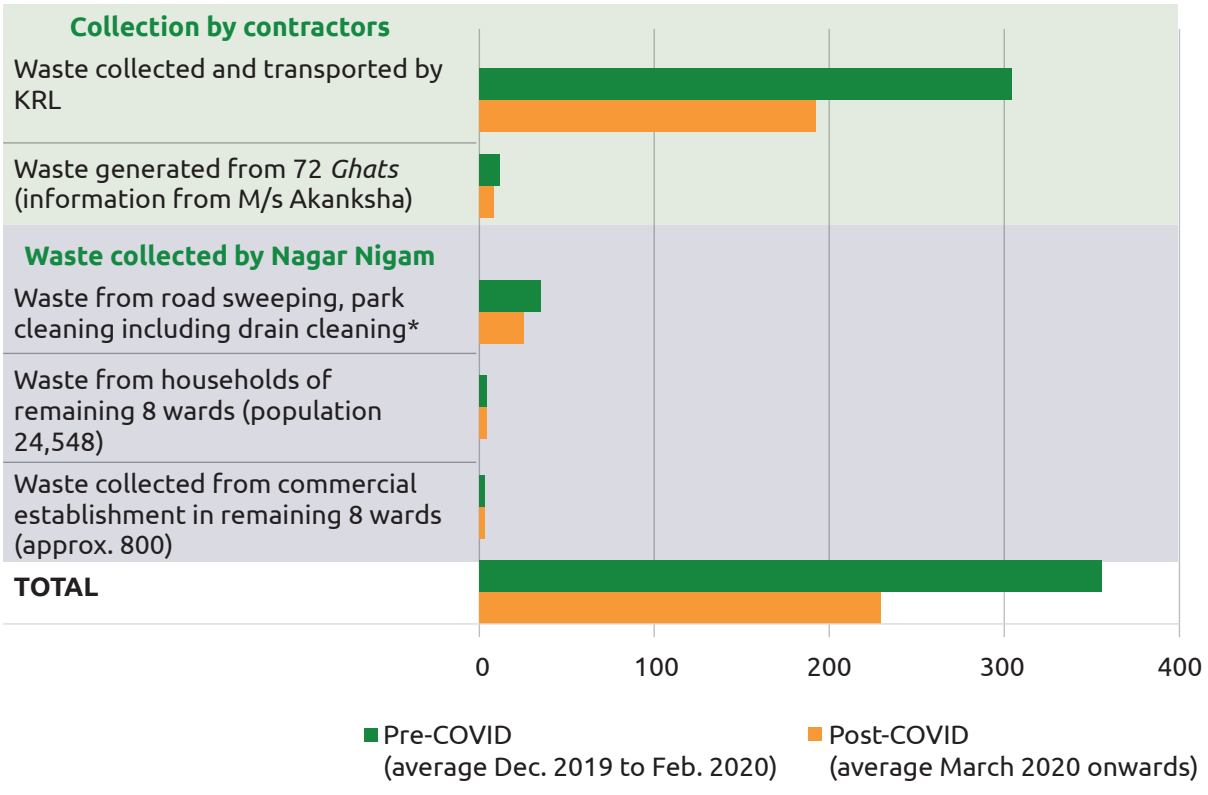
of 28.6 tons/day can be estimated. The total estimated waste generation of residential, commercial and tourism sources is 73.2 tons/day, excluding street sweeping waste, waste from *Ghats* and bulk waste generators.

Waste quantification based on collection vehicle data

However, this is in stark contrast to the data provided by the waste contractor KRL Waste Management Company Haridwar Private Limited (KRL) for the month of November, which shows that 215 tons/day of waste have been collected and transported by the company. This includes solid waste generated in 52 of Haridwar's 60 wards. Waste amounts recorded by KRL were recorded at the weighing bridge of Haridwar's waste treatment facility.

Since COVID-19 had a strong impact on disposal behavior, business activities of commercial establishments and tourism influx, a comparison of pre- and post-pandemic waste generation data was conducted. Both data were made available by the local waste contractors KRL and Akanksha Enterprises, supported by additional data from HNN.

Table 7: Estimation waste generation in Haridwar.



*per truck load has been assumed to be 5.0 tons. Truck body volume amounts 10 m^3, waste density considered to be 500 kg/m^3.

The waste generation data in the table show a strong decline of waste amounts in the last year. As a major reason, the impacts of the COVID-19 pandemic were identified. The strong decline of the tourist influx to Haridwar due to travel restrictions and lockdowns, resulted in a decrease of business activities of local commercial establishments and companies.

If daily street sweeping and *Ghat* cleaning waste amounts are added to the estimated waste generation of 73.2 tons/day within this study, a total amount of 106.2 tons/day are calculated. Also, this value remains in stark contrast to the recorded waste amount of 229.5 tons/day by the waste management service providers.

This assessment did not include a validation of the recorded data. The certainty of the weighing bridge data provided by KRL cannot be evaluated. For a detailed design of the collection system within specific wards, further evaluation of all waste generators is required. Until then, it has to be assumed that the waste collection system of KRL and the other waste management service providers is able to collect the stated amount of 229.5 kg/day. Based on the population of 251,197 (2018), a total waste generation of 229.5 tons/day results in a total average per capita waste generation of 0.91 kg/day.

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6. Current Status of Waste Management

6.1. System Overview

HNN is the responsible institution for urban solid waste management within the municipal boundaries as per regulations of the Indian Solid Waste Management Rules (Ministry of Environment, Forest and Climate Change, 2016). Until December 2020, the HNN had outsourced Haridwar's urban waste management services to a private agency KRL Waste Management Company Haridwar Private Limited to manage waste in 52 of the city's 60 wards. KRL had the responsibility to collect, transport, process, treat and dispose the municipal solid waste from these 52 wards. In the remaining eight wards, the HNN was responsible for the waste management, in four wards with the support of two Self-Help Groups (SHGs) Mahila Sawayam Shayata Samuh and Nari Shakti Sawayam Shayata Samuh.

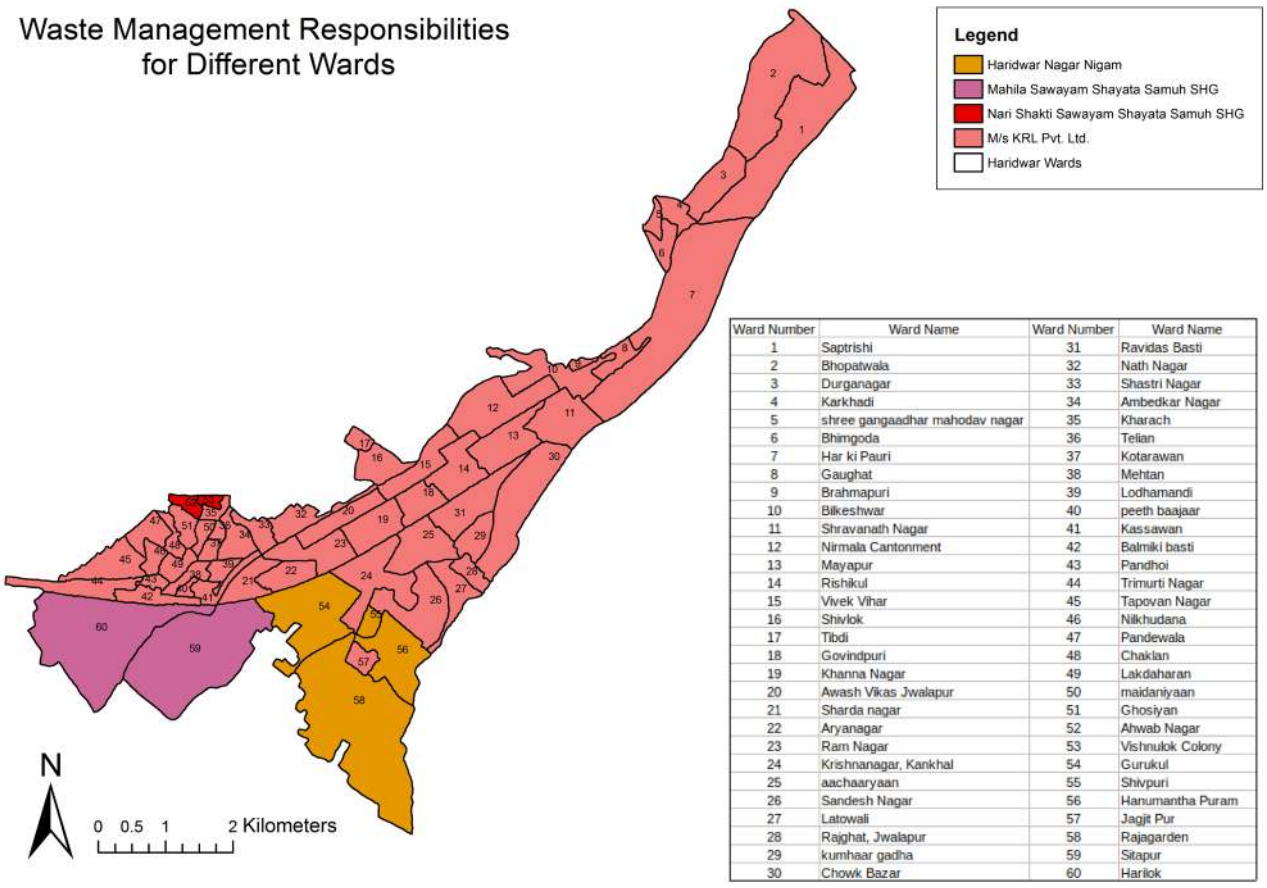
Another agency M/s Akanksha Enterprises is assigned with the management of waste from the 72 *Ghats* of the city. The agency takes care of the cleaning of *Ghats* including an area up to 100 m from the water boundary. Major waste generators in Haridwar are approx. 41,300 households, approx. 6,000 commercial establishments, the tourist and floating population and other generator groups presented in Table 8.

Table 8: Waste generators, Haridwar.

Category	Number
Households	41,335
Commercial establishments	6,000
Hotels	517
Dharamshala	283
Schools and Colleges	120
Hospitals	52
Ghats	72
Municipal markets vegetable & fruit market/*mandi*; poultry and slaughterhouse	6
Restaurants	271

In Haridwar, street sweeping is collected as a separate waste stream. Apart from littered waste, street sweeping contains a high inert fraction with sand, silt and stones from the streets. Along with street sweeping waste, drainage cleaning waste is collected, containing wastes with a comparatively high moisture content. Both inert fraction of street sweeping waste and moisture content of drainage cleaning contribute a major waste share to the overall waste stream composition. According to the HNN, the municipal waste management staff is comprised of 322 permanent waste collectors and 138 additional contractual waste collectors, responsible for waste collection, street sweeping and drain cleaning. These numbers exclude personnel by KRL and Akanksha. HNN has not integrated informal workers in the public waste management system so far.

