Decentralised waste management:
A mitigation strategy for climate change

A GHG study on Dry Waste Collection Centres (DWCCs) in Bengaluru

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Hasiru Dala

About Hasiru Dala

Hasiru Dala (meaning Green Force in Kannada) is a social impact organisation that focuses on securing justice for waste pickers through interventions co-created with waste pickers, in the areas of identity rights, access to family education, healthcare, housing, pension, skill development, market and employment access, and multi-tier policy advocacy. Hasiru Dala has worked with waste pickers in Bengaluru since 2011, and was incorporated as a Charitable Trust in November 2013. We are present in 2 states, 18 cities and 64 villages in South India.

Hasiru Dala believes in people-centric decentralised sustainable solid waste management. We work with all stakeholders in solid waste management, including local government, citizens, volunteers, corporates and brands that are interested in sustainability and the circular economy.

Hasiru Dala's aim is to bring recognition to waste pickers and informal waste collectors and their contribution to the city; create space formally in the local bodies waste management system to facilitate predictable income where possible. Broadly, our vision for the future involves an inclusive society for waste pickers and other informal waste workers, free of discrimination based on their age, class, caste, religion, occupation, gender and sexual orientation.

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First and foremost, thank you to all the waste pickers whose work has inspired the creation of inclusive decentralised and sustainable recycling infrastructures such as the Dry Waste Collection Centres (DWCCs) which are the focal point of our study. We would also thank all the waste picker entrepreneurs running the DWCC's and the other waste pickers involved in sorting and grading of the recyclables in the Jayanagar Division of Bengaluru, where this study was conducted.

We would like to thank Women in Informal Employment: Globalizing and Organizing (WIEGO), Green Partners, and Resources & Waste Advisory Group (RWA) for making the Green Calculator 2.0 tool available for conducting studies to calculate the contribution of the informal waste workers and inclusive recycling systems like DWCCs in reducing the greenhouse gases emissions. We would also like to thank WIEGO for their monetary support to conduct the study.

This research study has been enriched through several interactions with different people. The authors would like to express their gratitude to the people who advised and gave critical reflections on the study and helped the report to come to fruition. We are thankful to Lubna Ananthakrishnana of Kagad Kach Patra Kashtakari Panchayat (KKPKP) and Shikher Gupta for their inputs in the use of the GHG Calculator 2.0.

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Dedicated to all the waste workers and their families who, while facing the brunt of climate change, contribute immensely towards climate mitigation.

Preface

Climate change is no longer a far off concept, we are experiencing it right now. We need to do everything in our reach to mitigate climate change.

For the first time ever, Hasiru Dala has done a study in 2022 wherein a reduction of 1,743 tonnes Co2 equivalent/year is estimated in 7 Dry Waste Collection Centers in Bengaluru. This study has demonstrated the need for decentralisation of waste management which is easier to govern, creates employment, reduces environmental pollution and mitigating climate change.

Reducing waste is always the first priority, next is avoiding waste reaching the landfill. Hasiru Dala has shown us that a skilled waste worker is essential to mitigation because of the attention to detail during the sorting process. Along with BBMP, Hasiru Dala is working on operating Dry Waste Collection centres and has been successful in collection and sorting the dry waste that comes to the centre.

I have seen Hasiru Dala grow for more than a decade, starting with humble beginnings in organising and training waste pickers, and today they have completed a study on GHG Hasiru Dala deserves credit for identifying the waste picker as climate mitigators. I congratulate them for their years of constant work and wish them to do more.

I appreciate the participation of BBMP, South Zone in conducting such an important study. I am hoping the results shown in the study create awareness on the importance of decentralised waste management in Karnataka.

Mahesh.T

Chief Environmental Officer
Karnataka State Pollution Control Board (KSPCB)

