Preventing Plastic in Nepal Rivers by Boosting the Informal Sector

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List of Abbreviations

ABS	Acrylonitrile Butadiene Styrene
ADB	Asian Development Bank
ABD	Acrylonitrile Butadiene Styrene
BRBIP	Bagmati River Basin Improvement Project
EPR	Extended Producer Responsibility
HIPS	High Impact Polystyrene Sheet
HDPE	High-density Polyethylene
IWS	Informal Waste System
KMC	Kathmandu Metropolitan City
LDPE	Low-density Polyethylene
LMC	Lalitpur Metropolitan City
MOUD	Ministry of Urban Development
MOFALD	Ministry of Federal Affairs and Local Development
MRF	Materials Recovery Facility
MSW	Municipal Solid Waste
NR	Nepali Rupee
PP	Polypropylene
PET	Polyethylene terephthalate
PS	Polystyrene
PVC	Polyvinyl Chloride
PPE	Personal Protective Equipment
PRISM	Poverty reduction of informal workers in solid waste management
RDF	Refuse-derived Fuel
RIPL	Preventing plastic in Nepal rivers by strengthening the informal sector project
SASAJA	Samyukta Safai Jagaran
SWM	Solid Waste Management
SWMTSC	Solid Waste Management Technical Support Center
WW	Waste Workers
UWGR	Unit Waste Generation Rate

Executive Summary

This report summarizes key findings of the initial baseline assessment of hotspots for plastic pollution in rivers in Kathmandu Metropolitan City (KMC) and the kinds of plastic that are commonly found in those spots, as well as challenges commonly faced by informal recycling sector workers. The baseline survey was undertaken as part of the RIPL project, financed by the Norwegian Retailers´ Environment Fund and the Norwegian agency for development cooperation; implemented by GRID-Arendal, the Norwegian Geotechnical Institute (NGI), the Center for Research and Sustainable Development Nepal (CREASION), Doko Recyclers and International Solid Waste Association (ISWA). The findings from this report are the result of field research, stakeholder interviews that took place in Kathmandu during the course of late 2021 and 2022 and a desktop literature review.

The rivers in Kathmandu Valley including Bagmati and its tributaries such as Bishnumati, Manohara, Hanumante, and Dhobikhola are thought to be extremely polluted by plastic waste. In order to further understand the composition and abundance of different types of plastic and non-plastic wastes, this project undertook a plastic river mapping from 3 survey sites in Manohara river (Pepsicola town planning area), Hanumante River, and Bagmati river. Forty six percent of material collected were plastics and the remaining fifty four percent were non-plastics that included glass, metal, cloth and landfill waste. Identified plastics from the waste were further classified into recyclable plastics and non-recyclable plastics according to their difference in recyclability in the current context of Nepal.

Within the plastic waste segment, twenty three percent of plastics were considered to be «easy to recycle», which was composed primarily of Polyethylene terephthalate and High-density Polyethylene. The seventy seven percent of plastics collected considered «hard to recycle» included Nylon, Expanded Polystyrene, (mixed and dirty), Low density Polyethylene, Polypropylene, and Tetra Pak. Among non-plastic segments, non-recyclable landfill waste comprised the highest volume with sixty two percent.

Based on these survey results, a much higher proportion of plastics than other materials ends up in rivers. The Informal Recycling Sector plays a significant role in solid waste management filling the gaps left by municipal bodies and other entities in waste management. With an estimated 19,845 informal recyclers in Kathmandu Valley, on average over the course of a calendar year, there is an enormous potential to increase capacity and thereby reduce plastic pollution.

A representative group of informal recyclers were interviewed (n=40) at three scrap centers and two transfer stations to get a better understanding of their situation and the extent to which they work with plastic materials.

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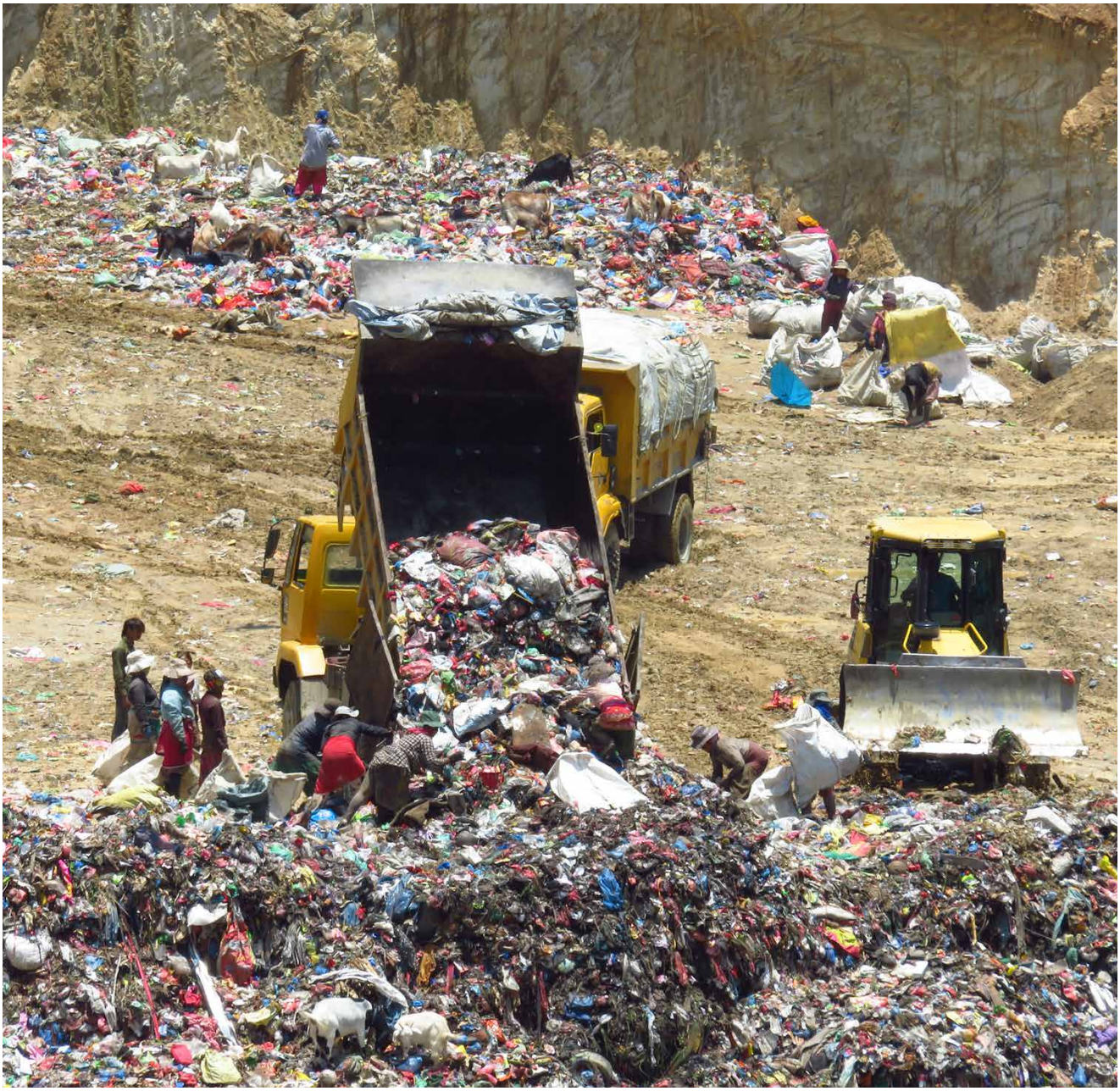
The interviews revealed that informal recyclers handle all types of plastics, sorting a larger share of low density polyethylene and polypropylene plastics (seventy percent) and a lower share of polyethylene terephthalate and high-density polyethylene (thirty percent). On average, 350 kilograms of plastics are sorted by each individual in the scrap center per day, with some individuals sorting over 400 kilograms per day, and generally women are thought to be more knowledgeable and able to work at a quicker pace in sorting activities, although they may also be more unaware of the market buying and selling prices of plastic.

Based on the findings of this baseline survey, we provide the following recommendations to prevent plastic pollution in the Kathmandu Valley:

- To prevent plastics from entering rivers, it is recommended to further identify hotspot areas along river banks where dumping and collection of plastic waste is most rampant, prioritize areas of interventions for collection and processing of plastic, and implement a systematized door to door collection in areas where waste pick up is limited or lacking.

- To strengthen the informal recycling sector, it is important to build relationships of trust and involve them in participatory planning of the solutions for managing plastic waste, as the main partners and beneficiaries of the interventions. Training and capacity building on how to develop and operate plastic collection hubs is one possible intervention.

- To strengthen the business case/private sector for such an intervention, it is recommended to develop of a model for collection and processing of plastic waste that is replicable for entrepreneurs, both



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currently involved and interested in this sector. Such a model requires development of a business case and operational modality for operating collection and processing centers near hotspots, and formulating a comprehensive and financially viable plan for these.

- For policymakers regulations such as Extended Producer Responsibility (EPR) schemes, waste taxes and bans can be an area of intervention for responsible management of waste at the sources itself. Likewise, coordination with local authorities and government bodies working actively on measures to prevent waste from ending up in rivers and to enhance the existing municipal waste pickup services would be beneficial; and coordination with social organizations, youth groups, women's groups and the private sector in waste management is important to create awareness of waste management systems.
- Technical solutions should also be considered. Solutions for sorting and cleaning of plastics should be explored, particularly for those classified as non-recyclable in nature due to dirt. It is recommended to consult with relevant technical and private partners – both local and international, for devising solutions for 'hard to recycle' grades of plastics, and researching and finding technical and innovative solutions for these grades of plastics, including in their use as Refuse-derived fuel (RDF) is needed.

Limitations

This report is intended as a 'rapid assessment' of the role of informal recyclers, the challenges and opportunities they face, as well as a baseline mapping and audit of river hotspots for plastic waste.

Introduction

Solid waste management: the numbers

Municipal solid waste (MSW) includes all items from homes and businesses that people no longer have any use for, commonly classified as trash or garbage (US EPA) but which can include recyclables. Many homes and businesses dispose of materials that are recyclable and have a value in the waste value chain, that is, they could be further reused or recycled, including items such as food, paper, plastics, textiles, wood, glass, metals, and others.

Municipal solid waste in Kathmandu[1] has been increasing day by day due to population growth, rapid urbanization, and institutional and infrastructural development across all sectors. The establishment of factories and industries, development and expansion of trade and commerce, adoption of advanced technology, and changes in consumption habits fueling consumerist and convenience-based practices, have caused an increase in waste generation as well as a change in the nature and composition of solid waste, not only within the Kathmandu Metropolitan City (KMC), but across the entire Valley. Yet, solid waste management systems implemented by KMC and others have not been able to keep up with, and manage the increased volume of domestic waste, industrial waste, chemical waste, healthcare institution-related waste, or harmful/hazardous waste, which results in serious challenges to the environment and human health.

With increased urbanization and industrialization, a rapid growth in plastic consumption has also occurred in Nepal. Plastics have become an integral part of industry, commerce, and everyday life due to their wide usage in packaging, communication, electronics, automotive and industrial applications. There is a steady growth in plastic consumption owing to its user-friendly and convenient design which incorporates strength and low density at a comparatively low cost (Subramanian, 2000, Khanal, 2022). Polyethylene terephthalate, High-density Polyethylene, low-density Polyethylene, Polyvinyl Chloride, Polypropylene and Polystyrene are the most extensively used polymers in the plastic industry globally. Polyethylene (high-density Polyethylene and low density Polyethylene) occupies the largest fraction of the plastic waste stream followed by Polyethylene Terephthalate (Faraca & Astrup, 2019). Other plastics like Polystyrene, Polyvinyl Chloride, Polypropylene, etc. can be found in lesser amounts.