HNN is currently facing challenges in handling and managing the generated urban solid waste amounts, especially in relation to processing, treatment and disposal of waste. Major constraints are observed in the introduction and establishment of source segregation and scientific processing and disposal for the generated waste amounts. KRL has 23 permanent employees, no contractual employees and 145 sanitary workers. Akanksha is realizing its services with 385 sanitary workers. A major funding source is the Central Finance Commission (CFC), the *Swachh Bharat Mission* (SBM), the State Finance Commission (SFC), earlier flagship programs like the Jawaharlal Nehru National Urban Renewal Mission (JnNURM), other ongoing initiatives like *Namami Gange* as well as revenue generated from city's own resources such as taxes.



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28	Rajghat, Jwalapur	58	Rajagarden
29	kumhaar gadha	59	Sitapur
30	Chowk Bazar	60	Harilok

Figure 16: Waste management responsibilities for different wards, Haridwar.

In both the *Nagar Nigams*, a major share of the expenditure are salaries and wages. The allotment of funding for SWM-related infrastructure development is comparatively low, similar to the utilization of funds received from different grants such as SBM and *Namami Gange*. Under *Namami Gange*, a 150 million INR fund is available for a three-year duration, from which the services of Akanksha are covered. The expenditure on awareness and education has been minimal at both places. Waste collection fees in Haridwar are as outlined in Table 9 .

Table 9: Waste collection fee rates in Haridwar.

Categories	Annual waste fee in INR	Unit
Residential	600	per unit
Commercial (offices)	1,800	per unit
Hotels (on what basis area or room)	240	per room
Hotels with restaurants facility	240	per room
	4,200	per restaurants
Schools/colleges	6,000	per unit
Residential schools/colleges (with hostel facility)	12,000	per unit
Ashram/dharamshala	6,000	per unit
Shops	1,800	per unit
Restaurants	4,200	per unit
Vegetable/fruit *mandis*	1,800	per stall
Hospitals (on what basis)	240	per bed

6.2. Collection and Transportation

Until December 2020, the door-to-door collection was majorly carried out by KRL, the responsible waste management contractor. KRL used 145 tricycles and six auto tippers to collect waste from households and commercials establishments in the 52 wards assigned to them. However, KRL did not collect waste from the slum area. In the remaining eight wards, HNN itself collects the waste. As mentioned above, in four of the eight wards, HNN is supported by two SHGs. HNN has provided six tricycles to each SHG to facilitate waste collection. The two SHGs collect segregated waste (dry and wet separately) from two wards (i.e. Sitapur and Harilok), with a waste management fee of 70 INR/household/months to cover the SHGs monthly expenses. The fee rate is higher than the 50 INR/household charged in the areas previously serviced by KRL.

As mentioned above, Akanksha is assigned with the management of waste from the 72 *Ghats* of the city. The agency takes care of the *Ghat* cleaning including an area up to 100 m from the water boundary. Akanksha does not collect waste from any wards or temples and does not collect charges, since they are entirely funded through the *Namami Gange* fund. The waste of temples is disposed into the city's community bins. From the *Ghats*, a daily amount of 8-11 tons/day is obtained, with one *Ghat* generating an average amount of 250-300 kg. The average composition of *Ghat* waste is 70% dry and 30% wet waste. Drain cleaning across the city is also carried out by HNN with its own personnel. Additionally, HNN has 150 community bins which are regularly (mostly daily) collected by tractors, transported to the dumpsite, located at Sarai, and returned after emptying.

Besides the collection with motorized vehicles, KRL and HNN use manual tricycles and pushcarts for waste collection, particularly for the primary collection in narrow lanes or high-density areas.

Pushcarts and tricycles, however, are not able to transport their waste load to the dumpsite at Sarai, which would be a distance of three to seven kilometers. Hence, the manual collection vehicles store their load in open sites at the roadside, mostly at the location of the community bins. From there, the openly stored waste is picked up by the secondary collection system through tractors. While primary collection mostly occurs in the morning hours, the secondary collection may take place in the afternoon or the evening. As a result, collected waste of the primary collection system remains without any containment in the street for several hours (sometimes days), prone to dispersion by wind and precipitation and accessible by animals and vermin. During the open storage, also informal waste collectors access the storage point and remove high-value recyclables.

This mismatch in timing between primary and secondary collection results in a major plastic leakage and a significance nuisance for the urban population. Additionally, commercial establishments, in particular of small and medium size, commonly store their waste without containers at the roadside for pickup by the collection vehicle. While a significant pollution is observed by this practice, the pollution level increases if the waste collection vehicles are late or do not appear on the respective day. KRL transported the collected waste to the city's dumpsite at Sarai. HNN is responsible for transporting street sweeping and drain cleaning waste to the dumpsite, while Akanksha arranges their own transport to the dumpsite. HNN had provided few vehicles to M/s KRL for facilitating the collection and transportation of waste to the dumpsite.

Table 10: Number of available collection and transportation vehicles Haridwar (information collected from HNN, M/s KRL and M/s Akanksha).

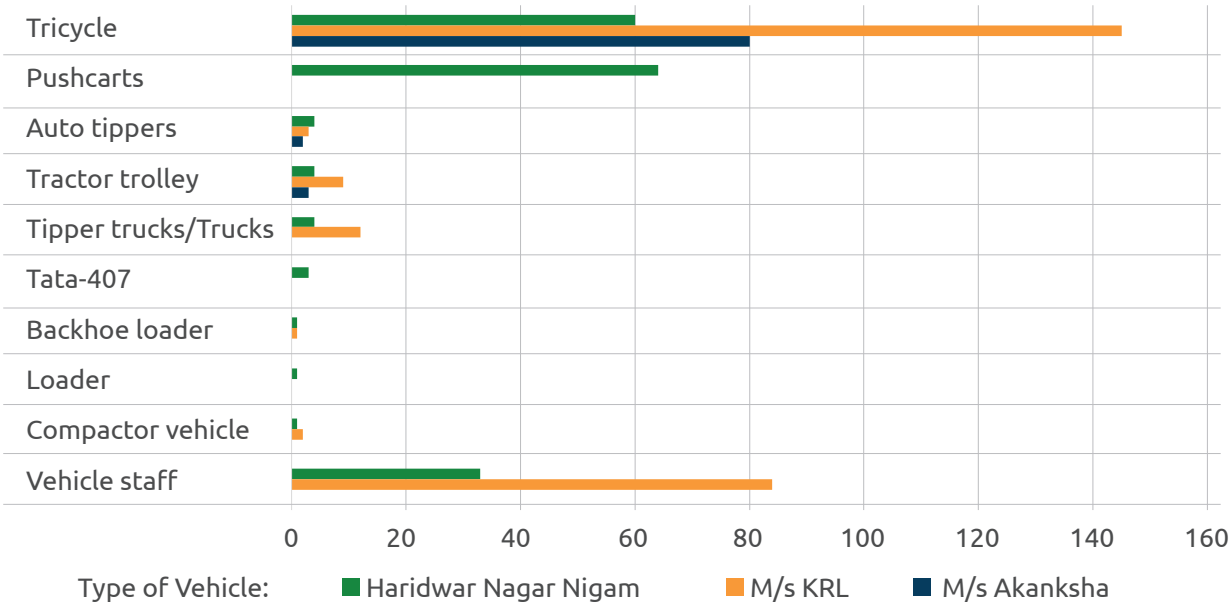

Figure 17: Community bin with collection tricycle in front, Haridwar.

Figure 18: Community bin near hotel Madhuban, Haridwar.

6.3. Treatment and Disposal

To ensure an environmentally sound management of MSW, HNN had entered a concession agreement with KRL Waste Management Company Haridwar Private Limited in October 2012. The contract type was a Build-Operate-Transfer (BOT) project, which involved the development of a solid waste management system for Haridwar, including an improved collection and transportation system and a sustainable treatment of the collected waste amounts through composting and the development of a sanitary landfill.

In May 2015, an environmental clearance was granted to KRL for the construction of an MSW treatment plant in Sarai village. The plant had a designed capacity of 100-150 tons/day, the landfill site of 50 tons/day. 20 hectares of land at Sarai Village were assigned by the Haridwar Development Authority for this waste management project. The plant was designed to produce compost which was sold to local farmers at 500-600 tons/trolley load of approx. 2 tons. The plastic and MLP separated at the plant by the trommels of 45 mm, 25 mm, 15 mm and 4 mm was sold to recyclers outside of Haridwar. The quantity was rather low, averaging to one truck load of 7 tons every third day. All the waste collected from households, commercial establishments, institutions, hotels, street sweeping, community bins, drain cleaning, and from temples were transported to the plant at Sarai village and the nearby landfill.

Figure 19: Sarai Dumpsite, Haridwar.

HNN was contractually obliged to pay a tipping fee to KRL to cover KRL's capital and operational expenses. The tipping fee amounted to 361 INR/ton at the time of this assessment. KRL allowed informal workers to enter the Sarai dumpsite and collect valuables from the dumped waste. Although KRL has constructed the MSW plant in the vicinity of the Sarai landfill, it was not operated during the period of this assessment. The landfill, initial designed as sanitary landfill facility, was operated as open dumpsite during the assessment. Currently, all waste collected from households, commercial establishments, institutions, hotels, street sweeping, community bins, drain cleaning and from temples in Haridwar is disposed without treatment on the open dumpsite, prone to landfill fires and waste dispersion by wind and animals and generating significant greenhouse gas emissions.