List of Acronyms

BBMP	Bruhat Bengaluru Mahanagara Palike (Greater Bengaluru Metropolitan Corporation)
CFLs	Chlorofluorocarbons
CNG	Compressed Natural Gas
CO2	Carbon Dioxide
eCO2	Carbon Dioxide equivalent
CH4	Mehtane
DWCC	Dry Waste Collection Centre
GOI	Government of India
GHG	Greenhouse gases
HD	Hasiru Dala
HDPE	High Density Polyethylene
IPCC	Intergovernmental Panel on Climate Change
LDPE	Low density polyethylene
MLP	Multi-Layered Plastics
MoEFCC	Ministry of Environment, Forest, and Climate Change
MRF	Material Recovery Facility
MSW	Municipal Solid Waste
MT	Metric Tonnes
PET	Polyethylene terephthalate
PP	Polypropylene
PVC	Polyvinyl chloride
RWA	Resident Welfare Association
RWA	Resources & Waste Advisory Group
3Rs	Reduce, Reuse, Recycle
SBM	Swachh Bharat Mission
SWM	Solid Waste Management
ULB	Urban Local Bodies
WIEGO	Women in Informal Employment: Globalising and Organising
WoW	Women of Wisdom

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Executive Summary

For over 10 years, Hasiru Dala's main focus has been the inclusion of waste pickers in social benefits and guaranteeing dignity of livelihood. Hasiru Dala (HD) was creating gender and economic equity for waste pickers years before it became a part of global climate conversations. For the first time ever, Hasiru Dala has identified and calculated greenhouse gas (GHG) abatement through waste worker interventions for the year 2022. Not only is HD working exclusively with vulnerable communities, but these very waste pickers are off-setting carbon emissions – benefiting the entire city of Bengaluru. In this report, HD demonstrates the data for the first time.

Findings

In this study, Hasiru Dala applied the GHG Calculator 2.0 tool developed in partnership with Green partners and RWA (Resources & Waste Advisory Group) to calculate the contribution of the 7 waste pickers run Dry Waste Collection Centres, and the additional practices/models in ward 177 of Bengaluru. Thus, the Overall GHG Savings to be 1763 tonnes Co2 equivalent per year.

- The contribution of the 7 waste pickers run Dry Waste Collection Centres in GHG savings to be 1,743 tonnes Co2 equivalent per year which is equal to what it would take over 2,000 acres of forest to sequester according to the United States Environmental Protection Agency Carbon Calculator
- The Textile project in the DWCC of Ward 177 mitigates 17.11 Tonnes Co2 equivalent/ Year.
- A lane composter installation in one street of Ward 177 as a part of a zero waste initiative mitigates 3.03 Tonnes Co2 equivalent/ Year.

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Chapter 1: Introduction

1.1 Setting up the context

Currently, Bengaluru generates about 4500 tonnes of Municipal Solid waste everyday[1] . The Bruhat Bengaluru Mahanagara Palike (BBMP) is the municipal corporation of the Greater Bengaluru Metropolitan Area, responsible for the Solid Waste Management including collection, transportation, processing, and disposal of the Municipal Solid Waste. In order to enhance the efficiency of municipal solid waste (MSW) management in the city, the BBMP has implemented several measures and initiatives to streamline the entire process and ensure segregation of waste at source among the citizens.

For over 10 years, Hasiru Dala (HD) has worked with waste pickers across India to ensure dignity of labour[2]; many times working closely with the BBMP to implement better employment policies. While waste pickers have finally achieved some social and political benefits and have been acknowledged as vital members of society, their contributions to the climate crisis have not yet been understood to the full extent. In Bengaluru, the physical and social infrastructure of Dry Waste Collection Centres (DWCCs) contribute to both social and economic inclusion of the waste pickers. The decentralised system of DWCCs helps to capture the dry waste of a ward to manage most of it inside the ward. By collecting and segregating the recyclable materials from the dry waste, DWCCs and waste pickers help in preventing the volumes of waste that goes to landfills and thereby reduce the emission of methane. Simultaneously, the waste picker also contributes in recycling and substitution of virgin raw materials which is another important way to reduce GHG (Chintan, 2009).

Municipal Solid Waste releases three main Greenhouse gases Carbon Dioxide (CO_2), Methane (CH_4) and Nitrous Oxide (N_2O) potent greenhouse gases and other non-methane organic compounds[3] which is produced when dry and wet waste are mixed. Landfills where the waste ends up being disposed of releases this "Landfill gas" during the decomposition for many years. Methane emissions from the landfill are the largest source of GHG emissions from the waste management sector (Bogner 2007) followed by incineration. The emission levels keep rising gradually over the years of the decomposition process. In fact, the United Nations Environment Program states that "Globally, if food waste could be represented as its own country, it would be the third largest greenhouse gas emitter, behind China and the United States. The resources needed to produce the food that becomes lost or wasted has a carbon footprint of about 3.3 billion tons of CO_2."[4] Zero waste management helps in combating climate change. In Bangalore, the localised waste management system which is the Dry waste collection centre (DWCC) acts as an Climate mitigation infrastructure. Waste pickers are the pillars of this infrastructure and play a crucial role in reducing Greenhouse gas emissions by diverting waste from landfill, recycling and promoting a circular economy. While existing studies[5] substantiate the significant role of waste pickers in the GHG mitigation, it is worth conducting a study contextualised to Bengaluru to understand the contribution of DWCCs in GHG mitigation. In order to determine the GHG mitigation, Hasiru Dala conducted a comprehensive study taking into account the specific local conditions, different sources of emissions and factors affecting the waste management.