[1] There is a lack of up-to-date and available solid waste management baseline data in municipalities across the Kathmandu Valley, nor is the data consistent across years and across different surveys, which leads to inconsistencies in the numbers presented. The majority of the data presented in this chapter is derived from the report "Solid waste management and circular economy" (Pathak, 2021), unless otherwise indicated.

Within the Kathmandu Valley a huge number of these plastics are released into the environment, and especially into the rivers, because of inappropriate waste management, including lack of source segregation, low levels of waste collection and recycling of certain plastics, overfilling/beyond capacity landfills, and human behavior, including open dumping and dumping of waste directly into rivers.

The system of solid waste management in Kathmandu Valley contains multiple steps (Figure 1). On average, 1262 tons of MSW is generated on a daily basis by the 18 municipalities within the Valley. This represents twenty five percent of the MSW generated daily in Nepal.

Of this, sixteen percent(200 tons/day) goes directly to scrap dealers (persons selling small, leftover, or previously discarded pieces of metal, plastic, rubber or paper for a profit). Three percent (38 tons/day) is reduced (this part of the waste is already reduced in the sources as organic wastes and others). Fifty two percent (659 tons/day) is collected from households and commercial entities by private companies mostly, while some areas are covered by municipality as well and twenty nine percent (364 tons/day) ends up on the streets. The waste collected is not segregated and is mixed with recyclables which are further sorted (both formally and informally) at transfer stations or transfer points and at the landfill site.

Out of the twenty nine percent which ends up on the streets, about half (fourteen percent of total waste) is collected and sent to various municipal transfer stations and private transfer stations. The other half (fifteen percent of total waste generated – 183 tons/day) is uncontrolled waste. Despite a relatively high solid waste collection efficiency in Kathmandu Valley (eighty five percent compared to other cities in Nepal, open dumping and burning are still common waste management practices due to a lack of waste treatment and recovery facilities, except for dry recyclable materials, which happens through the informal recycling sector.

To summarise, of the 1262 tons of waste generated daily in Kathmandu Valley, an estimated (figures rounded to nearest 0.5 decimal):

- Three percent is reduced at source
- Eighteen point five percent is recovered and sent to scrap dealers for recycling
- Sixty three point five percent ends up in landfill
- Fifteen percent is inappropraitely managed: either burnt (three percent) or dumped (twelve percent)

This last segment of uncontrolled waste is the prime contributor to plastic ending up in the drainage system and in the rivers of the Valley, one of the foci of this baseline study. For the RIPL project, we are primarily concerned with the fifteen percent that is inappropriately managed and the nineteen percent which is recovered and sent to scrap dealers.

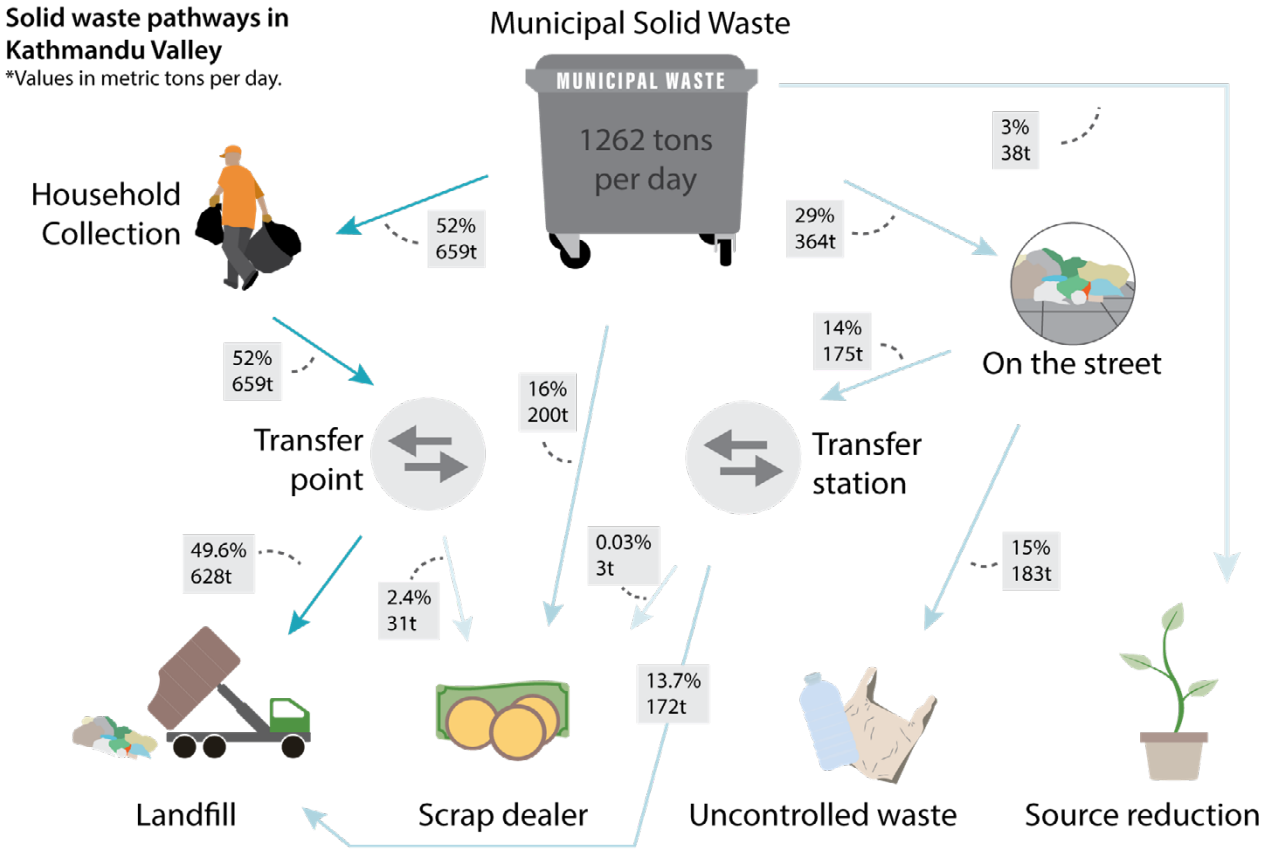

Figure 1: The movement of Municipal Solid Waste in percent of total and tons per day through different points of waste management in Kathmandu Valley (Source: Pathak, 2021).

Role of formal and informal recyclers

There are three main waste collectors in the entire value chain:

1. municipal waste workers considered as 'formal waste workers' who are on payroll and receive certain benefits from the municipality.
2. private waste companies employing both formal and informal waste workers in their operations. The formal waste workers are hired and on fixed payroll. However a significant number of waste workers are informally hired ad hoc from the informal waste sector, who work on day basis.
3. informal waste workers who are working independently in the waste value chain as defined in the earlier section of this report.

Both the private sector and municipal services collect waste (Figure 2). Private sector services collect directly from sources such as households and business localities, while municipal services collect from street piles. Nearly 60 private companies operate in KMC and Lalitpur Metropolitan City (LMC) alone and have at their disposal almost 200 vehicles for different types of waste, with various capacities. The private companies are not allowed to use municipal transfer stations, but have temporary transfer points, generally at the river corridors where they separate recyclable fractions.

Household waste management in Nepal starts mainly with women in the household sorting waste into categories for further disposal. Waste collection is formally carried out through a door-to-door pickup system. However, in some hard-to-reach places for vehicles, or areas with sparse households in the outskirts of the Valley, households deposit their waste cumulatively at a convenient point near their residence and the waste pickers collect it from those designated locations.

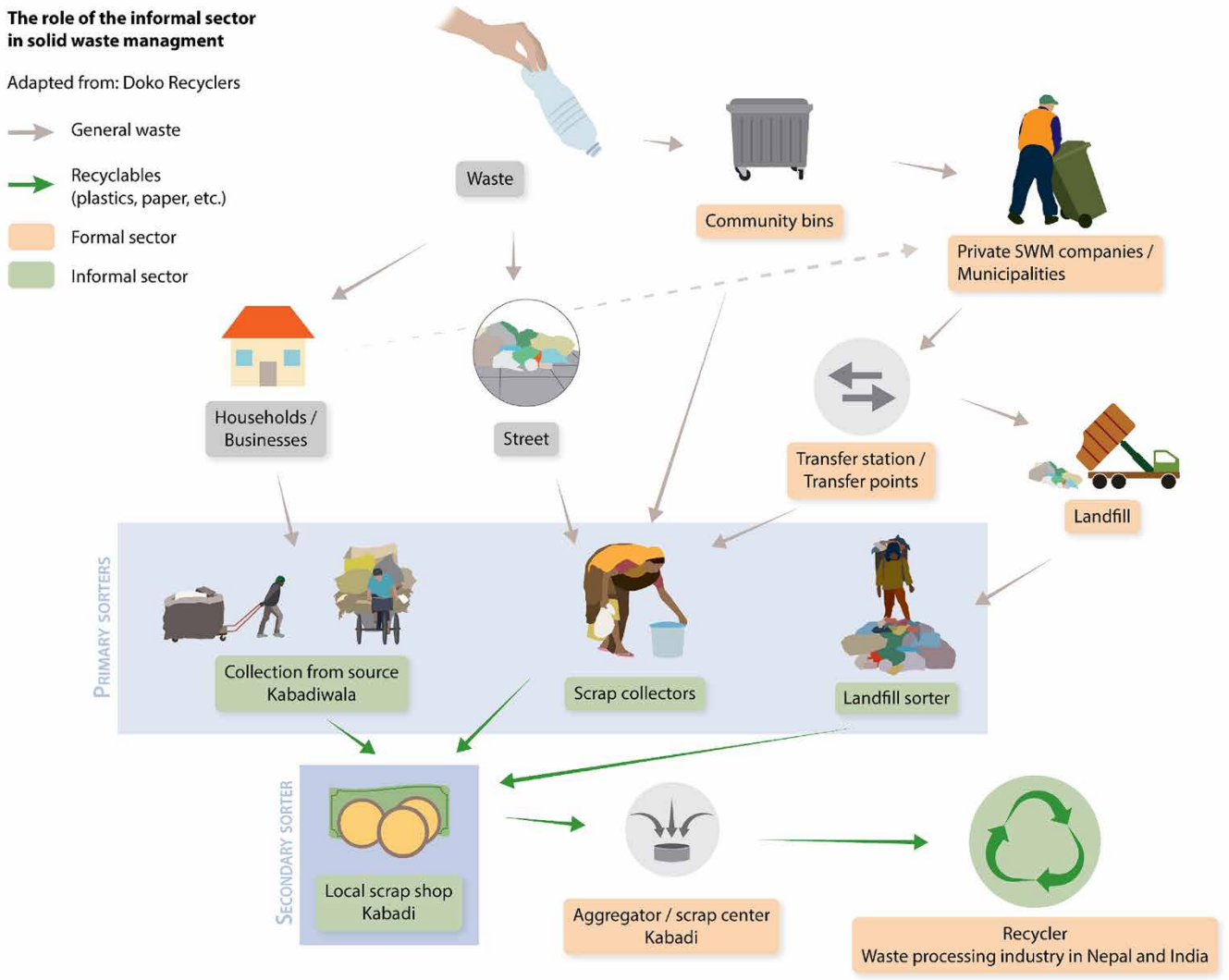

Figure 2: The involvement of informal recyclers in the solid waste management process. (Source: Doko Recyclers and CREASION)

Household waste is collected by private companies and sent to various transfer points, while the municipal services transport it directly to the transfer stations. A transfer point is mostly operated by private companies. The waste is unloaded from smaller tricycles to bigger trucks for transporting waste to the landfill site, and some of the recyclable materials in the waste stream is removed. From several private company operated transfer points, 31 tons/day is sorted and sold to scrap dealers. Similarly, 3 tons/day is also sorted and given to scrap dealers from the municipal transfer stations. Ultimately 628 tons/day from private sources and 172 tons/day from municipal sources is transferred to the landfill site. The private sector is responsible for depositing the vast majority of waste that ends up in landfills (about eighty percent of the total share) while the municipal services deposit much lower amounts (fourteen percent for KMC and seven percent for LMC) (Pathak, 2021). Private and municipal services within Bhaktapur collect a total of 28 tonnes/day and dispose of it at the Hanumante River corridor.