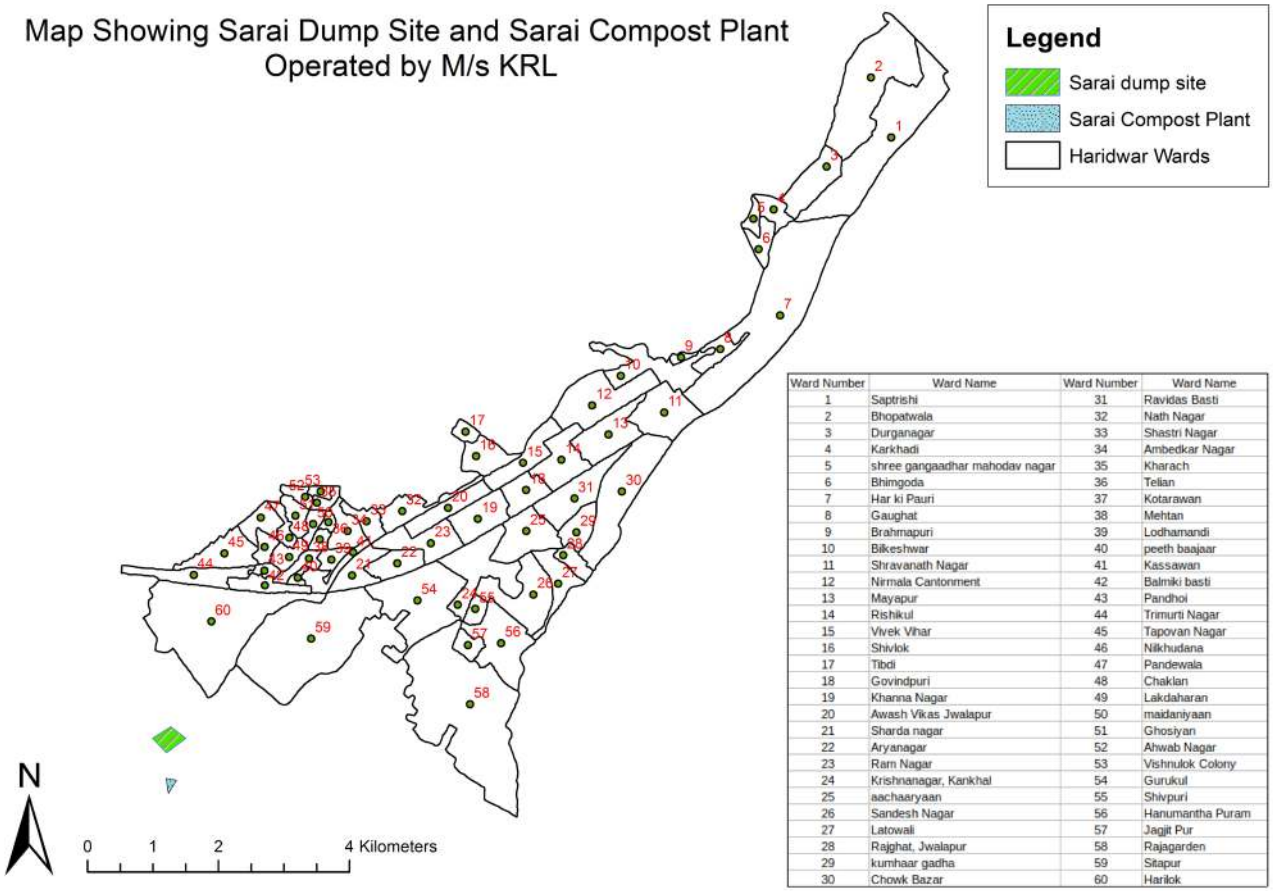

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Figure 20: Map showing Sarai Dump site and Sarai compost plant operated by M/S KRL, Haridwar.

6.4. Data Management Systems

HNN currently has no data collation and analysis system of solid waste collection and treatment. The only waste quantification mechanism is weighing data at the KRL site, since HNN pays a weight-based tipping fee KRL.

7. Plastic Leakage

The system analysis of plastic waste leakage in Haridwar with the Waste Flow Diagram provides an estimation of existing leakage flows. According to the methodology and considering the observed system characteristics, it can be assumed that 78% of the total generated plastic waste is collected by the official collection system. 9% enter the system through informal sector collection, while 13% remain uncollected. 72% of the total generated plastic waste is disposed on the city's main dumpsite. From the dumpsite, it is estimated that 1% re-enters the environment (e.g. by wind dispersion). In this methodology, however, waste collection on the dumpsite is not considered, which would slightly reduce the total amount of disposed waste.

Following the methodology, 8% of the total generated plastic waste ends up in the terrestrial environment. It is calculated that 19% of the city's plastic waste amount can be considered as mismanaged.

Table 11: Unmanaged plastic waste results from the waste flow diagram, Haridwar.

	Baseline	Unit
Unmanaged plastic waste	1,069	tons/year
Unmanaged plastic waste	19	% of plastic waste generation
Contribution from uncollected waste	69.37	% of mismanaged plastic waste
Contribution from collection service	28.86	% of mismanaged plastic waste
Contribution from informal value-chain collection	0.11	% of mismanaged plastic waste
Contribution from transportation	0.01	% of mismanaged plastic waste
Contribution from disposal facilities	1.65	% of mismanaged plastic waste

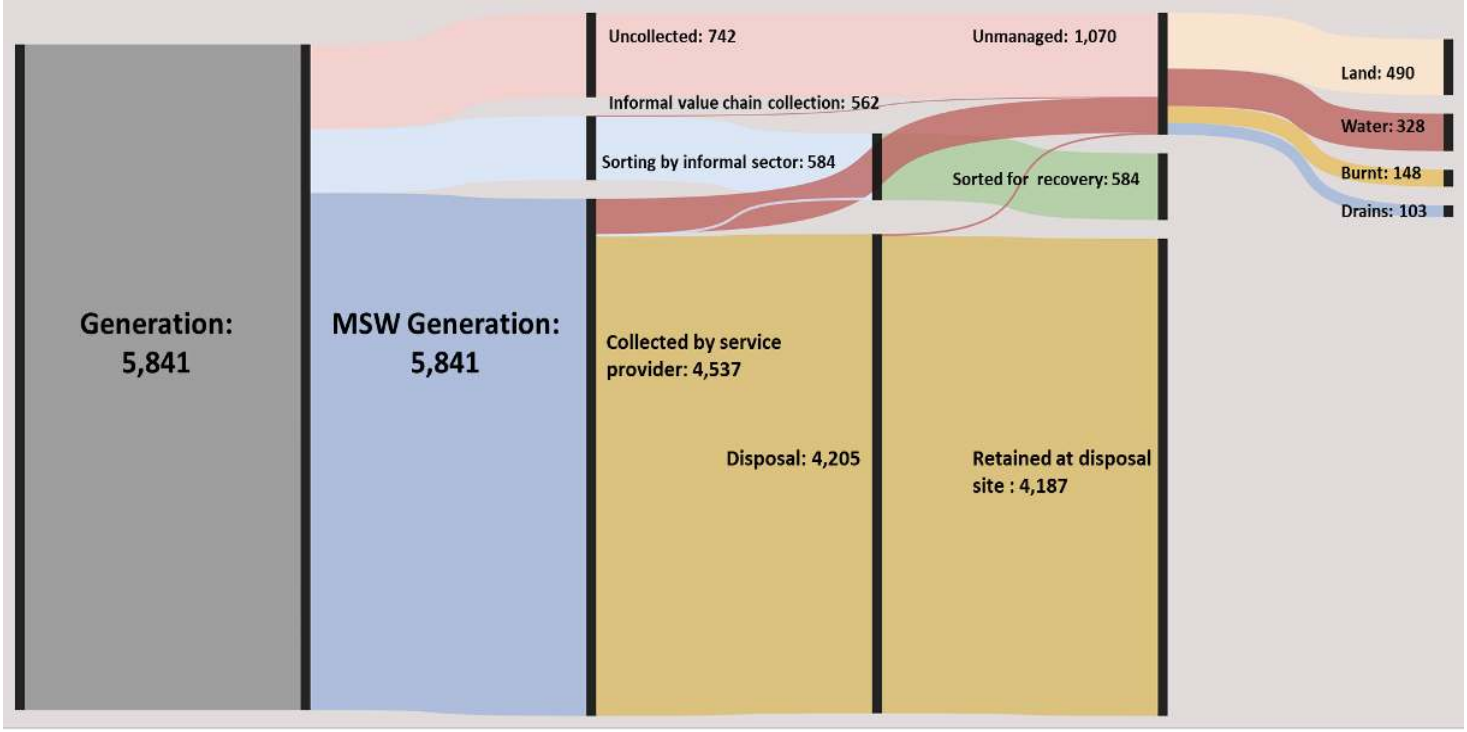

Figure 21: Waste flow diagram of Haridwar.

Figure 22: Waste collection at Har Ki Pauri Ghat.

Table 12: Municipal solid waste generation, collected and uncollected waste as well as plastic waste generation in Haridwar based on waste flow diagram data.

	Plastic waste	Municipal Solid Waste	Unit
	Baseline	Baseline	
Municipal solid waste generation	5,840	83,435	tons/year
Municipal solid waste generation	16	229	tons/day
Collected waste	5,099	82,694	tons/year
Collected waste	87	99	% of waste generation
Uncollected waste	742	742	tons/year
Uncollected waste	13	1	% of waste generation
Waste sorted for recovery (excludes energy from waste)	584	3,504	tons/year
Waste sorted for recovery (excludes energy from waste)	10	4	% of waste generation
Waste sorted for recovery by formal sector (excludes energy from waste)	0	0	% of waste generation
Waste sorted for recovery by informal sector (excludes energy from waste)	10	4	% of waste generation
Energy from waste	0	0	tons/year
Energy from waste	0	0	% of waste generation
Disposal in disposal facilities	4,205	78,880	tons/year
Disposal in disposal facilities	72	95	% of waste generation

During the field assessment in Haridwar, littering of MSW comprising plastic was observed in almost all locations. In order to identify key plastic leakage hotspots, discussions with staff of HNN, from Akanksha and KRL were held. The suggested hotspots were visited and verified. In Haridwar, the plastic waste leakage hotspots along the value chain were largely found at the locations of community bins. Community bins were found to be largely used by the slum population and commercial establishments. Apart from community bins, multiple blackspots could be identified in open spaces and along the riverbanks. Plastic accumulation hotspots were found in drains, irrigation lines and at the banks of the river Ganga. In particular the untapped drains lead to significant plastic waste emissions into the river.

The major hotspots are pointed out in Figure 22 and Table 13. Figure 22 shows that the great majority of plastic waste hotspots are located in close vicinity of the river. Here, the density of commercial establishments and tourism establishments is significantly higher. Hotspots in Haridwar occur with less significance in majorly residential areas. This leads to the assumption that in particular commercial establishments and tourism activities are an (indirect) cause of major plastic waste leakage hotspots. Due to their close vicinity to the river, plastic leakage into the river is more likely to occur (e.g. due to dispersion by wind).