1.2 Waste and Climate change

The different components in managing the municipal waste including the collection, transportation and treatment has a significant potential in contributing to climate change. [6]This intricate link is influenced by diverse factors such as the region, infrastructure development, composition of the waste and its management practices. The report released by the Global Alliance for Incinerator Alternatives (GAIA)[7] reveals that the waste sector holds the third-largest source of anthropogenic methane emissions worldwide, contributing roughly 20% of all such emissions. As a counterpart to this finding, a study published in the Journal "Nature Climate Change" estimates that waste management activities contributes to 5% of the total global anthropogenic Co2 emission[8].

In light of these alarming figures, the improper management of the municipal waste creates serious environmental problems directly intensifying the global warming situation through the release of greenhouse gases into the atmosphere[9]. Primarily, the landfills act as a notable source of methane emissions. Due to the inefficiency in the Source segregation of waste, the huge amount of mixed waste gets dumped in the landfills thereby exacerbating the climate impact. Further, the improper waste disposal practices add up to the repercussions through open dumping, or the infamous 'Black Spots' in the neighbourhoods[10]. These practices contribute to the open burning of waste, which not only releases Carbon dioxide but also other harmful pollutants into the environment.

Nevertheless, Waste management has a greater potential in reducing the effects of global warming and is inextricably linked to the climate mitigation activities. By adopting the sustainable waste management practises, the emissions trajectory can be reshaped to meet the climate goals. These practices encompass the reduction of the mixed waste reaching the landfill, promoting rigorous recycling methods, channelising and streamlining the different types of waste, and transitioning to the circular economy. Recognising the waste management sector as a contributor to climate change and accelerating it to the mitigation path can immensely reduce the emission of greenhouse gas. This can be achieved through devising legal framework and strategies for building climate resilience which will be pivotal in the battle against climate change.

1.3 Waste, Climate Change and Legal framework in India

Hasiru Dala has been a key actor in the evolution of sustainable SWM policies and practices at the city, state and national level. Right from piloting the first DWCC in Bangalore to taking it across the state of Karnataka along with the policy advocacy for integration of the informal waste pickers in the DWCCs. Here, we shall look at the existing SWM policies situated within the larger framework of Climate Change.

1.3.1 National Policies on Climate Change and Waste Management

In the 1970's and 1980's a series of environmental legislations like The Water (Prevention and Control of Pollution) Act, 1974 and The Air

(Prevention and Control of Pollution) Act, 1981 laid down standards to regulate emission of air pollution for the Industries and manufacturing sector. Later, the Government of India enacted the Environment Protection Act, 1986 a first of its kind legislation with respect to Climate Change in India. It set the path for the State and National level interventions to protect and improve the quality of environment; prevent and to abate environmental pollution. The penalties levied by the State Pollution Control Boards (SPCB) or Central Pollution Control Boards (CPCB), obtaining Consent Orders and Environment Clearances are some ways of regulation.

The Municipal Solid Waste (Management and Handling) Rules, 2000 enacted under the Environment Protection Act, 1986 mandated the Urban Local Bodies to ensure collection, segregation, storage, transportation, disposal, processing and disposal of the solid waste generated in the city. Later the comprehensive National Action Policy on Climate Change (NAPCC) was launched in 2008 with focus on 8 national missions including the National Mission on Sustainable Habitat, promoting energy efficiency as the core of urban planning and also emphasised on waste management and recycling. It also acknowledged the historical vulnerability of India to climate variabilities and disasters. Solid Waste Management Rules, 2016, the Plastic Waste Management Rules, 2016, the Construction and Demolition Waste, 2016 and the E-waste Management Rules, 2016 extended the regulatory coverage of legislation over various emerging issues within waste management to combat climate change. The E-Waste Rules to be specific took forward the commitment and introduced the principle of "Extended Producers Responsibility".