The recent data on solid waste in Kathmandu Valley indicates that waste generation has increased significantly over the years. This has put tremendous pressure on the government to manage solid waste efficiently. Several studies, including the baseline survey conducted by Asian Development Bank (ADB), estimates that the total municipal waste is composed of eleven percent to sixteen percent recyclable plastics (UNDP, 2021). Informal recyclers directly engage in recovering these recyclables. They play a significant role in solid waste management filling the gaps left by municipal bodies and other entities in waste management (Bajracharya et al., 2022).

Differences between Formal and Informal Recyclers

In Nepal, self-employed recyclers and others informally employed by scrap dealers are among other workers in a larger informal sector that are defined as workers without any employment security, and social security (Bhaskar, 2013). The informal work ranges from people scavenging through waste for valuable recyclables, to informal private collectors of recyclables for sale to scrap centers, as well as organized collectors and sorters of recyclables. Bajracharya et al. (2022) states 'Not all entities such as municipalities, social enterprises, private recyclers, and aggregators working in the waste sector provide a formal contract and formal monthly wages to waste workers. Thus, the informal recyclers are technically working in an informal setting despite being affiliated'. They are also not given different social security and health benefits. So, despite being affiliated to a formal entity, they fall under the informal sector bracket.

As per the definition, these workers are provided a basic monthly salary without any additional social security benefits. Only a few municipalities (Kathmandu and Lalitpur Metropolis) provide their municipal workers with a bank account, salary and social security benefits, whereas the majority of informal workers affiliated receive a monthly salary in hand. A report by the World Bank estimates that nearly 700 sweepers in Kathmandu Metropolitan City, 150 in Lalitpur Metropolitan City, 100 in Bhaktapur Municipality, and 19 in Madhyapur Thimi municipality are employed for sweeping and pre-collection of waste services. These informal recyclers fall under the formal waste workers' bracket as they are provided with a bank account, social security benefits, and a monthly salary amounting to an average of 3000 USD per annum (Pathak, 2021). The informal work ranges from people scavenging through waste for valuable recyclables, to informal private collectors of recyclables for sale to scrap centers, as well as organized collectors and sorters of recyclables.

Dias and Samson (2016) have also categorized waste workers on the basis of their work:

- Itinerant waste buyers/ Cycle hawkers: Itinerant buyers are those who visits people's doorsteps and typically ride a bicycle, buy high-value recyclables like newspapers, plastic, glass, unsoiled mixed paper, cartons, and metal and sell large amounts of well-sorted clean material to scrap centers
- Street waste pickers: Street pickers recover recyclable materials from the waste that has been dumped in the streets. They mostly use jute bags to collect the recovered materials.
- On route/truck waste pickers (municipal collectors or informal): Formal collection crews providing door-to-door service who, with permission, segregate recyclables from collected waste to supplement their salaries.
- Landfill waste pickers: Waste pickers who recover valuable recyclables from landfill and sell to scrap centers for their livelihood.
- Processors of organic waste: Workers handling only organic waste for the compost plant.
- Sorters: Workers selecting and sorting recyclables by type and cleaning it for further processing.

Informal waste workers are often generalized as "Kawadi" for itinerant buyers, and "Safaikarmi" for waste collector, sorter, picker, and handler in the Nepali society. Programs such as 'Healthy Waste Workers for Sustainable Waste Management' have tried to coin informal recyclers as 'SafaiYodha' meaning "environmental protector" while the International Alliance of Waste Pickers (IAWP) has coined the term 'Fohor Sankalak', meaning "waste pickers". The value given to informal sector activities by society is reflected in the names given to them.

Recovery of recyclables and plastics

Nepal is struggling to manage municipal solid waste in urban centers due to a lack of segregation at the source, recycling, and proper disposal (Nepal, 2022). Materials recovery starts in the household, primarily with women who are most likely to segregate waste at the source and manage degradable waste at home. Yet women are also likely to give paper or plastic waste away to waste collectors for free, sell it to informal waste workers or throw it away as landfill waste. If the capacity of women is strengthened, they could potentially capture more plastics for recovery at home or in other locations where they informally work.

Recovery of plastics and other recyclable materials allows them to be reused or recycled, which enables a circular economy where resources move from a use - discard model to a use-reuse continual flow which eliminates resources from being wasted. Developing recycling facilities in Nepal can allow for waste to be appropriately managed locally, rather than being exported to India for further use and recycling, and hereby strengthening the local waste value chain. Pathak and Mainali (2018) claims that 18 million USD recyclables are recovered annually and circled back into the loop contributing to the economy.

There is an increasing trend in material recovery from MSW in Kathmandu Valley over the years, from 100 tons/day in 2005 to 140 tons/day in 2013, which further increased to 250 tons/day in 2017 and 350 tons/day in 2021 (SWMTSC/GoN) (Pathak, 2021). Pathak (2021) estimates the monetary value of recovered materials at sources in Kathmandu Valley to 3700 million NPR (Ca. 28 M USD) per year (Pathak, 2021). According to a survey on the business of scrap dealing conducted by Pathak in 2021, approximately fifty percent of the scrap dealers collect materials from the source (cycle hawkers/kabadis); seventy four percent of the surveyed scrap dealers started their business with their own investment; about fifty five percent of the scrap dealers invested from 100k NPR up to 500k (ca. 800-3800 USD) in their scrap businesses and about fifty two percent of the scrap dealers in the Kathmandu Valley are Indian nationals.

Scrap dealers are private business owners who often pay informal recyclers for the recyclable materials that they collect. An updated estimate of the number of scrap dealer operations can be found in Part 2 of this report. To further strengthen this data, Kathmandu Municipality has started collecting taxes from trucks carrying scrap waste through multiple exit points from Kathmandu Valley. Over the next phase of the project, data for plastic waste generation will be requested to increase understanding of the quantitative contribution of the Informal Recycling Sector to waste management.

The plastic recycling value chain businesses and industries in Nepal are concentrated at the smaller end of the value chain. High value and easily recyclable grade plastics, High-density polyethylene, Polyethylene terephthalate and Low- density polyethylene are easily accessible and are bought within and outside the Valley by aggregators and processing industries, while low value recyclables such as multi-layered plastics (MLP) , plastic packaging, diapers, other single use plastics and non-recyclables either make their way to landfill, are burnt or are dumped. In the 'Plastic pollution in the rivers of Kathmandu Valley' section (Part 3) of this report, the study explores the causes and reasons for low value plastics ending up in landfills and open environments.

A daily estimated 36 tons of plastics are recovered for recycling in Kathmandu Valley (Table 1), which represents three percent of the total amount of municipal solid waste generated daily in the Kathmandu Valley (Pathak, 2021).

However, with limited infrastructure available for plastic recycling, technologies for sorting, and a lack of incentives and subsidies from the government, there are many grades of plastic with recyclable properties which are not being recycled within Nepal. Some common examples are Polypropylene, Polyvinyl Chloride, Acrylonitrile Butadiene Styrene, High Impact Polystyrene Sheet, and mixed plastics. Most of these plastics end up in either landfill sites or find their way to dump sites commonly

Table 1: Buying and Selling Prices and Total Monetary Value of Plastics in Kathmandu Valley. Source: Pathak, 2021.

Type of Major Recovered Recyclable Fraction	Quantity (ton/day)	Average Buying Price (Nrs/kg)	Average Selling Price (Nrs/kg)	Monetary Value of recovered materials at source (in 1000 NRs) Per day
All types of plastics	36	30	35	1077.82

situated on riverbanks, open uninhabited areas, mountain sides and other areas. A few grades of lower value plastics also get dumped due to the high cost of logistics and interstate transportation tax. Women, as the principal waste segregators in households and in the informal recycling sector, play an important role in recovering plastics for reuse and recycling.

Another type of waste coming from households and businesses are plastics from e-waste, which are non-recyclable plastics, including plastic types like Acrylonitrile Butadiene Styrene, High impact polystyrene sheet and other packaging plastics such as multilayer plastics, composite plastics, flex, low grade plastics (including contaminated and mixed plastics whose grade identification is difficult), black hard plastic, Styrofoam (Expanded Polystyrene) and Rexin.

Despite this, around the world there are various research initiatives, experiments and innovation efforts going on for making plastics recyclable in a useful way to transform some of the MLP, non-recyclable plastics and low value plastics to make useful fuels for factories and industries such as cement factories. Other initiatives include making use of Polypropylene, mixed plastics and shredded Multi-layered plastics to make building blocks, and to convert tetra pak plus Multi-layered plastics into composite boards.

Common sites of informal and formal recycling

Plastic waste in Kathmandu Valley is collected from households, streets, temporary transfer stations, riversides, the Banchare landfill, and dumpsites by the informal recyclers. The plastics come in a mixed form which is then sorted by their types in case of Polyethylene Terephthalate, high-density Polyethylene, low density Polyethylene and color in case of Polypropylene and low density Polyethylene. The recyclers often tend to purchase plastic waste according to their color grading in the case of Polypropylene and low density Polyethylene, thus the sorters segregate them on the basis of their color. Most plastics are bought either from the landfill, Hotels, restaurants, cafés (HoReCa) as a whole, or from itinerant buyers.

Many of the transfer stations and points are established by the river banks as the banks were uninhabitable due to severe pollution in the river, which has improved over time due to improvements in the roads and pavements around the river banks. In addition to transfer stations, temporary setups such as scrap yards exist on the river banks and many of which are still operating. Therefore, river banks are a hub of activity for recycling, including for women informal recyclers women.

Informal recyclers are a mobile population that are not confined to a single geographic location and are mostly engaged seasonally. They migrate for work and are involved in other informal sectors such as farming during harvest season, masonry, plumbing, and other types of labor. Thus, it is challenging to accurately determine or estimate their numbers. However, a few estimates exist for the number of informal recyclers in Kathmandu Valley. Bhattrai (2003) estimated that between 5000 to 7000 were involved in reclamation and recycling in the Kathmandu Valley as cited by Dangi et al. The Poverty reduction of informal workers in solid waste management (PRISM) project identified 8367 informal recyclers in 2014, of which 6582 were men and 1785 were women, and 416 scrap dealers in five municipalities of Kathmandu Valley- Kathmandu Metropolitan City, Lalitpur Metropolitan CIty, Bhaktapur Municipality, Kirtipur Municipality and Madhyapur Thimi Municipality (Practical Action, 2014). Whereas, the same project estimates around 10,000 to 15,000 waste pickers and 700 to 800 scrap dealers engaged as informal workers in Kathmandu Valley. In 2014, a study by the Himalayan Climate Initiative (HCI) reported 12,000 informal recyclers affiliated to scrap centers, with an average of 15 informal recyclers in a scrap center. In 2018, the number of scrap centers has been estimated to reach up to 1000 (Pathak & Mainali, 2018).