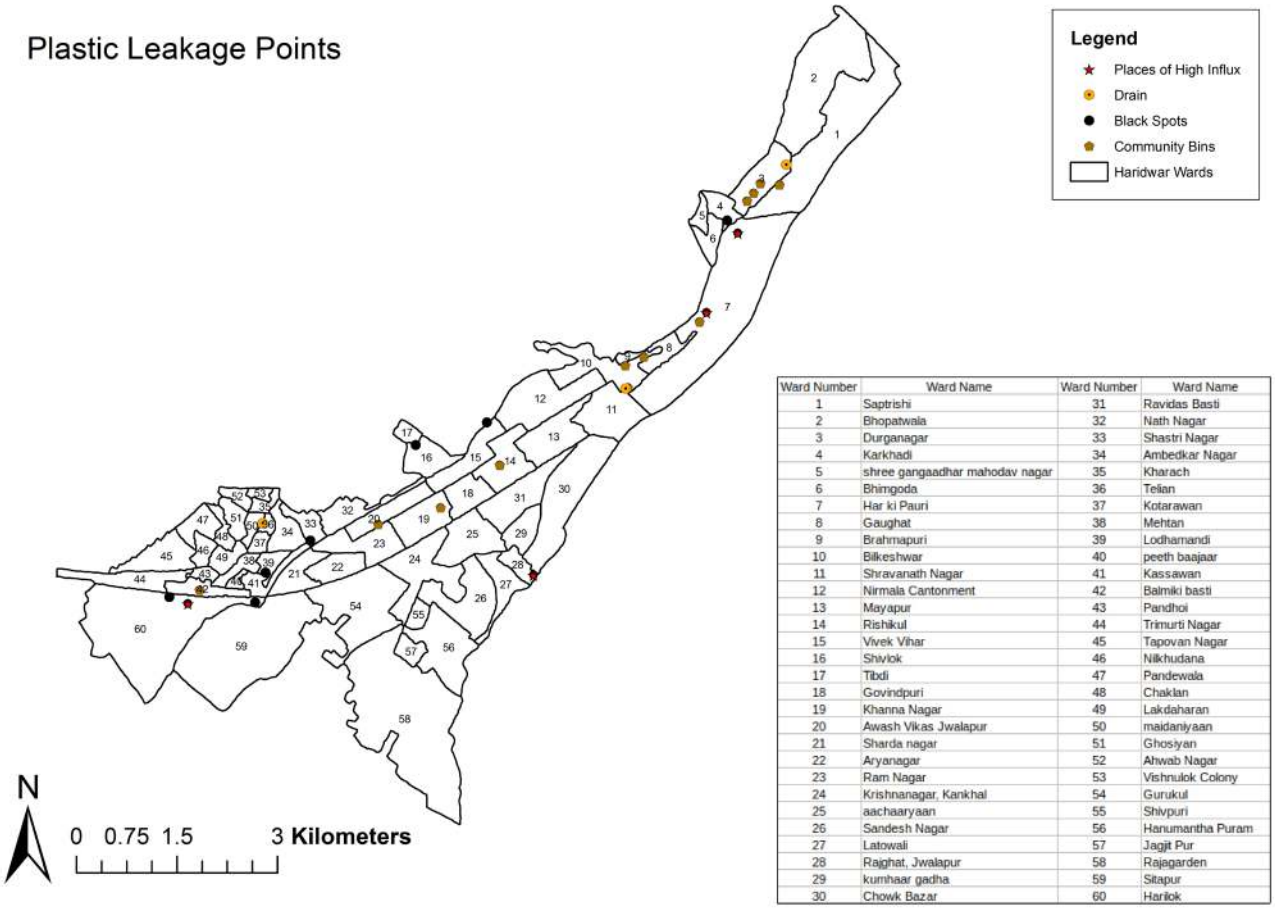

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Figure 23: Plastic leakage points of Haridwar.

Table 13: GPS coordinates and locations of hotspot, Haridwar.

Hotspots	Type
1	Drain at Bhagirathi Nagar, Bhooptwala
2	Black spot Sukhi nadi ka pool
3	Place of high influx from where leakage happens - Shamshan Ghat
4	Place of high influx from where leakage happens - Har Ki Pauri Ghat
5	Drain falling in river at Laltarao pul
6	Place of high influx from where leakage happens - Shamshan Ghat, Kankhal
7	Black spot opposite Canara bank, Jwalapur
8	Black spot Jwalapur
9	Black spot near Viswakarma Setu
10	Black spot at Ganga Ghaat Jatwara Pul
11	Black spot at Subhas Nagar, Jwalapur
12	Drain at Jwalapur
13	Black spot at Tibdi
14	Black Spot at Hill Bypass

Figure 23: Black spot in front of Carana Bank, Haridwar.

Figure 24: Community bin Tulsi chowk, Haridwar.

Figure 25: Black spot opposite Shivlok Colony, Haridwar.

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Reducing Plastic Waste in the Ganga

8. Assessment of Informal Sector

The informal waste sector (informal waste collectors and *Kabadi Walas*) has a crucial role in managing the waste from Haridwar. The survey was conducted to obtain basic information on the type of waste collected and traded by the informal sector, as well as information on traded amounts and number of informal waste collectors. A detailed mapping of the informal waste sector was done within the city. Around 40-45 scrap vendors and traders, called *Kabadi Walas*, are active within Haridwar's city boundaries, out of which 20 participated in the survey. Neither an official nor unofficial register exists for *Kabadi Walas* and only larger shops could be identified through the field survey. Hence, the total number of *Kabadi Walas* can only be estimated.

With almost one fourth of all surveyed *Kabadi Walas* being registered in the taxation scheme of the government and having a linked bank account for transaction, it can be deduced that the waste collection business is increasingly formalized. With respect to informal waste collectors, an estimated number of approx. 400 are active in the city. In Haridwar, a type of informal lease agreement exists for the informal waste collection of recyclables, concluded between individual informal waste collectors and the supervisors of the waste collection system. The informal waste collectors pay for the place from where they collect and segregate valuable waste items. These locations, such as community bins or litter spots, are assigned to the informal waste collector after paying a certain amount to the waste collection company's supervisors. After this transaction, only the respective informal collector is allowed to search valuable materials at this location. It was found that at almost every community bin of the city this payment system exists.

In an industrial area adjacent to Haridwar, a large amount of commercial and industrial waste is generated. Although not part of Haridwar's collection and disposal system, this waste stream is also sorted by informal collectors at open storage points and majorly sold to the *Kabadi Walas* of Haridwar. Hence, the total waste amount traded by Haridwar's *Kabadi Walas* does not only origin within the city's boundaries. None of the assessed *Kabadi Walas* were recyclers, but traders who directly procure recyclable materials from informal waste collectors and households and sell it to recyclers in other cities (e.g. Roorkee). The informal collectors collect valuables on a daily basis from community bins, litter spots on roadsides and near community bins as well as other blackspots of the city and sell them to the *Kabadi Walas*. The *Kabadi Walas* in turn aggregate, store, transport and sell it to the recyclers.

Earnings

The earnings of the *Kabadi Walas* range between 20,000-40,000 INR/month. Most of the *Kabadi Walas* have bank accounts and few of them also GST registrations.

Figure 27: Informal Waste collectors at landfill.

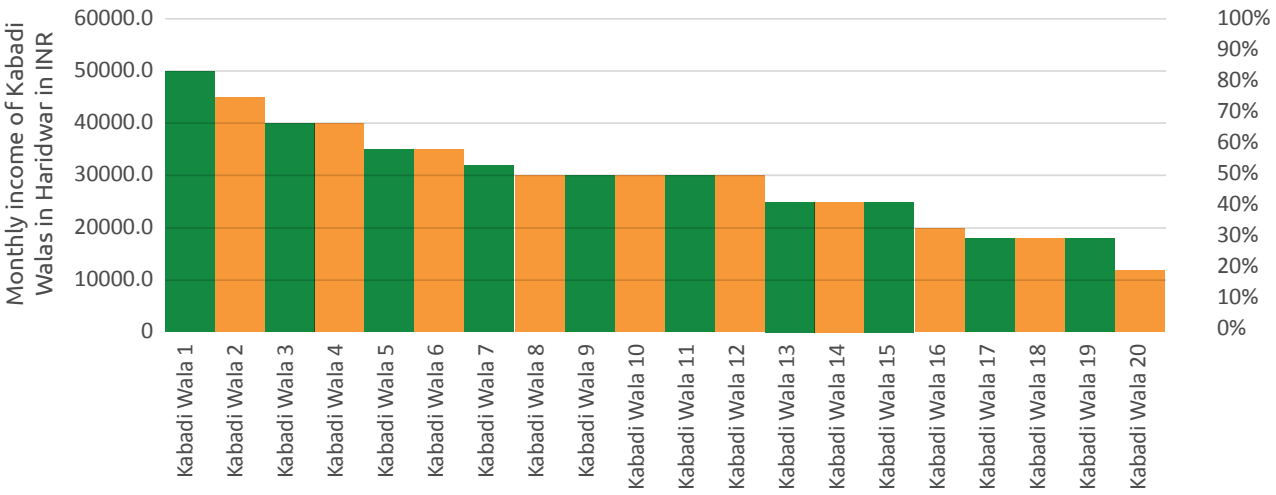
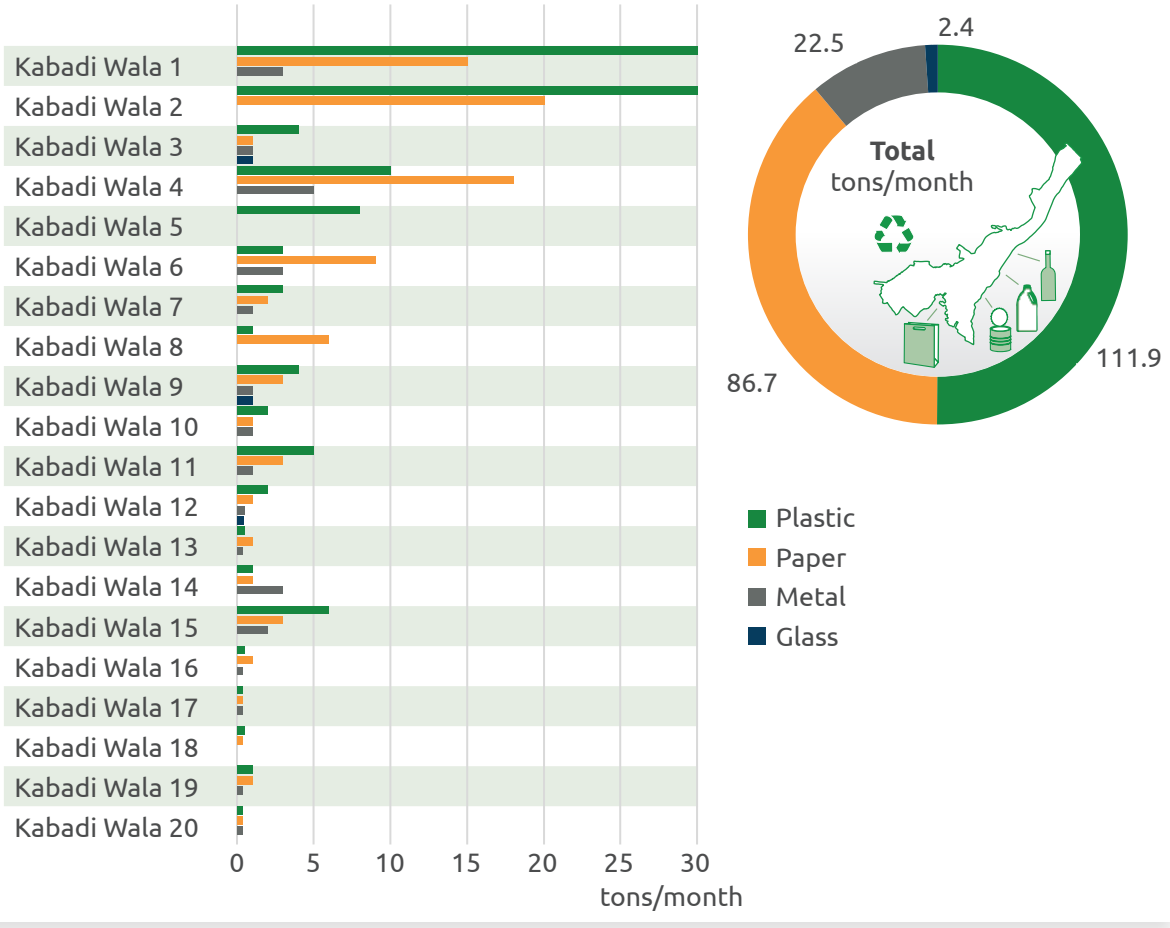


Figure 28: Monthly income (INR) of Kabadi Walas in Haridwar.