Public Interest Litigations (PIL) came to be used as a means of citizens' environmental activism. The National Green Tribunal Act of 2010, established the Green Tribunals with jurisdiction over cases with substantial questions relating to the environment as well as is embedded with the philosophy of "polluters pay" principle and the doctrine of sustainable development.

1.3.2 Integration of waste pickers

Swacch Bharat Abhiyan or the Clean India Mission was launched by the GOI on the occasion of the 150th Birth Anniversary of Mahatma Gandhi in 2019. It gave impetus to the need for constructing toilets for all and decentralised solid waste management based on the principles of 3Rs (Reduce, Reuse, Recycle). Following the Solid Waste Management Rules, 2016 the Manual for Municipal Solid Waste Management produced by the SWM (Urban) clearly outlines the role of the state governments in "acknowledging the primary role played by the informal sector of waste pickers, waste collectors and recycling industry in reducing waste and provide broad guidelines regarding the integration of waste picker or informal waste collectors in the waste management system.[11]" It also provides for starting a scheme on the registration of the waste pickers and waste dealers. On the other hand it directs the Municipal authorities to recognise organisations of waste pickers, provide Identity cards,

integrate them in the solid waste management including door to door collection of waste, formation of SHGs and other social protection measures.

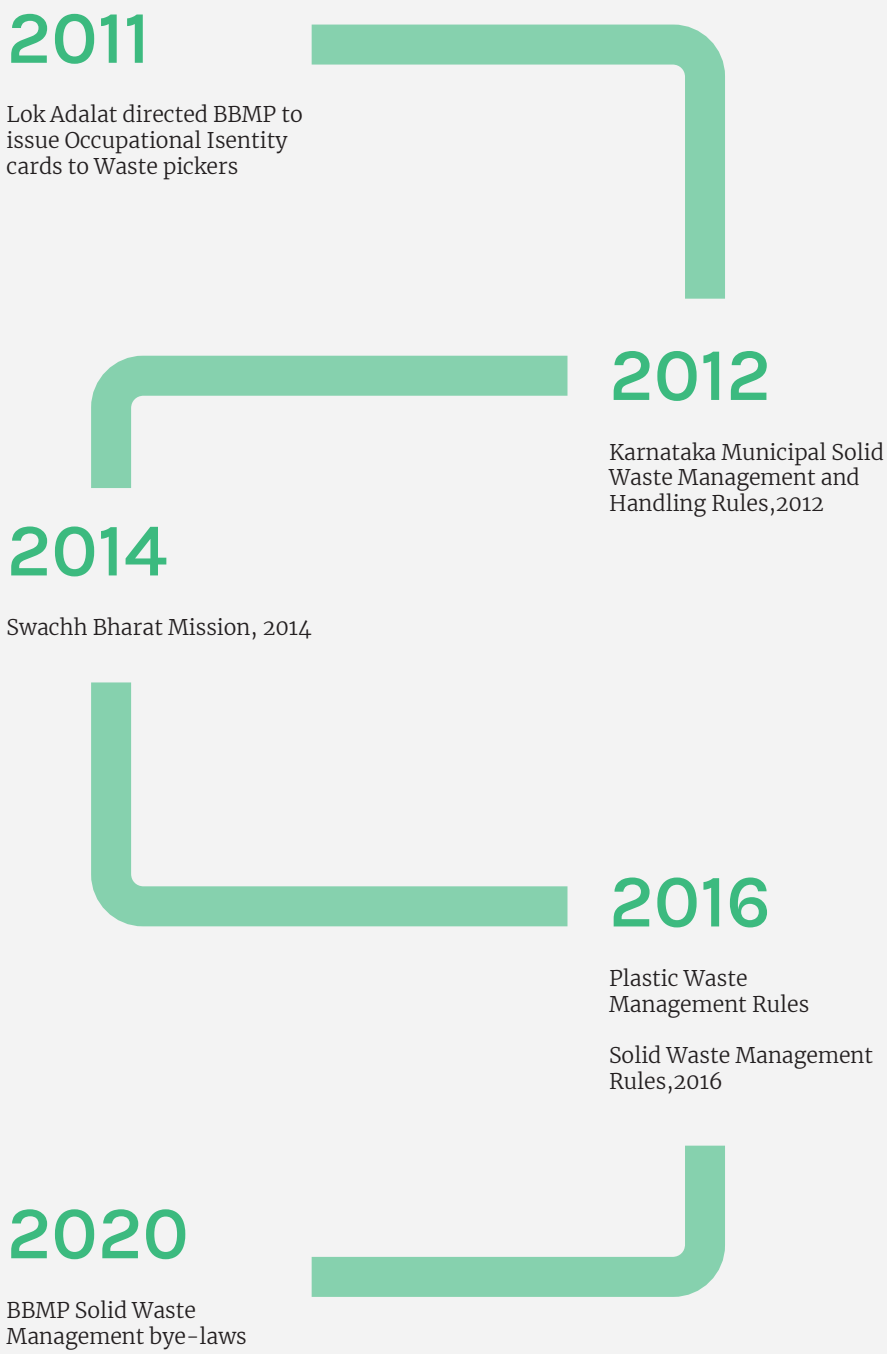
It acknowledges the waste pickers right to access recyclables and directs the waste generators to handover segregated waste to the waste pickers or collectors authorised by the local body and to set up Material Recovery Facilities (MRFs) to enable sorting of recyclable waste by the waste pickers. The Swachh Survekshan Rankings includes an indicator 1. 5 (b) Benefits extended to all informal waste pickers as part of the Service Level Progress Indicators with 75 marks. The SBM toolkit for Swachh Survekshan encourages ULBs to engage informal waste pickers/women/ transgenders in the MRF centres in indicator 2.4 with 150 marks. It also declares that the Informal Waste Pickers, if available, should be given the first right to collect & sell recyclables. [12] This has encouraged the implementation of the same by the cities across India to achieve better rankings in the Swachh Survekshan.