At Transfer Stations

Once waste is collected by the municipality or by a private company, it is taken to a waste transfer station, or 'materials recycling facility', where waste is sorted and separated before being transferred again to another area or facility either for recycling or landfill. Kathmandu Metropolitan City (KMC) and Lalitpur Metropolitan City (LMC) have transfer stations at Teku and Balkumari respectively, but these are not considered to function efficiently (Figure 3).

These transfer stations are a hub for informal waste workers to pick recyclables and recover whatever is possible before collected waste is loaded for final disposal at the landfill. Other municipalities around Kathmandu, including Bhaktapur and Thimi municipalities, do not have any transfer stations and thus all the waste is directly transported to the Banchare Danda landfill site.

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Figure 3: Teku Transfer Station operated by KMC.

At Landfills

The mountains of household waste are piled up outside of Kathmandu at a landfill, which is situated near a river. Waste recycling recovery continues at this location, mainly through informal recyclers climbing around to pick out the reusable materials. Most of the informal workers are women, who form an essential link in the Nepali waste management chain (Knowledge for Development, 2020).

Until June 2022, municipally collected waste was dumped into the Sisdol landfill site in Kakani Rural Municipality of Nuwakot district, which is located to the southwest of Kathmandu and at a distance of 26 km from the Teku transfer center. It is spread over 740 ropanis (37.65 hectares) and was formerly a gorge. The Sisdol site remained operation for many years after reaching its capacity, and was only recently replaced by the Banchare Danda landfill site. Over 200 families with 1200 family members who reside near the Sisdol dump site have been categorized as highly affected households.

At present, all of Kathmandu Valley's municipalities, except for Bhaktapur municipality, dump their solid waste in the newly operated Banchare Danda landfill site (Figure 4), located about 2 km past Sisdol, in Dhading district and is spread over 85 hectares of land. It has been operational since May 24, 2022, and has a planned operational lifetime of 25 years.

The new landfill site is built with modern techniques to collect leachate in multiple storage units and pipes are laid to collect methane gas. However, there is no waste sorting infrastructure installed to segregate waste mechanically: currently the informal recyclers manually sort the waste in the dump piles.

© Nepali Times

Figure 3: The new landfill site in Banchare Danda

Social and health challenges faced by informal recyclers

While waste picking has both environmental and economic benefits, it has several occupational health, economic, psychological, poverty and social challenges. Due to the nature of their work, which is unhygienic and unsafe, informal recyclers face occupational risks including chemical hazards, infection and risk of injury. They work in close contact with chemicals, hazardous substances and sharp objects, which are found in mixed waste. Some of the common health issues reported include respiratory diseases, eye infections, stomach problems, typhoid fever, and diarrhea (Cruvinel et al., 2019). Women may also experience a high incidence of infections of the reproductive and urinary systems due to the lack of safe hygienic practices. Along with physical health risk, a recent study of 1287 informal recyclers found that women, older persons, or those who are separated or divorced are at a higher risk of depression. Those with social protection and financial savings were less likely to have depressive symptoms (Karki et al., 2021).

While recognition for informal recycler contributions is slowly growing, they still lack the respect that they deserve and their work is considered to be at the lowest level of the societal pyramid. Due to this, their work still hasn't been recognised in the national policy for solid waste management. Their social status, self-esteem, desire for well-being and confidence are stifled by a lack of social recognition, and stereotyping, which was also observed during the RiPL project's first workshop on 'Networking and Sharing Challenges' (Mumuni, 2016). However, during the COVID-19 pandemic, attention was paid to informal recyclers by prioritizing vaccination for these workers directly after healthcare workers and army personnel. Furthermore, although harassment, violation and individual attacks are used as tactics to keep control over women of the informal waste sector (GRID-Arendal, 2022; Aidis and Khaled, 2019), such cases have not been reported recently in Nepal.

Sapkota et al. (2020) identified occupational health hazards followed by social humiliation as the major challenge that workers of the informal waste sector face. Black et al. (2019) reported among 1278 informal recyclers surveyed, thirty three percent had been ill in the previous three months and respiratory ailments were common. The same study also found the majority were insufficiently protected against occupational hazards associated with their work. The most prevalent injuries were glass cuts (fortyfour percent) and metal cuts (forty four percent). Less than half of the informal recyclers (forty seven percent) had been vaccinated against tetanus and only eight percent against hepatitis B. The work was considered as 'risky' by seventy three percent of informal recyclers, but sixty eight percent did not use Personal Protective Equipment (Black et al., 2019). Moreover, the study by PRISM project found informal recyclers being called abusive names, being mistreated by society, even their own family members and within the profession, leading the informal recyclers to frustration and mental stress (Practical Action, 2014).

Drivers of plastic pollution in rivers

Waste generated by households in Kathmandu Valley

At the household level, an estimated 0.245 kg and 0.209kg is generated by each individual daily in Kathmandu Metropolitan City and Lalitpur respectively. This represents a ten percent and twenty three percent increase since 2013. This is around half of the total municipal solid waste generated in the region (Table 3) so is the most significant source of solid waste material for informal and formal recycling efforts.

Of the studies available for the Kathmandu Metropolitan City, about seventy five percent of the waste generated at household level is biodegradable, while plastics occupy 2nd and 3rd place respectively. Different studies have given different results in waste composition (Table 2): The 2021 Bagmati River Basin Improvement Project (BRBIP) study estimated plastics to comprise seven percent of household municipal waste, while the earlier 2020 study (CPC-KMC 2020) estimated a slightly higher ten percent of plastics (Table 3). The differences observed between the studies are due to the different methodologies adopted by each study.

Table 2: Comparison of the increase of average household Unit Waste Generation Rate (UWGR) with municipal solid waste Unit Waste Generation Rate across municipal areas. Sources: ADB, 2013; BRBIP, 2021.

	Average household waste generated in the Kathmandu Metropolitan City – Unit Waste Generation Rate (kg/cap/day)		Municipal solid waste – Unit Waste Generation Rate (kg/cap/day)	
Municipality	**ADB (2013)**	**BRBIP (2021)**	**ADB (2013)**	**BRBIP (2021)**
Kathmandu	0.23	0.24	0.46	0.49
Lalitpur	0.19	0.20	0.37	0.41
Bhaktapur	0.16		0.35	

Table 3: Characterization of Household Waste in Kathmandu Metropolitan City by material type and % of weight composition of total. The percentage of weight of plastics are highlighted in bold. Sources: CPC-KMC, 2020; BRBIP, 2021.

	Household waste composition of Kathmandu Metropolitan City (in % of weight)	
Material	**Data from CPC-KMC, 2020**	**Data from BRBIP (2021)**
Biodegradable waste	75.5	75.7
Paper/Cardboard	3.85	9.48
Plastics	**10.35**	**6.71**
Metal (Ferrous and Others)	0.47	3.36
Glass	1.94	1.84
Textiles	1.61	0.28
Rubber/Leather	0.26	–
Wood	–	–
Others (diapers, dust, etc.)	6.03	2.63

Challenges of solid waste management in Kathmandu Valley

The report "Solid waste management and circular economy" prepared by the World Bank funded research (Pathak, 2021) identifies a number of challenges to solid waste management in the Valley:

- There is a lack of baseline information data, which is also required for the design of specific Solid Waste Management (SWM) projects
- While several SWM projects have been piloted in Kathmandu Valley over the last years, the technologies have not been scaled up and are not customized for site-specific and context-relevant solutions depending upon the nature of waste, and resources available;
- Considered as per the municipality's approach, recovery of scrap materials from solid mixed waste is not a priority. Waste management practices are not formalized, and resources are not utilized properly for financial sustainability of Integrated Solid Waste Management (ISWM) systems;
- There is delay in the Solid Waste Management Public-Private-Partnership process in Kathmandu Valley. The Integrated Solid Waste Management project for Kathmandu Valley initiated in 2009 has not been concluded yet as a result of issues with land, financing mechanisms, technology selection, and the management of existing formal and informal solid waste workforce, etc.

Methods
PART 1

Informal Recyclers, demographics and challenges

Definition of informal recyclers

Informal collectors of recyclables, or informal recyclers, are mainly referred to as a person or a group of people who make their living by recovering the valuable materials found in waste from. households, landfill sites or transfer stations, and roadsides (Kunwar & Singh, 2021). Informal recyclers are devoid of social security, employment, and health benefits as they are not usually associated with any company or organization. However, they are part of the waste value chain and are paid for extracting and selling valuable materials. In the case of Nepal, scrap centers and recycling companies employ workers for sorting, cleaning, baling, and processing of recyclables. However, most of these workers are working without any aforementioned benefits. They have been termed as informal recyclers in this report as they often maintain informal arrangements with the scrap owners where they sort the waste. According to WIEGO, the informal sectors are those economic sectors that are neither regulated nor protected by the state. Hence, in this report we define informal recyclers as below:

An Informal Recycler is a person or a group of persons working individually (self-employed) or associated with an organization, who make their living through waste recovery, sorting, and baling, but who lack formal adequate social security, employment, and health benefits.

Interviews, Surveys and Workshops

Using numbers and methodology provided by Practical Action (2014) as a basis, this project provides an updated number of informal recyclers to more accurately estimate the total amount of materials they are recovering. The estimate is based on an interview of 5 key respondents (see below), who provided their expert judgment on estimates of different categories of informal recyclers. The average of these responses was then used for each category. Each category was added up to obtain the overall number of informal recyclers in Kathmandu Valley on a yearly basis. 10% was deducted from the total value to account for possible double counts between categories.

Interviews

Five people who have been involved in the informal recycling sector for more than ten years were selected by CREASION to be interviewed and classified as 'key informants'. Key informant interviews were conducted to identify the current number of informal recyclers. The key informants were selected because they each related to different positions within the solid waste management process and could provide an overview of the number of informal recyclers in Kathmandu Valley.

The following five people (1 woman, 4 men) were selected for interview:

- Maya Tamang is a waste picker who has been involved in collection and sorting of recyclables for more than 20 years. She used to recover recyclables from the landfill and her livelihood was supported through waste picking. She is one of the founding members of Samyukta Safai Jagaean (SASAJA,) a waste workers owned cooperative, and has been able to advocate for the rights of informal recyclers. Currently she is involved as Community Mobiliser in a project implemented by Medecins du Monde – France.
- Dhurba Acharya is a private waste entrepreneur and the president of Solid Waste Management Association of Nepal (SWMAN). All private waste management companies registered in Kathmandu Valley are members of SWMAN.
- Ashish Khanal is a PhD scholar, who has conducted several studies on the situational analysis of informal recyclers in Nepal.
- Kedar Phuyal is an apex trader who works with all the existing scrap centers in Kathmandu Valley. (For this report, an apex trader is defined as someone that buys from intermediate traders (scrap centers) and prepare these materials for onward trading to end-of-chain recyclers.[2]
- Rabi Tamang is a scrap center owner, who employs 13 workers informally in his center, paid on a per kilo basis. He has been involved in this field for more than a decade. He buys recyclable materials from itinerant buyers, and landfill waste pickers.