Monthly dispatch of inventory

Since the purchase and sale of the collected valuables is carried out on a weight basis, the *Kabadi Walas* record their monthly turnover. The individual and total amounts are presented in Table 14.

Table 14: The average amount of collected and sold recyclable waste by informal waste workers in Haridwar.



With 111.9 tons per month, plastic recyclables are the largest fraction of dry waste collected and sold by the informal sector. This equals to an amount of 3.7 tons/day. Out of all plastics, the largest share traded and sold is PET (1.8 tons/day), followed by HDPE (1.0 tons/day) and LDPE (0.7 tons/day). This is followed by paper, metal and glass. The 20 *Kabadi Walas* surveyed in this assessment sold about 225-250 tons/month of dry waste. Similar to neighboring cities like Rishikesh, the *Kabadi Walas* also collect waste from outside of the city's boundaries (in particular the industrial area outside Haridwar). As a result, these recorded numbers cannot be directly assigned to the generation of recyclables of Haridwar only. Since MLP does not have a significant market rate, most of the *Kabadi Walas* do not trade it.

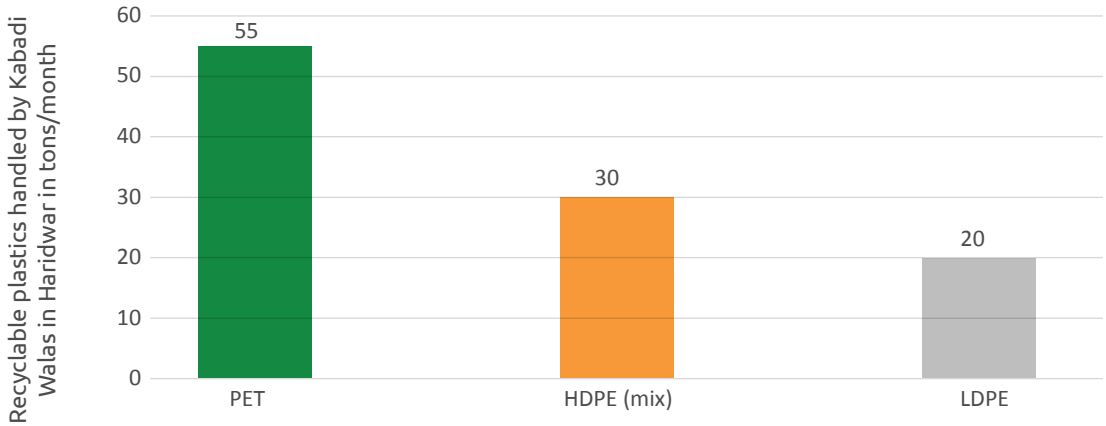


Figure 29: Plastic handled by Kabadi Walas in tons/month, Haridwar.

Pricing

The pricing of the material depends on the quality and level of segregation. The survey of the *Kabadi Walas* revealed that *Kabadi Walas* maintain homogeneous pricing when purchasing waste from the informal collectors. Few of the smaller *Kabadi Walas* pay below their capacities. The rates can vary on a daily or weekly basis. There are certain factors which decide the rates, such as availability of transport or material quality. This differential amount is the profit margin of the *Kabadi Walas*.

Recyclers

Recyclers are located in neighboring cities like Mangalore, Saharanpur or Roorkee. Therefore, waste collected in Haridwar has to be stored and transported to these cities before it can enter the recycling process. This increases the transportation cost of the material and reduces the economic incentive for segregation of recyclable waste items of the informal sector. As a result, plastic materials with a low recycling values and profit margins, have fewer financial incentives for waste collection and are left in the waste stream.

Transportation

The *Kabadi Walas* have to arrange a regular transport of material, since they usually own only small facilities with low space availability for long-term storage. This increases the relative transportation expenses even further. The material gets dispatched on a fortnightly or monthly basis. Small trucks, auto trucks and pickup vans are used for carrying the material.

9. Public Awareness

9.1. Households

Household characteristics

In total, 383 households, with a total population of 2,152, completed the survey. Of the total 383 respondents, 102 were female and 281 were male. Respondents were given the option to answer both English and Hindi. More than 40% of the respondents were graduates or above. Nearly 50% of the HHs were either self-employed or run their own business. The average household size varied from 4.8 person in high-income wards to 6.1 in economically weaker wards. The average household size in the mixed wards was 5.6 persons/households.

Segregation at source

With approx. 70%, most of the households use a single dustbin to store their waste and therefore do not segregate. Only 20 % of the households store their waste separately in two bins, one dry waste bin and one wet waste bin. However, during the survey, 33% of the respondents claimed to practice source segregation of waste. The discrepancy occurs through a varying definition of waste segregation. Households which use one dustbin, but claim to segregate waste, mostly separate valuables like PET or metals, which are subsequently sold to *Kabadi Walas*.

In 90% of the households that do not practice source segregation, the left-over medicine is also disposed in the same bin. Few respondents admitted to throwing left-over medicines into open spaces. More than 90% of the households stated their general willingness to segregate their waste if they were asked to do so by their service provider. Few respondents also complained that the service provider does not demand segregated waste. As a result, they do not practice segregation. Few respondents mentioned that they used to handover segregated waste to the collector but stopped when they observed that the collector mixed both waste streams during collection. The main reasons for the low levels of source segregation include habit, lack of awareness (30%), and low to zero dry waste generation (40%).

Disposal of waste

To understand the disposal behavior of the citizens, respondents were asked to rank their preferred systems for waste disposal. 69% of all respondents use the door-to-door waste collection services by HNN (and formerly KRL). Only 24% use community bins as their first choice. 7% of the respondents admitted to litter waste in open spaces and roadsides as their first disposal choice. However, 13% of all respondents mentioned littering as their second choice of disposal. This magnitude is found to be in line with the estimated uncollected plastic waste by the Waste Flow Diagram.

Waste management responsibility

In 20% of the households, men are responsible for managing the waste. Waste management in Haridwar's households generally remains a task of female household members. More than 85% of the respondents believe that waste management is a joint responsibility of the citizens and the government.

Plastic waste prevention and perception

More than 70% of the respondents were aware of the ban imposed on the use of plastic bags which was introduced by the government in 2018. More than 60% of the respondents perceived a decrease in their personal use of plastic bags.

Waste collection services

Approx. 90% of the households observed a regular waste collection service in their area. Few respondents in the EWS wards claimed that the timing of the collection is an issue, as collection vehicles do not maintain a fixed schedule. More than 80% of the respondents stated that collection services are provided on a daily basis or on more than three days per week. 82% of the people use the official waste collection system regularly. Households which do not use the system regularly mentioned that collection fees are too high for them. A great majority of people emphasized their dissatisfaction over the irregular timing and the behavior of the waste collection staff.

Public perception of urban waste management challenges

The main challenges identified by household residents for the current solid waste management in the city were analyzed. 52% of all respondents perceive open littering as the key challenge in Haridwar's waste management, followed by irregular collection timing (22%), lack of municipal services (14%) and an insufficient amount of community bins (13%).

Collection fees

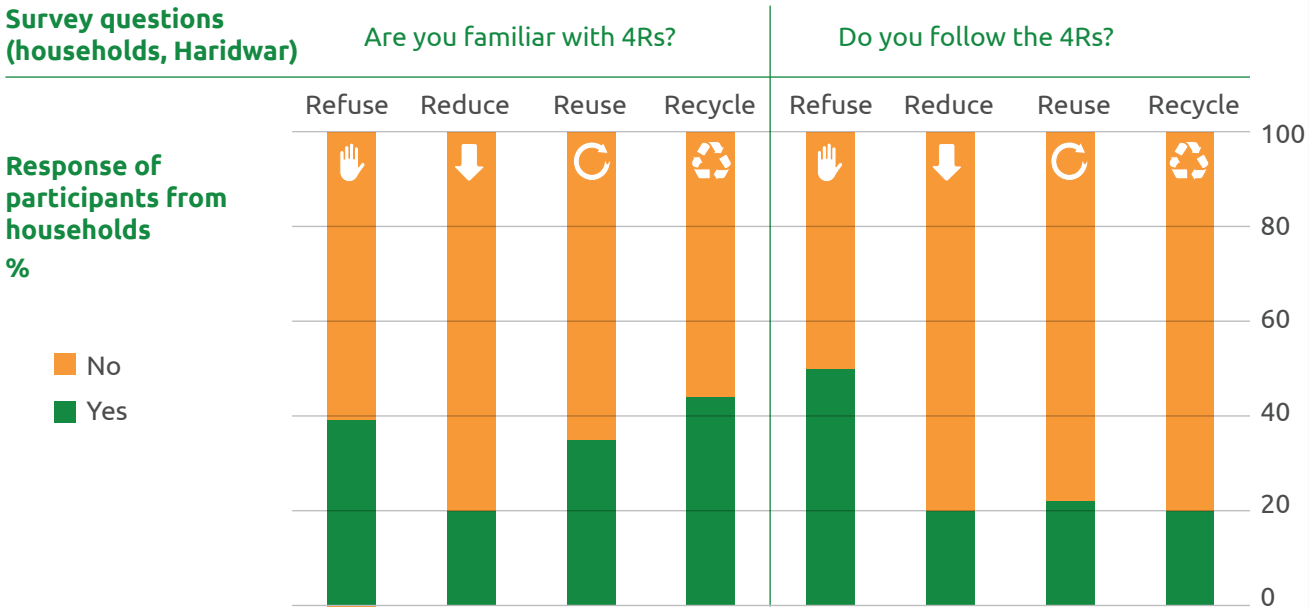
More than 90% of the households pay a monthly fee of 50 INR/months for waste management. Most of the people expressed their willingness to pay an additional amount of 10 INR per month for an improved waste management service.

Awareness

The overall awareness of the 4Rs and the waste hierarchy is low. While only 22% apply reuse in their day-to-day life, 50% stated that they practice waste prevention. Generally, only a minority of households from both high- and low-income areas are familiar with sustainable waste management practices.