1.3.3 State Policy

The Karnataka Municipal Corporation Act, 1976 which acts as a legal framework for solid waste management in Karnataka as Solid Waste Management is one of the main functions of the Urban Local Bodies (ULBs). The BBMP has issued a range of guidelines to improve the management of the waste in the city like the adoption of the SWM Bye-Laws, 2020.

The Government of Karnataka made budgetary allocations for the creation of DWCCs at scale across the entire state of Karnataka. This would mean that all Urban and Rural local bodies will have the support to start implementing the DWCC model going strong on the path of decentralised and sustainable solid waste management.

Figure 1:
Timeline of SWM Policies and Schemes



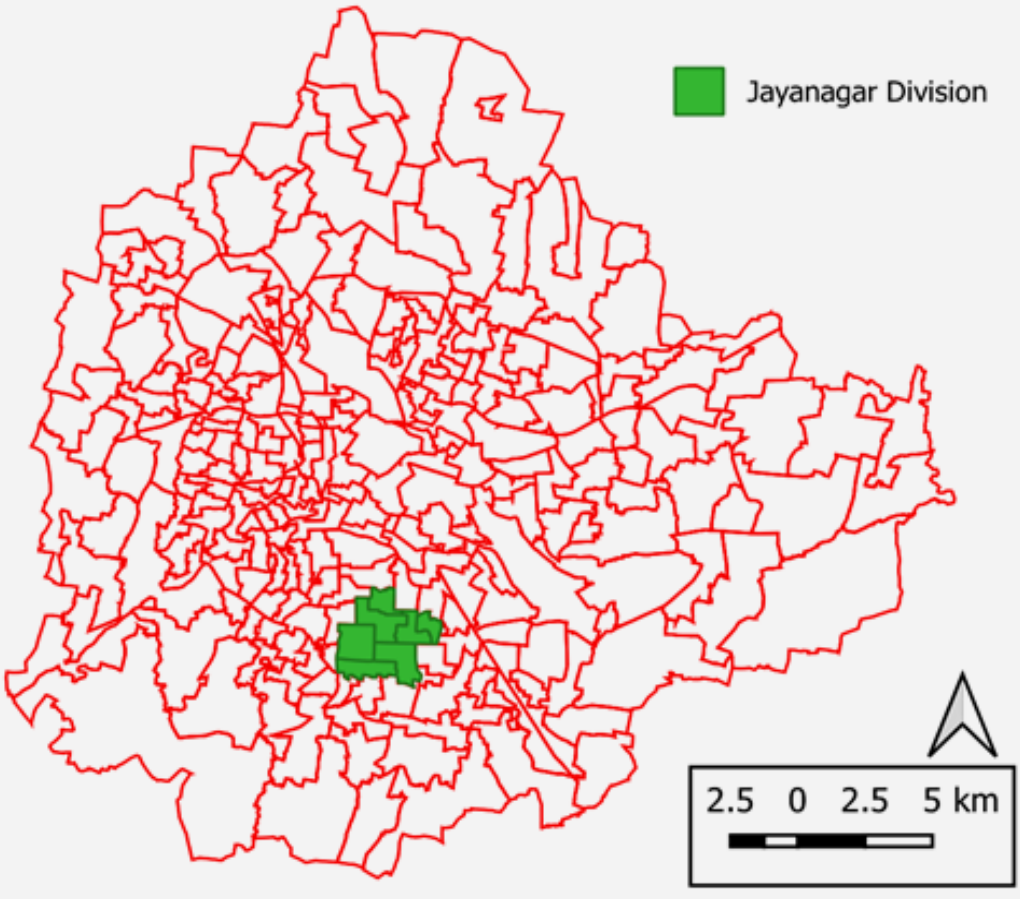
Chapter 2:
Understanding the solid waste management:
A Jayanagar division Story