[2] un-habitat_niva_report_leaving_no_one_behind_1.pdf (unhabitat.org)

Four of the interviews were conducted at their workplace and one was conducted on the phone. The informants were initially informed about the project and the need for an updated number of informal recyclers in the Valley. Based on their experience in the informal recycling sector, they were asked to provide an estimated number of informal recyclers. The interviews ranged from 5 minutes to 25 minutes.

Workshops

The RIPL project was kicked-off by hosting an opening event, panel discussion and workshop with ten informal recyclers where they interactively discussed survey questions and presented them to those in attendance, with informal recyclers' responses being recorded. Based on their responses, the questionnaire was modified to more clearly focus on the challenges and opportunities that informal recyclers face. The methodology for the workshop is described in Annex 1.

Surveys

A further 40 informal recyclers were surveyed to gain insight into the informal recycling situation and to get a better understanding of their situation. The interviews were conducted at five locations, three scrap centers (Maa Chandeshwori Scrap Supplier, Jalpa Suppliers and Chameli Mai Scrap) and two transfer stations (Haleshi Subas Collection Center and Creative Sarsafai Pvt Ltd). The respondents were chosen based on their willingness to participate. The respondents represented different sex, age, nationality, and working experience. The methodology for the survey is described in Annex 2 and 3.

Methods
PART 2

Baseline River Hotspot Mapping and Waste Audit

Given the lack of baseline data on the hotspots of river pollution in Kathmandu, field surveys were carried out in 2022 to 1) undertake a waste audit to determine volumes and types of plastics and other materials found in rivers, and 2) identify the hotspots of plastic waste generation and dumping along the banks of the rivers in Kathmandu Valley in order to locate intervention activities during the project.

River Hotspots Mapping

The river hotspots survey identified areas of Kathmandu where there is a suspected high leakage of plastic waste directly into the river. The survey mainly targeted the settlement areas along the river banks where plastic waste is directly dumped into the river. Several of the major reasons listed below were used for identification of such hotspots:

River hotspot identification methodology

- Hotspot and dumping sites through visual inspection and interviews
- Settlement density around the river corridor including slum settlements
- Possibilities of sewage mixture into the river
- Limited waste service availability in the area
- Unavailability of scrap centers in the neighborhood
- Waste transfer stations around river banks
- Large formal and informal markets such as vegetable and fruit vendors along the river side
- Sites of confluence/merging points between rivers or tributaries

Based on the above criteria, Doko Recyclers visited a number of sites along the river banks for preliminary visual surveys (Figure 5a-c). These were:

- Balkhu Market area (Bagmati River)
- Kalimati Area (Bishnumati River)
- Sinamangal and Tilganga Area (Bagmati River)
- Balkumari Area (Manohara River)
- Jadibuti Area (Manohara River)
- Bhaktapur Area (Hanumante River)
- Guheshwori Area (Bagmati river)
- Chovar Area (Bagmati River)

Figure 5a: Visual observation of plastic waste from the Balkhu Area near the river corridor (21 April 2022)

Figure 5b: Visual observation of small scale businesses next to river from the Kalimati Area (22 April 2022

Figure 5c: Visual observation of plastic and other waste being informally managed near river corridor and other waste from the Jadibuti Area river corridor (22 April 2022)

At these locations, it was observed that the waste workers collect most of the plastic items of higher value and sell them to scrap dealers. Based on the field visits made to various locations by the team from Doko Recyclers, a number of locations alongside the banks as well as confluence points of different rivers into the Bagmati River were identified where there is a high concentration of dumped plastics. Several of these locations were around large market areas such as the Kalimati Vegetable Market and Balkhu Fruits Market.

Through visual surveying and assessment through the sampling of plastic waste at various areas alongside the river, certain locations were identified that may be relevant as hubs for plastic processing centers within the scope of the project.

Waste Audit in Rivers

Following the initial river hotspots survey, in order to provide a more complete status of material types and specific types and grades of plastic grades found in the rivers of Kathmandu Valley, a sampling of three specific locations was undertaken by the staff of DOKO recyclers on June 29th, 2022: Manohara river (Pepsicola town planning area), Hanumante River, and Bagmati river (Table 4). This was done following an initial visual assessment of the rivers of Kathmandu. The three locations were chosen based on the following factors:

- An identified hotspot during initial survey carried out with 'River hotspot identification methodology'
- At merging points between rivers
- Possibility and ease of sample collection

At each of the three locations a sample of waste material was collected. The samples were collected to ensure the diversity of different waste materials were included. Aspects such as the size of waste materials, varying weight of materials, voluminous nature etc. were taken into consideration while collecting the samples.

Health and safety considerations included the use of hand gloves, steel rods, masks, gumboots and collection bags. The collected waste was weighed at the sampling sites and then transferred to the DOKO'S Materials Recovery Facility, where is was again weighed and sorted as per the category of plastics and other waste materials, as can be seen in the pictures.

A total of 74.86 kg of waste was collected from the three river sites. The collected waste contained Polyethylene Terephthalate bottles, Polypropylene plastics composite materials (food packaging), LD plastics

Table 4: River Sampling sites for plastic waste audit, RIPL baseline survey.

Sampling sites	Coordinates of the sampling site
1. Hanumante River Conversion Point	27.6680/85.3526
2. Bagmati River Corridor - Shankhamul Area	27.6788/85.3340
3. Manohra River	27.6904/85.3716

(milk packaging), HM plastics, shoes and slippers, styrofoam, mixed-layer plastics (which is considered a non-recyclable), plastic sacks from construction and demolition waste, metals, glass bottles and cloths. Due to the limited collection quantity, the sampling provides vital information in regards to the kind of materials floating in rivers but is not intended for the quantification of the amount of the different materials present in the rivers of Kathmandu.

The river sampling activity was carried out at the Bagmati River (Figure 6), Hanumante River and Manohar River (Figure 7) and subsequently sorted at DOKO Recyclers Waste Recovery Facility (Figure 8 and Figure 9).

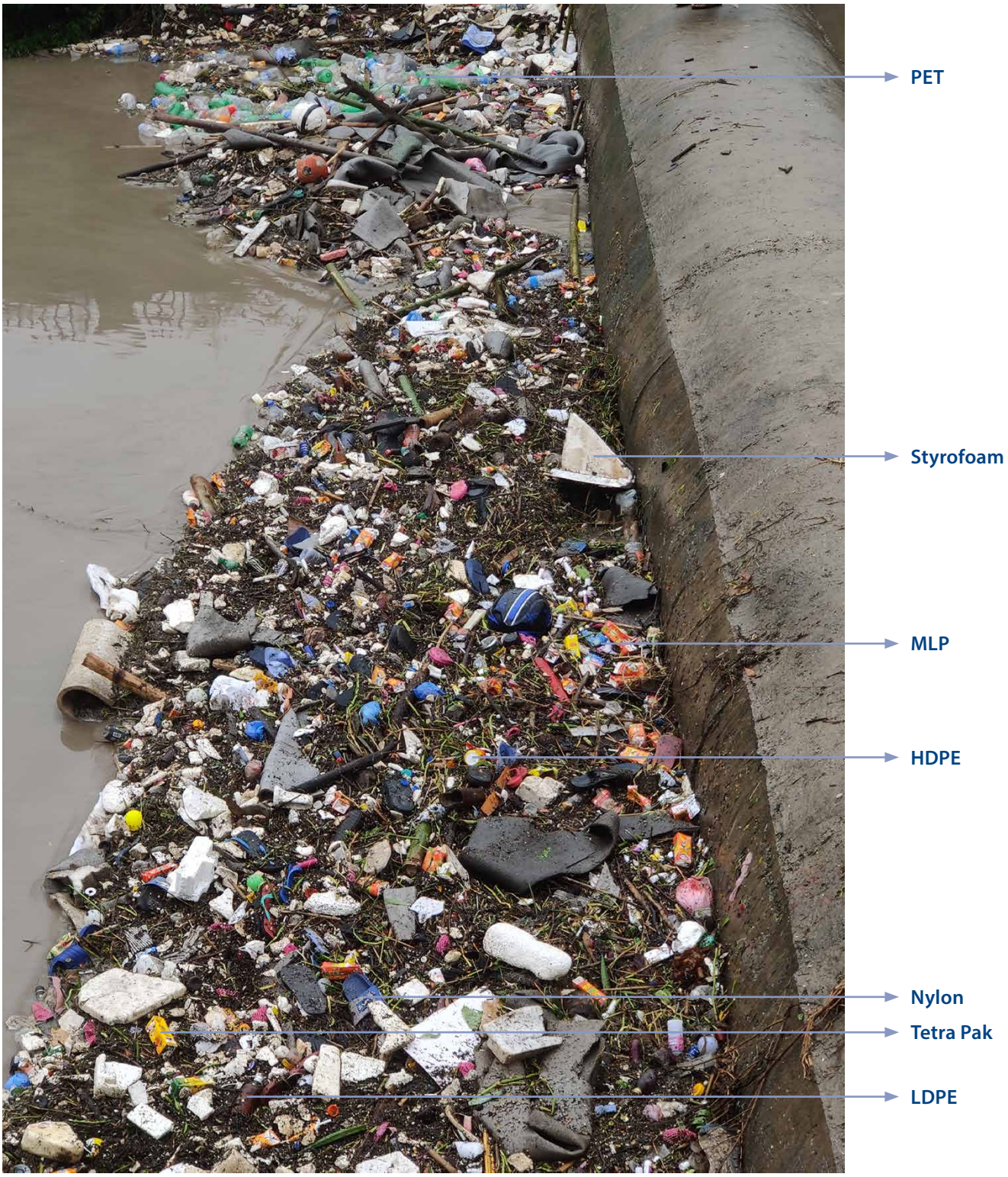

Figure 6: The labels on the above photo identify different composition of waste in Bagmati river from one of the sampling sites. (Source: Doko Recyclers)

Figure 7: Collection of samples from Bagmati River (top left); Hanumante River (top right); Manohar River (bottom left); and collection from river corridor (bottom right).

Figure 8: Sample inspection at Doko Recyclers MRF in Sano Thimi, Bhaktapur in steps 1–6 (left to right, top to bottom). Image 1– collected sacks at inspection site; Image 2 – weighing of the waste; Image 3 – unpacking of the waste from sacks; Image 4 – sorting of waste based on categories; Image 5 – weighing of each category of waste; Image 6 – display of sorted waste categories.

Figure 9: Sample identification and sorting as per category at Doko Recyclers MRF in Sano Thimi, Bhaktapur.

Tetra Pak

Nylon

PP

Aluminium

Sack & Cloth

Glass

Preliminary Outcomes
PART 1

Informal recyclers, demographics and challenges

Interviews – numbers of informal recyclers

Bhattrai (2003) estimated that 5000 to 7000 Informal workers were involved in reclamation and recycling in the valley as cited by Dangi et al. (2006). The Poverty reduction of informal workers in solid waste management (PRISM) project identified 8367 IWWs in 2014, of which 6582 were men and 1785 were women, and 416 scrap dealers (Practical Action, 2014). The same project estimates around 10,000 to 15,000 waste pickers and 700 to 800 Kabadis (waste/scrap dealers) engaged as informal workers in Kathmandu Valley. In 2014, a study by HCI reported 12,000 IWWs affiliated to scrap centers, with an average of 15 informal recyclers in a scrap center. In 2018, the number of scrap centers has been estimated to reach up to 1000 (Pathak & Mainali, 2018).