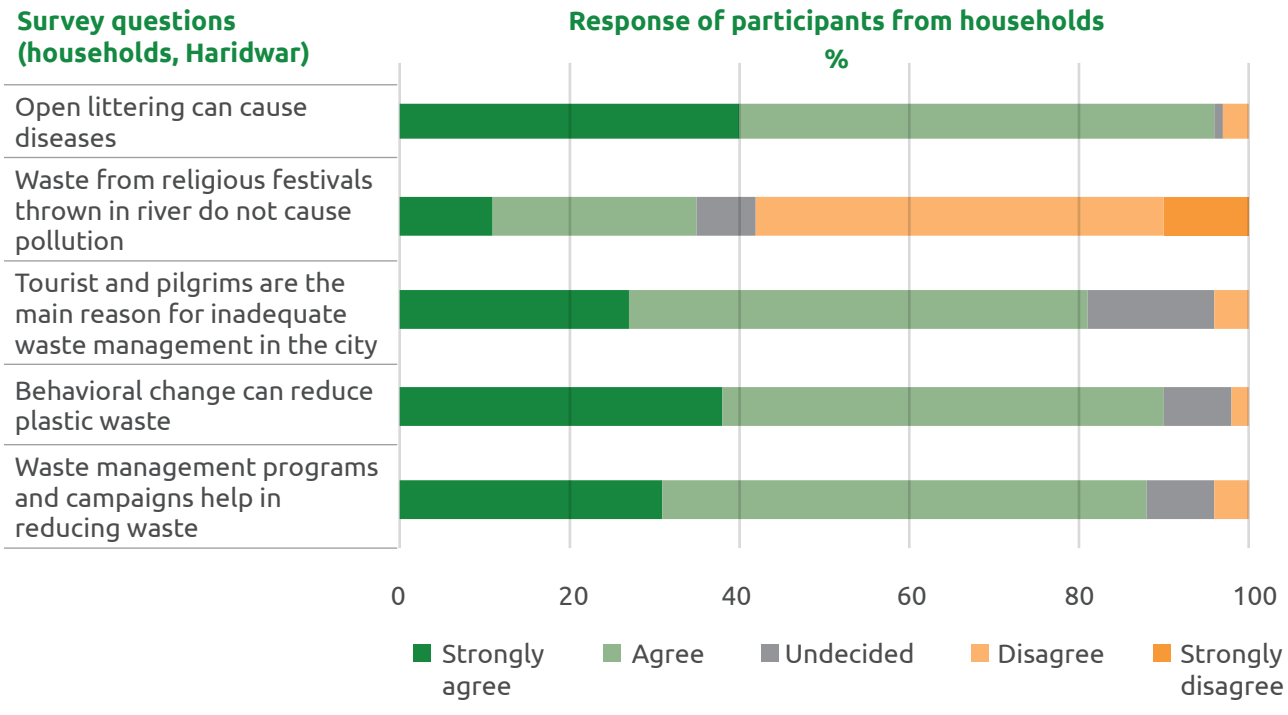
Figure 30: Awareness raising on household waste segregation.

Table 15: Household responses about 4Rs knowledge and practice in Haridwar.



96% of households understand the potential environmental and health implications of waste littered in open spaces. 81% of the respondents believe that tourism and pilgrims are the main reason for an inadequate urban waste management.

Table 16: Summary of awareness, engagement and solution related questions, Haridwar.



Approx. 90% of the respondents agreed that behavioral changes such as the use of environmentally friendly and reusable packing materials for shopping can reduce plastic waste generation.

A campaign through individually and personally approaching and informing households on waste management practices is preferred by 55% of all respondents. 28% of respondents felt that awareness campaigns disseminated through television are most effective. Social media campaigns and cleanliness drives are preferred by a minority of 13% of the respondents. School campaigns were not considered as a preferred channel for waste awareness activities.

9.2. Commercial Establishments and Institutions

Commercial establishments characteristics

Commercial shops dominate the commercial landscape of Haridwar and are a major source of waste in Haridwar. In total, 91 commercial establishments and institutions participated in the survey. The establishments selected for the survey conduct diverse business activities so that a greater variety of entities in the city are represented, such as groceries, hardware and electronics stores, pharmaceuticals stores, sweet shops and eateries, plastic stores, garments and shops for religious items.

Segregation at source

80% of the establishments use a single dustbin to store their waste. Only 17% segregate the waste into dry and wet. 79% of the establishments claimed to start segregating if asked to do so by their service provider. Reasons for the low levels of waste segregation include low to zero dry waste generation (43%), no time to segregate (15%) and lack of adequate provisions to store segregated waste (11%).

Disposal of waste

More than 80% give their waste to the waste collectors as their first choice of disposal and use community bins to dispose of their waste as second choice.

Plastic waste prevention and perception

87% of the establishments perceived no significant increase in plastic waste generation from their establishments over the course of the last year. This however may also be a result of the COVID-19 related decline in tourism and economic activities in the city and the entire region. Despite this fact, 38% of the respondents perceived an increase in use of Tetra Paks and 28% an increase in the use of PET bottles.

Figure 31: Waste identification after household waste segregation survey.

Waste collection services

Regular waste collection services are available for the commercial establishments. More than 90% of the respondents replied that the frequency of waste collection in their area is either daily or on more than three days a week. Approx. 90% of the establishments use the collection services regularly and two third of them are satisfied with the current waste collection mechanism.

Collection fees

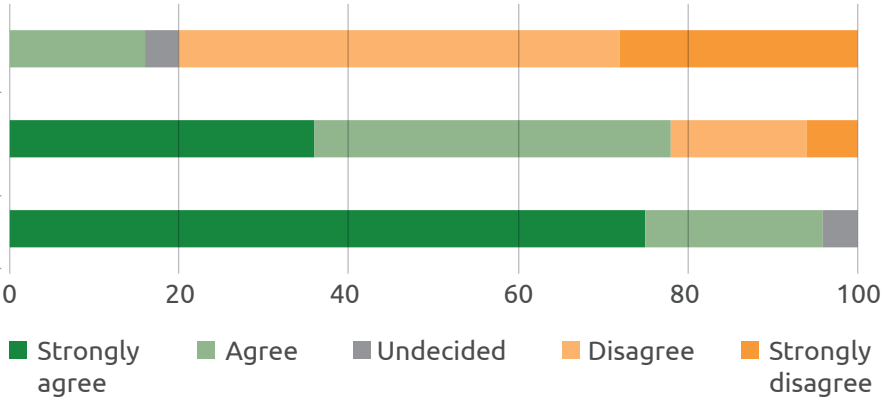
More than 90% of the establishments pay a monthly fee as waste management charges. Current charges vary from 150 INR/month for shops to 500 INR/month for restaurants and eateries. More than 25% of the respondents are willing to pay an additional amount of 50 INR/month for an improved waste management service. More than 90% of the respondents expressed a willingness to accept a higher purchase price for products with less packaging or a higher recyclability.

Awareness, engagement and solutions

The general awareness of households and waste generators on waste was found to be low. Principles of material reuse and refuse were known to one third of all participants. Only 25% of the respondents were aware of the importance and practices of recycling. An even lower share of participants follows the principles to reduce plastic waste. Only 9% hand over their waste for recycling. Among the most common items sold by the surveyed commercial establishments to *Kabadi Walas* were higher value materials such as paper and cardboard, PET bottles and other plastic items.

Table 17: Summary of survey outputs, commercial establishments, Haridwar.

Survey questions (commercial establishments, Haridwar)	Response of participants from commercial establishments %
Waste from religious festivals thrown in river do not cause pollution	
Tourist and pilgrims are the main reason for inadequate waste management in the city	
Behavioral change can reduce plastic waste	

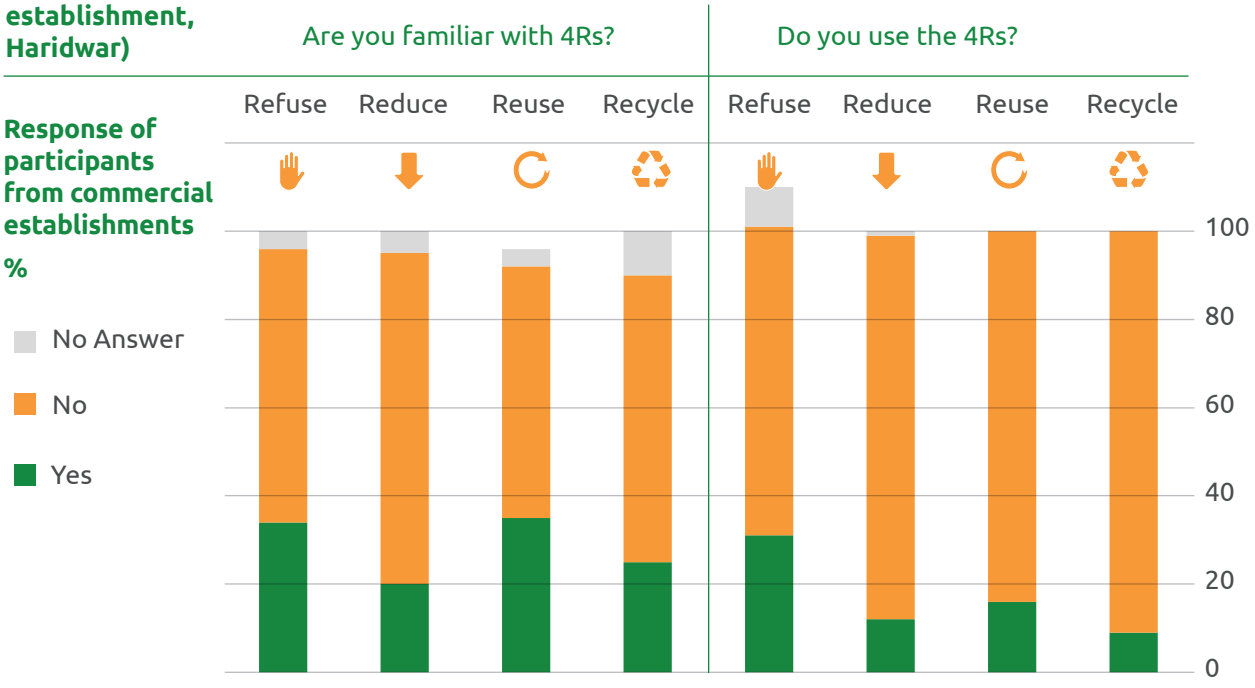


More than 90% believe that behavioral change in relation to lifestyle choices can help to reduce plastic waste. 54% of the respondents believe that door-to-door campaigns are the most effective mode of waste management campaigning.

Table 18: Summary of awareness, engagement and solution related questions, Haridwar.