Waste sector emissions were estimated to account for 20% of total global anthropogenic emissions [13]. Greenhouse gases (GHG) emissions generated from waste depend on several factors, such as the quantity and composition of the waste, the method of waste management and the disposal site. This chapter will explain the different waste management practises in the Jayanagar Division for the readers who are not familiar with the solid waste management systems of Bengaluru.

2.1 Selecting the Study area

After careful consideration, Jayanagar Division, which is located in the southern part of Bengaluru City, was selected as the site of our study. The division comprises seven wards - ward 168, 169, 170, 171, 177, 178, and 179, respectively. According to the 2011 Census, the total population of the division is 2,29,088 people, with 55,148 households. While the data from the census is somewhat dated, it provides a reasonable estimate of the population size.

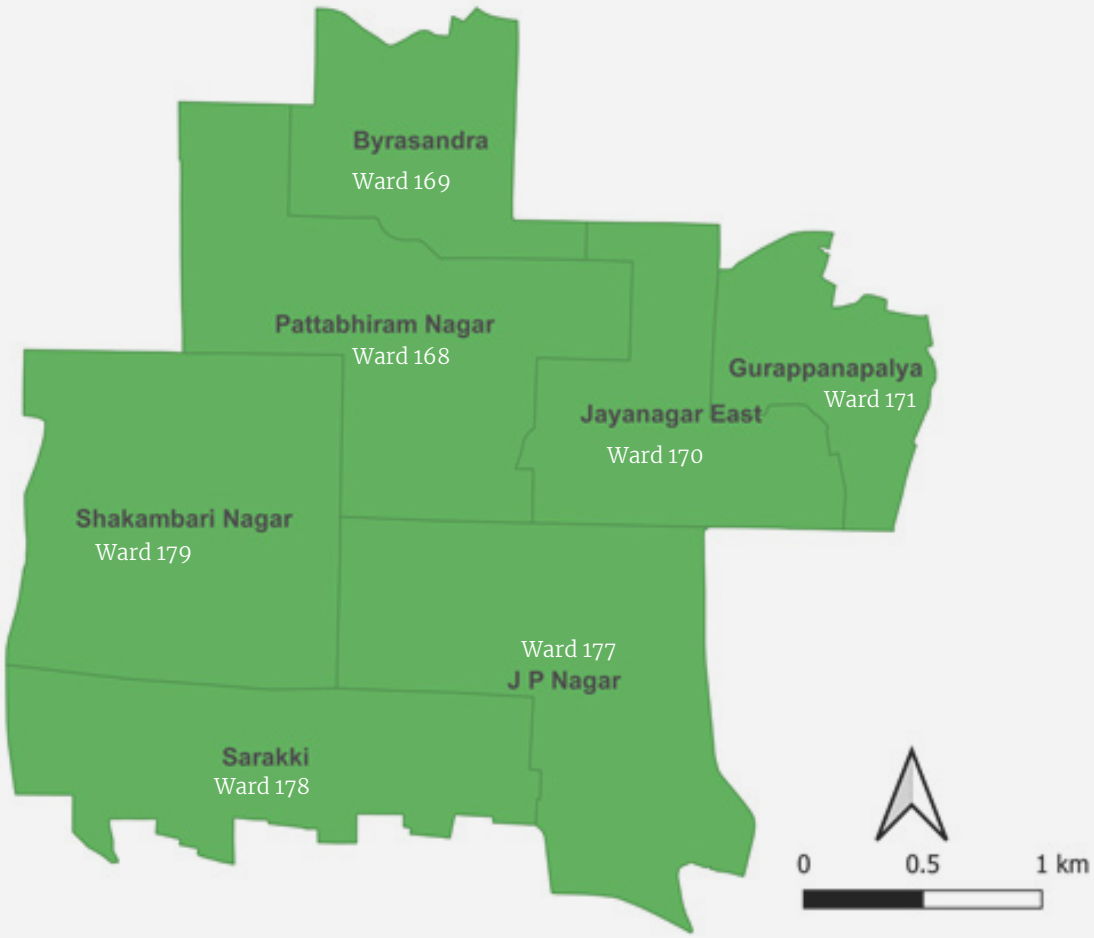
Figure 2: Bangalore Ward-wise map



Jayanagar Division is located approximately 9 kilometres south of Bengaluru City's central business district. The division spans an area of approximately 9.5 square kilometres and is bordered by Basavanagudi to the north, JP Nagar to the south, Banashankari to the west, and BTM Layout to the east.

One of the factors that influenced our decision to study Jayanagar Division is its strategic location. As a part of the larger Bengaluru Metropolitan Area, the division represents a microcosm of the waste management challenges facing urban centres across India. Additionally, the division's proximity to the central business district and major transportation hubs makes it an important economic and cultural centre