Based on the data provided by the aforementioned literature and the survey of five key informants, it is estimated that on average, 19,845 informal recyclers are working in Kathmandu Valley during the year in 2023.

Table 5 summarizes the approximate number and type of informal recyclers in Kathmandu Valley, as estimated by seven key informants within the sector.

Some reasons for this increased estimate of the total number of informal recyclers according to the key informants were:

- The number of informal recyclers in this sector has increased significantly after the Covid-19 pandemic when many people lost their jobs.

Table 5: Summary of estimates of the number and type of informal recyclers in Kathmandu Valley collected from the key informants during interviews and field surveys presented by Bajracharya, 2022.

Source	Types	Estimate	Explanation of estimate given
Maya Tamang	Landfill pickers (Banchare Danda and Sisdole)	250	On an average day, 250 workers can be found working in the landfill. However, it is estimated that 500 informal recyclers work in the landfill, hailing from Nuwakot, Dhading, and Kathmandu Valley.
Dhurba Acharya	Private waste management collection and disposal companies workers (Sorters, collectors)	2,500	During COVID-19, SWMAN provided benefits to 2500 workers affiliated to all entities in 2020. This includes collectors, and sorters in their transfer station.
Pratik Bajracharya (Field survey)	Street waste pickers	100	Based on the number of street waste pickers observed on roads
Pratik Bajracharya (Field survey)	Recycling companies sorters	200	10 recycling companies * 20 workers working as sorters
Ashish Khanal	Itinerant buyers/ cycle hawkers	3,000	Itinerant buyers (Cycle hawkers) are seasonal workers with around 7000 itinerant working during the summer season and shifting to lower belt during the off season.
Kedar Phuyal	Large scrap centers (Collection, sorting, baling)	1,000	28 large balers * 40 workers on average; based on field study
Rabi Tamang	Small collectors/ scrap centers (Plastics, paper, glass, metals)	15,000	1000 small collectors * 10-15 workers on average
	Estimation error (–10%)	–2,205	To account for over estimation and double counting
Total Number of informal recyclers in Kathmandu Valley			**19,845**

- Similarly, job loss as a result of the earthquake and economic blockade of 2015 has also pushed people towards this sector (Bajracharya et al., 2022).
- The population has increased with an annual rate of three point five percent, so there are more people in the population available to work in the waste sector
- The infrastructure and opportunities are mostly centered within informal recycling opportunities
- Lack of education and other technical skills limit informal recyclers from joining other sectors
- Since working in waste has a low barrier for entry, their peers influence them to join the waste sector. As shown by the survey, thirty three percent of the respondents were new to this field.

Surveys – Demographics and working environment of informal recyclers

The majority of informal recyclers are migrants, belonging to indigenous and minority communities, having low social status and in the low-income bracket. People from the lowlands and neighboring countries have been reported to have been involved in this sector in the Valley.

Of the forty participants in this survey, the majority (seventy three percent) belonged to indigenous groups (Rai, Magar, Limbu, Shrestha), followed by people from the lowlands (fifteen percent), and the rest belonged to Brahmin and Chhetri ethnic groups. Ninety eight percent of the respondents hailed from districts outside of the Valley. Among them, eighty seven point five percent have been

Table 6: Demographics of the 40 informal recyclers who took part in to surveys conducted at five locations (three scrap centers and two transfer stations) in the RIPL project. In total, 21 men and 19 women were included in the survey.

Variable	Group	Men		Women		Total	
		Number	%	Number	%	Number	%
Age group	18-25	12	57.1%	8	42.1%	20	50.0%
	26-35	6	28.6%	5	26.3%	11	27.5%
	36-45	3	14.3%	5	26.3%	9	20%
	>45	0	0.0%	1	5.3%	1	2.5%
Marital status	Single	10	47.6%	2	10.5%	12	30.0%
	Married	11	52.4%	17	89.5%	28	70.0%
	Divorced	0	0.0%	0	0.0%	0	0.0%
	Widowed	0	0.0%	0	0.0%	0	0.0%
Nationality	Nepali	21	100.0%	19	100.0%	40	100.0%
	Indian	0	0.0%	0	0.0%	0	0.0%
Migrant	Yes	21	100.0%	18	94.7%	39	97.5%
	No	0	0.0%	1	5.3%	1	2.5%
ID card	Citizenship card	21	100.0%	18	94.7%	39	97.5%
	None	0	0.0%	1	5.3%	1	2.5%
	Passport	4	19.0%	0	0.0%	4	10.0%
Education	No education	5	23.8%	7	36.8%	12	30.0%
	Primary	0	0.0%	0	0.0%	0	0.0%
	Lower Secondary	7	33.3%	7	36.8%	14	35.0%
	Secondary	6	28.6%	3	15.8%	9	22.5%
	Higher Secondary	3	14.3%	2	10.5%	5	12.5%
Involvement in years	<1 years	5	23.8%	8	42.1%	13	32.5%
	1-2 years	10	47.6%	5	26.3%	15	37.5%
	2-5 years	5	23.8%	6	31.6%	11	27.5%
	5-10 year	1	4.8%	0	0.0%	1	2.5%
	>10 years	0	0.0%	0	0.0%	0	0.0%

living there for more than three years whereas twelve point five percent have recently migrated. The main purpose of their migration was to earn a livelihood. Previously, sixty eight percent have been involved in other occupations such as masonry, agriculture, poultry, painting, labor and ended up working in the waste sector through their peers' influence. For five women whose primary work is in the informal recycling sector, three are married and are involved in this sector to support the household.

The majority of waste workers (thirty percent) are uneducated, thus due to lack of necessary skills and education, they are mostly involved in informal sectors or are trying to go abroad in search of better opportunities. The main reason for men migrating to Kathmandu is to fly to Gulf countries for work. Since Kathmandu has the only airport with international flights in Nepal, four of the men were found to have come to Kathmandu to go abroad but ended up working in this sector in the meantime. The number of street waste pickers has decreased substantially over the decade, with most working at a landfill, dumpsite, and transfer station.

There are a substantial number of women involved in picking and sorting of waste. All the women respondents were involved in sorting of plastics, while fifty two percent of men were found involved in sorting only, twenty nine percent in operation of machinery, fourteen percent in recovery of recyclables and fourteen percent of men did everything in parts. At most times, men did the heavy lifting work but in absence of men, women also had to lift baled plastics and heavy sacks. (Table 6)

Thirteen of the forty respondents were fairly new to waste picking and waste sorting with less than one year of experience, whereas only two of the respondents had more than five years of experience. This was the first job for five of the respondents (One man and four women), whereas two of the respondents were returnee migrants (both men), and the rest had been involved in various other sectors such as plumbing, labor work, agriculture, and livestock farming.

Informal recyclers work in groups, and their work provides them a sense of bonding and community. As reported by one of the respondents, aged 68, she finds her workmates as family and helps at times of need. They support each other to carry, sort waste and even help financially at times of need. While operating baling machines, there has to be coordination and the salary has to be shared between the sorter and machine operator. Moreover, no form of discrimination was observed during the study.

The respondents faced several health issues such as frequent cuts, fever, allergy, and cold. During the interview, one of the informal recyclers had a small cut in his fingertips from broken glass. It was noted that they only visit clinics when they have large cuts. In addition to cuts,, one of the respondents aged 37, complained about joint pain as the work requires them to be squatting for eight hours every day. A majority of the respondents didn't report chronic disease, but their children who often accompany them to the workplace often felt sick and had to visit the hospital frequently..

Workshops – Plastic Recycling challenges/ opportunities

All the respondents worked with plastic waste, sorting mostly low density Polyethylene and Polypropylene plastics (seventy percent), Polyethylene Terephthalate and high-density Polyethylene (thirty percent). On average, 350 kilograms of plastics were being sorted by the respondents in the scrap center per day, but some could sort more than 400 kilograms per day. Thirty percent of the respondents only collected the waste from a nearby dumpsite, whereas the remainder were only involved in sorting the collected waste in a scrap center, thus did not have to travel long to collect it. The women were paid 2.5 NPR per kilogram (0.02 USD) whereas the men were paid on a monthly basis. The monthly wage ranged from NPR 10,000 to NPR 30,000 (USD 76 to USD 228) with more men receiving between 20,000 – 30,000 NPR (Table 7). One woman received over 30,000 NPR per month. This is inline with other studies, which have shown that the average earning of informal recyclers is 15,000 to 20,000 NPR. Karki et al. (2018) found the median income was around 500 NPR per day and participants declared a median saving of 300 NPR per day.

Table 7: Number of male and female informal recyclers receiving wages in different brackets per month (Nepali Rupees) in Kathmandu, Nepal. Source RIPL survey 2022.

Wage per month (NPR)	Men	Women
<10,000	0	2
10,000 to 20,000	11	11
20,000 to 30,000	10	5
>30,000	0	1

Based on the first RiPL workshop, the women are more skilled and have more knowledge on the types of plastics. During the workshop exercise on business ideas, it is the women that came up with different types of plastics business ideas on plastic recycling compared to the men who were involved. They were unaware of the market buying and selling price of the plastic. In the interviews, women were found to be working at a quicker pace and sorted 300 to 400 kg of plastics per day.

The major challenge stated by the respondents was the quality of plastics being recovered. Ninety percent of respondents complained about the dirty or soiled plastics. Since they were working without any personal protective equipment, it was observed that working with soiled plastic was a problem for the respondents.

Thirty percent have been working in this sector for more than three years, it was observed that their quality of life hasn't improved. Their wage has increased by ten percent annually with the payment for plastics processed set by the scrap owner/ buyer based on buying prices quoted by the respective industry. The informal recyclers were aware of where to sell their recovered materials around their workplace. They shift their choice of where to market their materials due to untimely payment, unfair rate per kilo, and basic infrastructure. All the scrap dealers were located on the bank of rivers. One reason given for this is that the residents are hesitant towards establishment of scrap centers in residential areas due to foul smells.

The respondents were quite satisfied with their income even though some said, when asked, that it wasn't their primary choice. Eighty five percent of the respondents were satisfied and only fifteen percent showed their dissatisfaction. Their main reason for dissatisfaction was that they wanted better job situation such as shop keeping and tailoring. Most of the men come to Kathmandu in hope of going abroad, and four of the respondents who were men would like to leave the waste sector to go abroad. Almost fifty percent responded that they would like to continue working in this sector for the foreseeable future. None of the respondents felt they had job insecurity as they responded, 'there will always be recyclables to be collected' and in case they had to leave this sector they would get involved in any other informal sector such as masonry, painting, or shop work.

Preliminary Outcomes
PART 2

Establishing baselines: Plastics in Rivers Audit

Based on the knowledge and experience of RIPL project partners that are involved in the flow of recyclable materials and plastics in the waste management system in Kathmandu (Figure 10), the underlying drivers for plastic waste ending up in rivers are:

From households:

- Loose plastics (such as bags, film, protective fill) are not counted as scrap waste in general due to their voluminous nature and low value for such mixed plastics
- Packaging waste being the most common plastic waste which tends to be non-recyclable and part of landfill waste
- General cultural habits of mixing all types of waste and packing it into a polythene bag, handing it over to collection service provider, and if this service is unavailable, dumping it in the open environment or rivers
- Affordability – scrap pickers are not interested in picking up such low value waste from households
- Kathmandu Valley residents lack awareness and concern regarding the hazards of careless dumping of waste in or alongside rivers and its repercussions on the environment
- Waste that is dumped along the banks of rivers or into the rivers upstream flow downstream to city areas in Kathmandu Valley
- Delayed or no waste pickup from households of the settlement areas of Kathmandu Valley

From the Informal Recycling Sector

- Low value or no value, low grade plastic waste such as Multi-layered Plastics, Polypropylene, which are difficult to clean and recover.