Survey questions (commercial establishment, Haridwar)

Response of participants from commercial establishments %



10. Conclusion

In order to identify the data basis for project *Aviral*, a comprehensive assessment was conducted in Haridwar.

The baseline assessment included an investigation of the existing waste management system, a stakeholder analysis, a survey of public awareness levels, a characterization and quantification of municipal solid waste flows with a specific focus on plastic waste as well as an approximation of plastic leakage streams.

The aim of the assessment was to develop a detailed understanding of current waste management practices in Haridwar, identify potential areas of intervention and support the development of a city specific Plastic Waste Management Action Plan.

Currently, the city has not yet achieved full compliance with the regulations mandated by the Indian Solid Waste Management Rules 2016 and Plastic Waste Management Rules 2016 and 2018 (amended). One of the key elements of the Solid Waste Management Rules 2016 is the establishment and strengthening of segregation at source and the reduction of landfill inputs. Mixed waste is transported to the local dumpsites; alternative treatment infrastructures for dry waste are not available.

The municipality was found to be not adequately equipped to handle and effectively manage municipal solid waste. In addition to an overall shortage of personnel on the institutional level, a detailed knowledge on financial, managerial and technical aspects of waste management is barely available. A capacity building program on these aspects is required for urban waste management officials at regular intervals.

Overall volumes and capacities of primary waste collection vehicles and bins were found to be generally sufficient for the city's requirements. However, waste leakage, at community bin locations as well as open littering due to a lack of participation in the existing waste management system (e.g. to avoid waste management fees) are major challenges within the waste management system. Although newer waste collection vehicles have provisions for a separate waste collection, the separate waste collection and transportation must be ensured throughout the waste processing chain. A stepwise redesign of the collection system is recommended to successfully establish segregation at source.

Besides intensive public awareness campaigns to ensure segregation at source at the waste generator level, the infrastructure has to be adjusted to keep separately collected waste streams apart. At the processing level, a treatment infrastructure for waste streams is not in operation. All waste streams, both wet and dry, are disposed without further treatment on the city's dumpsite. The municipality has already set up a screening and shredding facility near the existing dumpsite, which is currently not in use. A strong alignment of this existing facility with new material recovery facilities is recommended to use synergies and scaling effects.

A separate collection of plastic waste only takes place through informal waste collectors on litter spots or from community bins for high-value materials like PET or HDPE. All other plastic wastes are either disposed on open landfills or leaked into the environment. In particular MLP and LDPE, having a low value for informal waste collectors, are disposed or leaked. To reduce waste transportation, home composting and decentralized composting facilities within the city are suggested for separately collected wet waste. Presently, the informal sector is spread throughout the city and poorly equipped for waste collection and processing. Simultaneously, the economic incentives to collect and processes low value plastic waste are too low for an effective reduction of plastic waste leakage. Providing basic infrastructure for collection,

transportation, storage and handling to informal workers is suggested to improve their ability to manage plastic waste, increases their profit margins due to higher process efficiencies and stops leakages into the environment.

Overall data availability and management on waste-related aspects are poor. This report identified vast data ambiguities regarding waste composition and quantities. Within the city, detailed quantitative nor qualitative data on waste streams are barely recorded. A cost-efficient system to quantify waste streams must be established in the city to identify leakage streams and to monitor the compliance of waste management contractors, with their contractual and legal requirements. Besides waste contractors, a monitoring system must be established for open littering, simultaneously to addressing the identified reasons for non-compliance with the existing waste management system. Data collection units (e.g. weighing bridges) are recommend being installed at all waste processing facilities. For monitoring the waste services, the facilities should be regularly calibrated and the data directly linked to the municipality.

In Haridwar, different organizations manage waste from different wards and sources. During this research, it was found that most of the organizations work in isolation. Therefore, a coordination mechanism among all the key players is suggested to align all individual activities and leverage synergies between the organizations.

The waste management byelaws of the Haridwar Municipal Corporation are detailed and extensive. However, the enforcement of the byelaws is barely done. From the investigation on ground it can be suggested that circle inspectors, municipal workers, sanitary inspectors, and supervisors are engaged in monitoring the compliance with the regulations at all waste generators, ensuring the sustainable removal of blackspots and issuing fines for non-compliance (e.g. littering).

An unambiguous, transparent and legal framework for all major waste streams, defining roles and responsibilities for each activity and determining infrastructure capacities as well as processes to each waste stream is suggested as a basis for further improvements of the waste management system. The aim of this framework could contain communicating the city's strategy on plastic waste management to all citizens as well as public and private entities in order to increase public participation, reducing environmental impacts of plastic waste pollution and increasing the technical and economic efficiency of waste management systems. Further, funding and business opportunities within (plastic) waste management have to be further developed and identified, including the introduction of national EPR systems. An open framework furthermore helps to increase accountability and traceability of plastic waste in the city and enables the municipality to set development targets, timelines and roadmaps for improving plastic waste management within a predefined time horizon.

Although the municipality is obliged to conduct public awareness raising campaigns for waste generators at regular intervals, long-term concepts or strategies for ensuring regular campaigns are barely available on a municipal level. Here, an unambiguous definition of roles and responsibilities within the municipality for public campaigns as well as for management of funding must be determined.

In order to improve the city's plastic waste management, a multilayered integrated approach is suggested, addressing various problems on multiple levels simultaneously. Since Haridwar is currently restructuring their waste management system and onboarding new waste management contractors, major changes of the existing systems are considered feasible through a close interaction between all relevant stakeholders and project *Aviral*.

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11. Sources

Central Pollution Control Board (2019). Annual Report Plastic Waste Management Rules. [online] cpcb, Ministry of Environment, Forest and Climate Change, Govt. of India, p.12. Available at: https://cpcb.nic.in/uploads/plasticwaste/Annual_Report_2018-19_PWM.pdf [Accessed 1 Feb. 2021].

eHealth Network (2018). Haridwar: The Gateway to Heaven Goes for Health and Hygiene. [online] Health the enterprise of healthcare. Available at: https://ehealth.eletsonline.com/2018/03/haridwar-the-gateway-to-heaven-goes-for-health-and-hygiene/ [Accessed 24 Jan. 2021].

GIZ, University of Leeds, Eawag-Sandec, Wasteaware (2020). User Manual: Waste Flow Diagram (WFD): A rapid assessment tool for mapping waste flows and quantifying plastic leakage. Version 1.0. February 2020. Principal Investigator: Velis C.A. Research team: Cottom J., Zabaleta I., Zurbruegg C., Stretz J. and Blume S. Eschborn, Germany. Obtain from: http://plasticpollution.leeds.ac.uk.

Government of Uttarakhand (2018). Principal Accountant General (Audit) Uttarakhand, Dehradun. [online] cag.gov.in. Available at: https://cag.gov.in/ag/uttarakhand/en/audit-report/details/47283 [Accessed 1 Feb. 2021].

HNN (Haridwar Nagar Nigam) (2018). Ward-wise population data Haridwar. Data collection and survey by HNN. Direct transfer of information (unpublished).

HNN (Haridwar Nagar Nigam) (2020). Personal exchanges with Haridwar Municipal Corporation, represented by Vinod Yadav, Assistant Commissioner; Rahul Kanthola, Taxation Department; Sunit Kumar, Sanitary Inspector; Rajendra Ghaghat, Senior Assistant; on 17-18 November, 2-3 December and 7-8 December.

Hoornweg, Daniel; Bhada-Tata, Perinaz (2012). What a Waste: A Global Review of Solid Waste Management. Urban development series; knowledge papers no. 15. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/17388 License: CC BY 3.0 IGO.

Ministry of Environment, Forest and Climate Change (2016). Solid Waste Management Rules. [online] Ministry of Environment, Forest and Climate Change Government of India. Available at: http://moef.gov.in/wp-content/uploads/2019/10/Solid-Waste-Management-Rules-2016.pdf [Accessed 17 Jan. 2021].

Ministry of Housing and Urban Affairs, Government of India (2019). Swachh Bharat Mission (Urban) Plastic Waste Management issues, solutions & case studies. [online], p.1. Available at: http://164.100.228.143:8080/sbm/content/writereaddata/SBM%20Plastic%20Waste%20Book.pdf [Accessed 1 Feb. 2021].

Nainital Tourism (n.d.). Uttarakhand Tourism. [online] www.nainitaltourism.com. Available at: http://www.nainitaltourism.com/Uttarakhand_Uttaranchal.html [Accessed 22 Jan. 2021].

Oyindamola, Kayode (2015). Journal of Engineering Science Invention. Design and fabrication of a tricycle for municipal waste collection, ISSN: 2319-6734, Volume: 4, Issue: 1, DOI:10.6084/M9.FIGSHARE.1393167.V1.

Pew Charitable Trusts and SYSTEMIQ (2020). Breaking the Plastic Wave Thought Partners A COMPREHENSIVE ASSESSMENT OF PATHWAYS TOWARDS STOPPING OCEAN PLASTIC POLLUTION. [online] One Planet Network, p.20. Available at: https://www.oneplanetnetwork.org/sites/default/files/breakingtheplasticwave_report.pdf [Accessed 1 Feb. 2021].

The Pioneer (2019). Biogas plant to take shape before Kumbh Mela. [online] The Pioneer. Available at: https://www.dailypioneer.com/2019/state-editions/biogas-plant-to-take-shape-before-kumbh-mela.html [Accessed 1 Feb. 2021].

The Week (2020). Alliance and GIZ Launch Partnership to Reduce Plastic Waste in Ganges. [online] The Week. Available at: https://www.theweek.in/wire-updates/business/2020/07/28/pwr21-alliance-to-end-plastic-waste.html [Accessed 22 Jan. 2021].

UEPPCB (2018). Annual Report 2017-2018. [online] ueppcb.uk.gov.in. Available at: https://ueppcb.uk.gov.in/files/ANNUAL_REPORT_2017-18.pdf [Accessed 29 Jan. 2021].

UN Habitat (2021). UN-Habitat to launch the Waste Wise Cities Tool to improve waste management systems globally | UN-Habitat. [online] unhabitat.org. Available at: https://unhabitat.org/un-habitat-to-launch-the-waste-wise-cities-tool-to-improve-waste-management-systems-globally [Accessed 1 Feb. 2021].

United Nations Economic and Social Commission for Asia and the Pacific (2010). Guidelines for solid waste management assessment (baseline survey) in secondary cities and small towns in Asia and the Pacific. [online] ESCAP. Available at: https://www.unescap.org/resources/guidelines-solid-waste-management-assessment-baseline-survey-secondary-cities-and-small [Accessed 20 Jan. 2021].

Urban Development Directorate Dehradun (2017). URBAN MUNICIPAL SOLID WASTE MANAGEMENT ACTION PLAN FOR STATE OF UTTARAKHAND. [online] Available at: https://udd.uk.gov.in/files/20170825_SWM_action_plan__revised_final_draft_with_comments_sent_to_state-_August_II.pdf [Accessed 25 Jan. 2021].