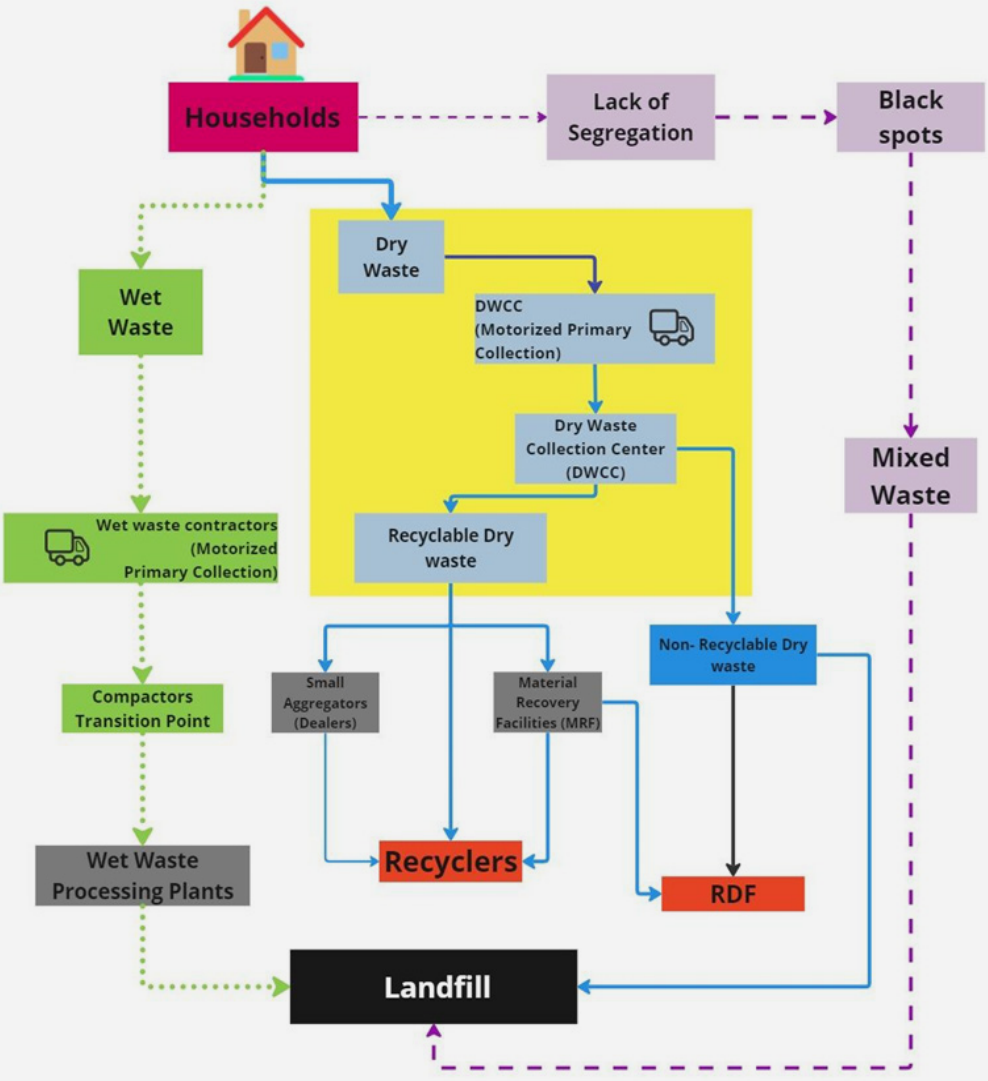
Figure 3:
Jayanagar Division Map



2.2 *Current Practises of handling Municipal Solid Waste in Jayanagar division*

The BBMP has established comprehensive ways of managing municipal solid waste (MSW), including collection, street sweeping, transportation, processing, and disposal. In order to enhance the efficiency of MSW management in the city, the BBMP has implemented several measures and initiatives to streamline the entire process. The most popular among them is the 2Bin1Bag method which was promoted by the citizens and SWM practitioners group - Solid Waste Management Round Table (SWMRT), Bangalore. Following a 2015 High Court order on the PIL filed by SWMRT it has been implemented across the city for better source segregation of waste, segregating them into Wet waste (Green bin), Reject waste (Red Bin) and Dry waste (bag). Hasiru Dala has been one of the prominent Resource Organisations supporting the DWCCs for citizen engagement to raise this awareness.