From business and commercial venues

- Commercial setups and restaurants are established alongside the river and many of these establishments end up dumping their waste alongside or into the river.

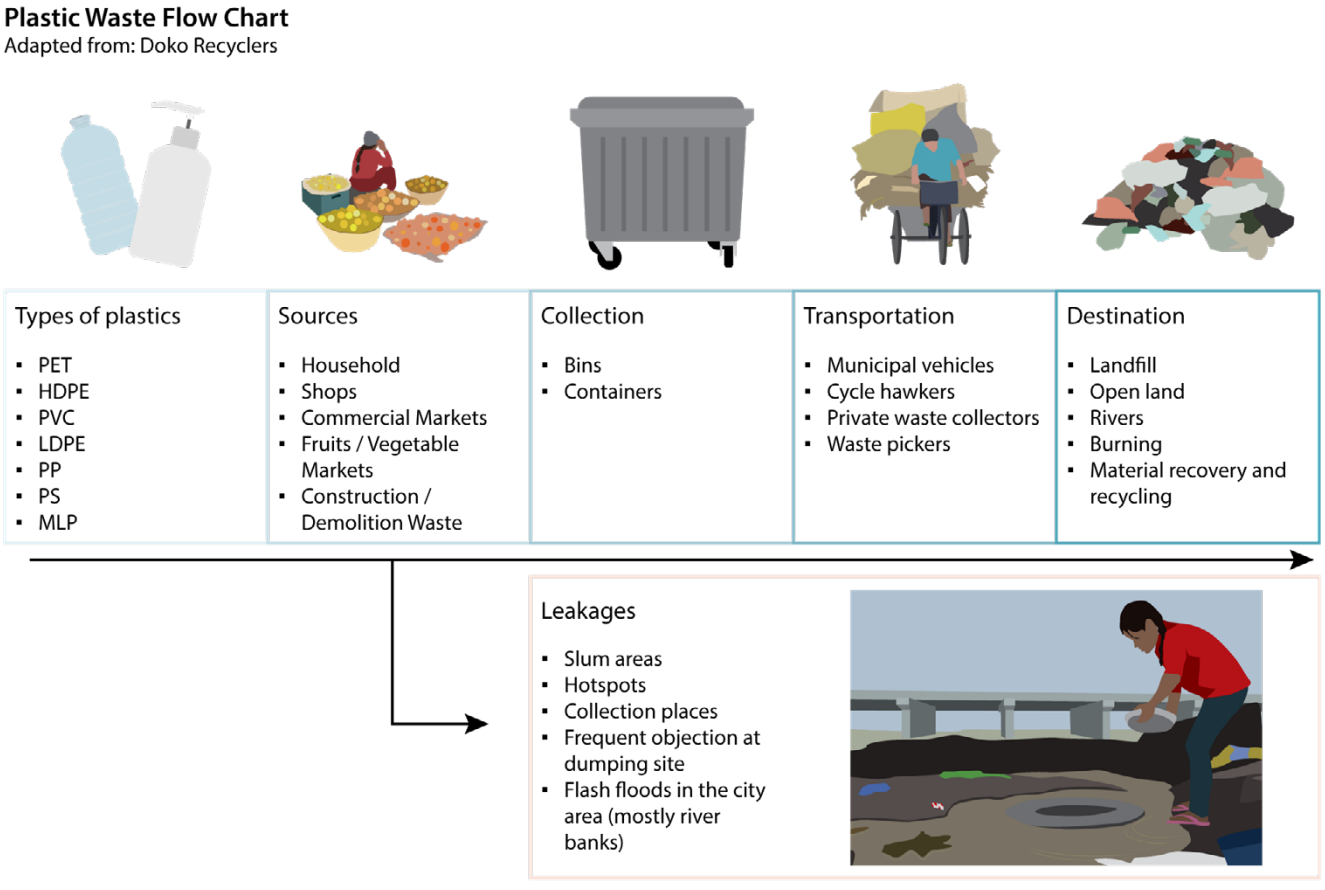

Figure 10: An illustration of the flow of plastic waste in the waste management stream in Kathmandu.

- The management of construction and demolition wase is expensive. Currently the municipality does not have a proper facility to treat such waste.
- Most clients do not want to bear the cost of sending the waste all the way to the landfill site
- The landfill site is at a distance from the ciity
- There is no service provider for transporting construction waste to the landfill
- Subcontracted local dump tractors collect plastic waste from construction sites, especially cement sacks and other construction materials, and dump it into rivers during the night hours

From municipal services

- Lack of municipal services in many outskirt areas around Kathmandu Valley has increased dumping practices along riverside.
- Within the Valley certain river corridor areas have slum settlements which do not participate in monthly waste collection services and practice illegal dumping.
- Lack of street sweeping and cleaning in dense marketplaces results in waste getting washed or carried away into river streams.
- Disruptions due to closure of landfill sites or employees strikes results in waste piling up in streets which has higher chances of being carried into streams and tenants in the Valley do not have space to store waste for longer duration in such a situation resulting in illegal dumping into streams.

Due to weather factors

- During the monsoon season, the level of river water rises. Additionally, high intensity of rainfall and increased frequency of flash floods leads to submersion and collection of most of the plastic waste dumped and deposited around the river banks and in drainage systems from the streets.

From private sector waste collectors

- When the landfill is shut then some private companies practice illegal dumping and tipping into rivers. Suburban areas can experience a lack of collection service or selective collection

In 2022 Doko Recyclers carried out a sampling of plastics found in hotspots for plastic pollution in rivers. Table 8 shows the types, quantities, grades and values of the materials that were found. Among the 75 kgs of collected waste, forty five percent were plastics and the remaining fifty four percent were non-plastics that included glass, metal, cloth and landfill waste. Identified plastics from the waste were further classified into recyclable plastics and non-recyclable plastics, as per their difference in recyclability (as per Nepal's context (Figure 11).

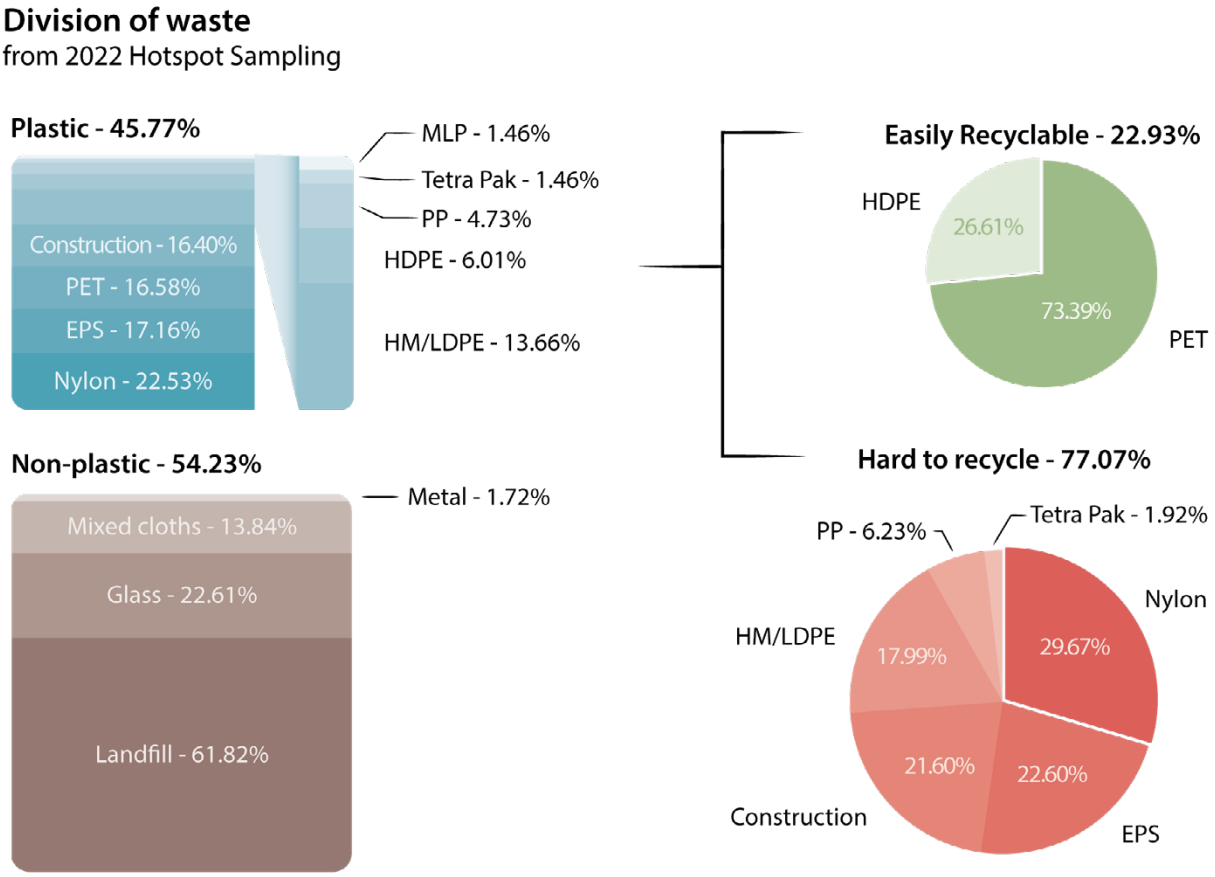

Figure 11: Division of sampling between plastic and non-plastic waste from RIPL 2022 Hotspot Sampling and division of sampling between easy to recycle and hard to recycle grade of plastics.

Table 8: Types of Materials, Quantity, Grades and Values* from RIPL 2022 Hotspot Sampling

SN	Material Types	Quantity (kgs)	Plastic Grades/ Resin Codes	Value of plastic
1	Landfill Materials	25.1	_	No value
2	Glass Bottles	9.18	0	Only white bottles (Rs. 0.5 per/bottle) Colored bottles have no value
3	Nylon (Shoes, Slippers - plastics)	7.72	7	Low value Rs. 5-10
4	Expanded Polystyrene (Styrofoam/Foam)	5.88	7	Negative recycling value (no value at all)
5	Polyethylene Terephthalate Bottles	5.68	1	High (Rs. 47/kg)
6	Mixed Cloths	5.62	_	Rs. 5/kg- Cloth
7	Sacks (Construction Plastic Waste)	5.62	_	Rs. 3/kg- Sacks
8	HM/low density Polyethylene Plastics	4.68	4	Rs. 35/kg
9	High-density Polyethylene	2.06	2	Rs. 50-60 High
10	Polypropylene Plastics	1.62	5	Rs. 5/kg
11	Metal (Ferrous and Non-Ferrous)	0.7	_	Ferrous (Rs. 30/kg) and Non-Ferrous (Rs. 140/kg)
12	Tetra Pak	0.5	7	No value
13	MLP	0.5	_	No value
	Total quantity	**74.86**		

*The values for each plastic material is provided by Doko Recyclers as per the transaction history of 2021-22. The items with zero value means the materials might be recyclable but due to the properties such as voluminous nature or lack of industry in the country, it has been termed as zero or negative recycling, as the recycling of the material would cost more than the gains from selling the product of it. Some materials have been termed as of no value due to the non-recyclable nature of the material.