Uttarakhand Tourism Department (2020). Tourist numbers and bed nights in Rishikesh and Haridwar. Data collection by Uttarakhand Tourism Department. Direct transfer of information (unpublished).

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12. Annex

Table 19: Ward Mapping of Administration

Ward Number					
Name of ward					
Area of the Ward					
Type of ward (Commercial/residential /mixed residential and commercial)					
For residential wards (high income/ mixed income/ EWS)					
Population	Male				
	Female				
Number of Households					
Number of Schools					
Number of College					
Number of Hospital					
Number of Nursing homes/clinics					
Number of Hotels/*dharamshala*					
Number of shops					
Number of offices/banks/insurance/etc.					
Number of shopping complex/malls/cinema hall					
Number of marriage hall/community center/ club					
Number of municipal market (vegetable & fruit market/mandi; poultry and slaughterhouse)					
Number of informal markets/street vendors					
Number of Restaurants					
Number of Temples/ places of worships					
Population of Informal settlements/slums/ unauthorized colonies					
Number of Industries					
Monitoring, Reporting, Compliant Redressal system					

Table 20: Details of tourist inflow in the city

Month	Number of tourists	National	International	Total number of bed nights
January				
February				
March				
April				
May				
June				
July				
August				
September				
October				
November				
December				
Total				

Table 21: Details of floating populations

Floating population per day (number)	

Table 22: Daily quantification of waste from different wards and community bins

Ward No. and Name	Area 1	Area 2	Area 3	Area 4	……..
Type of ward (Category)					
Number of HHs*					
Total Population*					
Total Waste (Kg)					
Waste > 60 mm size (Kg)					
60 – 25 mm size (kg)					
Waste < 25 mm size (kg)					
Total wet waste (Kg)					
Total dry waste (Kg)					
Metals (Kg)					
Glass & Ceramic (Kg)					
Rubber & leather (Kg)					
Textile (Kg)					
Paper (Kg)					
Others					
Total Plastic (Kg)					
PET (Kg)					
HDPE (Kg)					
PVC (Kg)					
LDPE (Kg)					
PP (Kg)					
PS (Kg)					
MLP (Kg)					

*only for daily quantification of waste from different wards

Table 23: Existing Status of Municipal Solid Waste Management at Ward level

Ward Number				
Responsible agency for MSW collection (Pvt./ local body)				
Whether waste is collected from door to door (Yes/No)				
Segregation of waste (dry, wet and domestic hazardous waste) – is being done or not				
Number of sanitary workers involved in waste collection				
Frequency of waste collection (daily/alternate days/twice a week or thrice a week)				
Number of community bins and capacity				
Whether waste is collected in Dry and waste fraction at community bins				
Number of secondary storage facility (apart from community bins) and total capacity				
Any processing facility at ward level (composting, dry waste MRF, biogas, etc.)				
Black spots and dumping grounds				
Quantity of waste collected daily (in tons)				

Table 24: Existing waste management facilities at city level

Area and capacity of primary waste storage facility			
Location of primary waste storage facility			
Number of community bins			
Frequency of collection from community bins (Daily/alternate days/weekly/etc.)			
Whether waste is collected in dry and wet waste fraction at community bins			
Amount of waste collected from road sweeping and drain cleaning			
Details of waste collection vehicles	Numbers	Capacity	Number of trips made each day (all together)
Auto tipper			
Tractors			
Trucks			
Push carts			
Tricycles			
Compactor			
Loader/Backhoe loader			

Table 25: City level data on Processing and Disposal

			Capacity	Area	Remaining Life	Technology adopted	Quantity of Waste Disposed Daily	Waste Types/ Characterisation	Rejects and Disposal Mechanism	
									Quantity	Characteristics
Waste Treatment/ Processing and Disposal Facility Present	Compost Pit/ Plant	windrow composting								
		vermicomposting								
		Others								
	Biogas Plant									
	Refuse Derived Fuel (RDF) Plant									
	Waste to energy plants									
	Special waste treatment facilities									
	Others									
	Illegal Dump Sites									
	Dump Site/ Sanitary Landfill									
Vacant Land Available with ULB for (centralized/ decentralized systems for waste treatment)						Location and Total land Area				
Vacant Land Available with ULB for sanitary landfill and dumping waste						Location and Total land Area				

Table 26: Infrastructure at Municipality level (excluding private agency)

Number of permanent staffs	
Number of contractual staffs	
Number of sanitary workers (permanent/contractual)	
Whether municipality has integrated informal workers to its municipal waste work? Share details of issuance of identity cards, contracts etc.	
Number of vehicles	
JCB	
Tipper	
Tractor trolley	
Truck	
Tricycle	
Compactor	
Tata-407	
Staffs for vehicles	
Does municipality collect MSW from any of the wards?	
If yes from how many wards, and their name/number	
Is road sweeping and cleaning done by municipality or some other contractual company? If done by some other company, name of the company.	
Quantity of waste collected from street sweeping	
Quantity of plastic waste collected from street sweeping	
What happens to the collected waste	
What happens to the collected plastic	
Fees collected from different categories	Charges (in Rs. Per month)
Residential	
Commercial (offices)	
Hotels (on what basis area or room)	
Hotels with restaurants facility	
Schools/colleges	
Residential schools/colleges (with hostel facility)	
Ashram/dharamshala	
Shops	
Restaurants	
Vegetable/fruit mandis	
Hospitals (on what basis)	
Does municipality have a engineered sanitary landfill site or a dumpsite? (Details and location)	
Average quantity of daily waste going to the landfill/dumpsite (tonnes/day)	
Has municipality done any mapping of formal/informal recyclers in the city? If yes, share details	
Availability of funds under SBM/ Nmami Gange/ other state govt. schemes? Please mention	

Table 27: Finance data from municipality (Source of income)

Sources of Income	Amount (in INR)	Percentage of total
Tax revenue		
Rental income from municipal properties		
Fees & User Charges		
Sale & Hire Charges		
Interest Earned		
Other Income		
Revenue Grants, Contribution and Subsidies		
Total		

Table 28: Finance data from municipality (Source of expenditures)

Expenditures	Amount (in INR)	Percentage of total
Establishment Expenses		
Administrative Expenses		
Operation and Maintenance		
Interest & Finance Expenses		
Programme Expenses		
Misc. Expenses		
Depreciation		
Change in Inventory		
Total		

Table 29: Infrastructure with private sector agency outsourced for waste collection and management

Number of permanent staffs	
Number of contractual staffs	
Number of sanitary workers (permanent/contractual)	
Number of informal workers integrated?	
How many wards waste is collected from, and their name/number	
Whether collecting waste in a segregated manner?	
Total waste collected (per day in tons)	
Characterization of waste (percentage of dry and wet waste)	
Quantity of plastic in waste collected (per day in tons)	
What is done with the collected wet waste	
What is done with the collected dry waste	
What is done with the collected recyclable plastic waste	
Number of vehicles	
JCB	
Tipper	
Tractor trolley	
Truck	
Tricycle	
Compactor	
Tata-407	
Staffs for vehicles	
Does KRL collects MSW from slums as well?	
If yes from how many slums, and their name	
Road sweeping and cleaning, is it done by Pvt agency or municipality? If done by Pvt agency quantity of waste collected from street sweeping.	
Quantity of plastic in collected waste from street sweeping	
Fees collected from different categories	Charges (in Rs. Per month)
Residential	
Commercial (offices)	
Hotels (on what basis area or room)	
Hotels with restaurants facility	
Schools/colleges	
Residential schools/colleges (with hostel facility)	
Ashram/dharamshala	
Shops	
Restaurants	
Vegetable/fruit mandis	
Hospitals (on what basis)	
Average quantity of daily waste going to the landfill/dumpsite (tons/day)	
Contract modality with municipality?	

Table 30: Detailed data from hotels

Name of hotel	
Number of rooms	
Monthly average number of guests (or percentage occupancy)	
In-house kitchen/Restaurants (Yes/No)	
Number of staffs	
Per day waste generation from restaurant/kitchen	
Per day waste generation from hotel/guests	
On site treatment mechanism available or not (compost/sorting/etc.)	
Waste is collected from hotel doorstep or from a common collection point	
Frequency of waste collection (daily/alternate days/twice a week or thrice a week)	
Disposal mechanism for domestic hazardous waste	

Table 31: Detailed data from institutions (schools and colleges)

Name of school/college	
Number of students	
Number of teachers and overall administration in school	
Is it a Co-ed, girls or boys school	
Does school adopt segregation at source into wet, dry and domestic hazardous waste?	
Canteen facility available or not	
Has school kept two bins in campus in classroom/in canteen?	
Daily waste generation	
Hostel facility for students and teachers – yes or no	
How many (teachers/other staff and students) reside in the hostel on daily basis (during operation)	
How many (teachers/other staff and students) reside in the hostel on daily basis (during vacation)	
How is school disposing domestic hazardous waste?	
On site treatment mechanism available or not (compost/sorting/etc.)	
Waste is collected from school doorstep or from a common collection point	
Frequency of waste collection (daily/alternate days/twice a week or thrice a week)	
Disposal mechanism for domestic hazardous waste	

Table 32: Detailed data for religious institution (temples, mosques, gurudwara, church, Ghats, etc.)

Name of place	
Type of religious place	
Segregation of waste at source (wet and dry)	
Average quantity of flower waste/day	
Total quantity of waste generated per day	
In house treatment facility for flower waste (compost/other)	
Frequency of waste collection (daily/alternate days/twice a week or thrice a week)	
Waste is collected from school doorstep or from a common collection point	
Frequency of waste collection (daily/alternate days/twice a week or thrice a week)	
Disposal mechanism for domestic hazardous waste	

Table 33: Ward wise data on informal waste collectors

Ward No.	No. of Waste Pickers/ collectors operating	Information on waste sale	
		Company/ Shop Name	Shop Address/ Location Details

Table 34: Data from informal waste collectors on the types and quantity of waste they collect

Ward No.								
Name of the Waste Picker								
	Paper	**Textile**	**Rubber**	**Leather**	**Metal**	**Glass**	**Plastic**	**Others**
Quantity of wastes collected								
Selling Price								
Details of recycler or aggregator where it is sold								
Plastic Types	**1- PET**	**2 - HDPE**	**3 - PVC**	**4 - LDPE**	**5 - PP**	**6 - PS**	**7 - Others**	
Quantity of plastic wastes collected								
Selling Price								
Details of recycler or aggregator where it is sold								

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Haridwar Baseline Assessment Report

November to December 2020

Powered by: ALLIANCE TO END PLASTIC WASTE
Implemented by: giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
In Cooperation with: SIA SUSTAINABILITY INNOVATIONS AND ADVISORIES PVT. LTD.