Among non-plastic segments, landfill waste (non-recyclable) comprised the highest volume with sixty two percent, These are rejected waste which has no value either in composting or recycling.

Normally recyclable plastics are those that can be re-melted and re-molded. Within the plastic waste segment, twenty three percent of the sample was found to be easy to recycle and seventy seven percent was hard to recycle grade. The remaining point five percent was non-recyclable plastics which contain polymers that form irreversible chemical bonds and cannot be recycled. Multi-layered Plastics was the only non-recyclable plastic found.

To know the extent of recyclability of recyclable plastics, the recyclable plastics were further divided into easy to recycle and hard to recycle (Table 12). According to the general rule of thumb, the lower the resin code, the more likely the plastic type is easy to be recycled. The resin code for plastic is given below:
1 – Polyethylene Terephthalate
2 – High Density Polyethylene

3 – Polyvinyl Chloride
4 – Low density Polyethylene
5 – Polypropylene
6 – Polystyrene
7 – Other (Acrylic, Polycarbonate, Polylactic fibers, Nylon, Fiberglass)

Thus, among the recyclable plastic sampled in our study, easily recyclable plastic comprised twenty three percent which was composed primarily of Polyethylene Terephthalate (seventy three percent) and high-density Polyethylene (twenty seven percent). The remaining seventy seven percent of the plastic found is hard to recycle, which included Nylon (thirty percent), Expanded Polystyrene (twenty three percent), (mixed and dirty) Low density Polyethylene (eighteen percent), Polypropylene (six percent) and Tetra Pak (two percent). These are typically not easily recycled because they are more difficult and expensive to process as are mostly mixed and contaminated with other materials. The plastic must then go through a proper cleaning and sorting process before it can be recycled, which can be time consuming and costly.

Of those that are easy to recycle, the reasons are:

Polyethylene Terephthalate

- Good grade, high value, high volume and excess demand, thus easy to recycle.
- The installed capacity of recycling is still low in Nepal thus a high volume is still sold to India.
- The polymer chain breaks down at a relatively low temperature, and so there is no degradation of the polymer chain during the recycling process.

High Density Polyethylene

- High grade, high value, high volume and have a good market thus easy to recycle.
- Mostly used partly into production of black pipes (ducts) mixing with virgin grade granules.
- Have light weight with high tensile strength and can be recycled repeatedly making it widely recyclable.
- Low density Polyethylene (Clean and sorted)
- High value grade if the scrap is clean and sorted.
- Mostly used in mixing with virgin granules in Black pipe (Duct) production industry.

The remaining seventy seven percent of the plastic found is hard to recycle, which included Nylon (thirty percent), Expanded Polystyrene (twenty three percent), (mixed and dirty) Low density Polyethylene (eighteen percent), Polypropylene (six percent) and Tetra Pak (two percent). These are typically not easily recycled because they are more difficult and expensive to process as are mostly mixed and contaminated with other materials. The plastic must then go through a proper cleaning and sorting process before it can be recycled, which can be time consuming and costly. The reasons for the difficulty to recycle these items are:

Low density Polyethylene (Mixed and Dirty)

- Low density Polyethylene is easy to recycle and has demand when it's in clean form, however, when it's contaminated, it loses its value in terms of recyclability.
- Mostly contaminated and must go through a proper cleaning and sorting process before it can be recycled. This can become time, energy and financially inefficient.

Polypropylene

- Low grade, low value and market thus hard to recycle.
- Well segregated white and other color POLYPROPYLENE (except black color) still high demand in Indian market
- Mostly contaminated, and must go through a proper cleaning and sorting process before it can be recycled. This can become time, energy and financially inefficient.

Expanded Polystyrene (Styrofoam)

- Low grade, low value and limited market, thus hard to recycle. Main challenge is the logistic cost for ferrying waste from one point to another hence the scrap dealers are not interested either in storing the waste and the limited buyers' market. Small scale projects are using it as filler material for construction bricks however collection still remains a challenge.
- Density and contamination are the two reasons. Polystyrene foam is 95% air so it is not cost-effective to store or ship. It is often contaminated with food or drink, and it is difficult to clean because it is so porous.

Nylon

- Low grade, low value and have no market, thus hard to recycle.
- Nylon is melted at a lower temperature, and some contaminants i.e., non-recyclable materials and microbes or bacteria can survive. Thus, all nylons have to be cleaned thoroughly before the recycling process which is again time and energy consuming.

Tetra Pak

- Low grade, low value and have no market, thus hard to recycle.
- Made with thin layers of polyethylene, paper and aluminum fused together. Hence, special equipment is required to recycle them (Julie, 2020).

Almost half of the waste collected (forty six percent) in the hotspot surveys was plastic waste, although it is only estimated that plastic comprises ten percent of the household waste stream generated in Kathmandu (Pathak, 2021). The reasons behind the high share of plastic waste in the river samples can be many - non-plastic materials might have a better recycling or collection system, the non-plastic materials may more often end up in the nature without being brought to the rivers, or the materials have such a different buoyancy than plastic, that it either does not float down to the sampled areas, or it has passed the sampled areas a long time ago. For example, organic materials degrade more quickly in nature than plastic, resulting in less accumulation of organic materials compared to plastic. Nonetheless, the high share of plastic shows the high need to handle plastic waste management differently, and increase the collection rates to reduce the amounts ending up in the river systems.

Out of the forty six percent plastic waste found in the hotspot samples, seventy seven percent was hard to recycle plastic, and twenty three percent was easy to recycle. Hence, three measures are important to decrease the amounts of plastic ending up in the rivers:

1. Improve collection of all easy to recycle plastic
2. Develop new technologies/collection methods for the hard to recycle plastic
3. Increase collection rates from households, market and industry; especially close to river systems

Conclusions and recommendations

Based on the literature review and studying the samples and visual observations of major points of plastic collection and dumping alongside the rivers in Kathmandu Valley, some key areas of intervention have been identified and mentioned below.

These recommendations are divided into "project plans", which are RIPL-planned interventions and "future work", which are general recommendations beyond the scope of the RIPL project and which are relevant for other actors in this field.

Project plans

The project initially planned five areas of intervention to reduce plastic in Nepali rivers: mapping hotspots for plastic pollution in rivers; strengthening the capacity of the informal sector; developing a business case for strengthening the private sector; making policy recommendations and piloting technical solutions. Based on results of the baseline activities carried out during the project's first year, RIPL will follow up with targeted actions:

1. Hotspot Mapping and Leakage prevention

The project has conducted an initial hotspot mapping and identified riverside dumping locations surrounding Kathmandu Valley and establish collection hubs in these locations to reduce riverside dumping and salvage all waste plastics from such locations.

The project will conduct a survey at the end of the project period to assess whether the situation is different than today.

2. Strengthening the Informal sector

The RIPL project has a strong focus on improving the livelihood of the Informal Recycling Sector, with a strong focus on women

The project will focus on awareness raising, such as producing videos about the important work informal recyclers are doing, as well as including them in project activities such as setting up collection centers.

3. Developing a business case for Strengthening the private sector

Collection centers will be set up as part of the project. They will typically be run by women (and in some cases vulnerable groups characterized by ethnicity, age or occupation) and will be structured as cooperatives where they can own and profit from the waste the center collects. This also means that they are more likely to work in their communities, bettering their communities and have access to educate and service households. Household clients can be further incentivized by being given a monetary value for the waste they segregate and handover.

This collection center setup will be based on an existing Doko model that trains workers on how to collect, manage, and sort, different types of waste. The model will also train informal sector operators on basic financial management needed to manage the center and will allow for collective ownership of the center by workers.

4. Provide policy recommendations

The RIPL project will inform the policy processes about plastic waste management in the Kathmandu Valley by communicating relevant insights to local government responsible for Nepal's solid waste management policy; members of the Department of Environment and Ministry of Forest and Environment who are involved in the Government of Nepal's Nationally Determined contribution (NDC) under the Paris Agreement for the period 2021-203; the Intergovernmental Negotiating

Committee (INC) on plastic pollution process and those involved in the National Adaptation Plan (NAP) with Adaptation measures based on circular economy and sustainable resource us; as well as other relevant actors involved in these processes through the various channels and events that our project partners use to communicate and disseminate information.

5. Piloting technical solutions

We will investigate gender-friendly technical solutions such as baling machines to increase the recyclability of hard to recycle plastic and non-recyclable plastic, based on feedback from informal sector recyclers involved in the project.

Future work

Based on the results of RIPL project work and from literature review, we have some general recommendations to prevent plastic pollution in Kathmandu Valley, intended for other actors and stakeholders to consider:

1. For mapping of plastic pollution hotspots:

- Further identifying hotspot areas along the river banks where dumping and collection of plastic waste is most rampant.
- Prioritizing areas of intervention, in terms of the approach to be taken in choosing locations for collection and processing hubs and target groups for intervention.
- Mitigate leakage through systematized door to door collection in areas where waste pick up is limited or lacking.

2. To strengthen the informal sector:

- Find and connect with informal recyclers in the identified hotspots as they will be key beneficiaries and partners during project interventions.
- Assess the perspectives and willingness of the informal recyclers to participate in implementation of any solutions designed for managing plastic waste.
- Training and capacity building of the informal recyclers regarding development of collection and processing hubs and operational mechanism of these hubs.

3. To strengthen the private sector:

- Development of a replicable model for collection and processing of plastic waste for entrepreneurs, both currently involved in or interested in joining this sector.
- Development of business case and operational modality for operating collection centers near identified hotspots.
- Formulating a comprehensive and financially viable plan for collection and processing centers near the hotspots.

4. For policy

- Lacking segments of regulation like EPR (Extended Producer Responsibility), waste taxes and bans can be an area of intervention to push for formulating and implementing rules and regulations for responsible management of waste at the sources itself.
- Coordinate with concerned local authorities and government bodies to working actively on prevention measures to waste ending up in rivers through careless dumping activities and to enhance the existing municipal waste pickup services.
- Coordinate with social organizations, youth groups, women's groups and the private sector in waste management to create cumulative efforts in areas of awareness and implementation of waste management systems.

5. For technical solutions:

- Explore solutions that could be implemented in sorting and cleaning for plastics which currently are non-recyclable in nature due to dirt but can be converted into recyclables.
- Consulting with relevant technical and private partners - both local and international, for devising solutions for 'hard to recycle' grades of plastics.
- Researching and finding technical and innovative solutions for 'Hard to Recycle' grades of plastics, especially avoiding types of energy generation with a carbon footprint and including a thorough analysis of the alternatives and impacts on the countries climate goals.

Annexes

ANNEX 1: **Workshop 1 findings**

ANNEX 2: **Preliminary survey**

ANNEX 3: **Interview questionnaire (summary survey)**

ANNEX 4: **Overview of informal recyclers**

ANNEX 5: **Action plan**

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This report summarizes key findings of the initial baseline assessment of hotspots for plastic pollution in rivers in Kathmandu Metropolitan City and the kinds of plastic that are commonly found in those spots, as well as challenges commonly faced by informal recycling sector workers. The baseline survey was undertaken as part of the RIPL project, financed by the Norwegian Retailers´ Environment Fund and the Norwegian agency for development cooperation; implemented by GRID-Arendal, the Norwegian Geotechnical Institute (NGI), the Center for Research and Sustainable Development Nepal (CREASION), Doko Recyclers and International Solid Waste Association (ISWA). The findings from this report are the result of field research, stakeholder interviews that took place in Kathmandu during the course of late 2021 and 2022 and a desktop literature review.