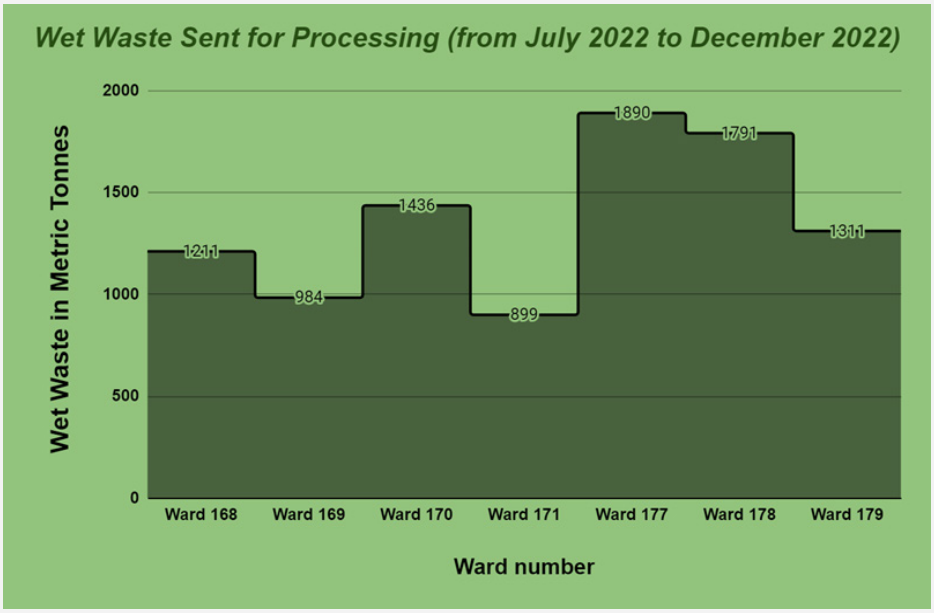
Figure 4: Current practises of handling MSW in Jayanagar division



2.3 Wet waste management

The BBMP has decentralised the management of wet waste. The bulk waste generators are required by law to manage the wet waste generated by their residents. For this, the Resident Welfare Associations (RWAs) with the help of Waste pickers and other experts have been composting the wet waste (kitchen waste, garden waste) within their campus. The other citizens/waste generators have access to Wet waste collection services provided by the BBMP's wet waste collection service contractors who pick up the wet waste separately everyday. The wet waste thus generated from Jayanagar division is sent for co-processing to the Chikkanagamangala SWM plant. However, certain pockets of the division have not achieved a complete level of segregation.

Figure 5: Quantity of wet waste sent for processing from Jayanagar division

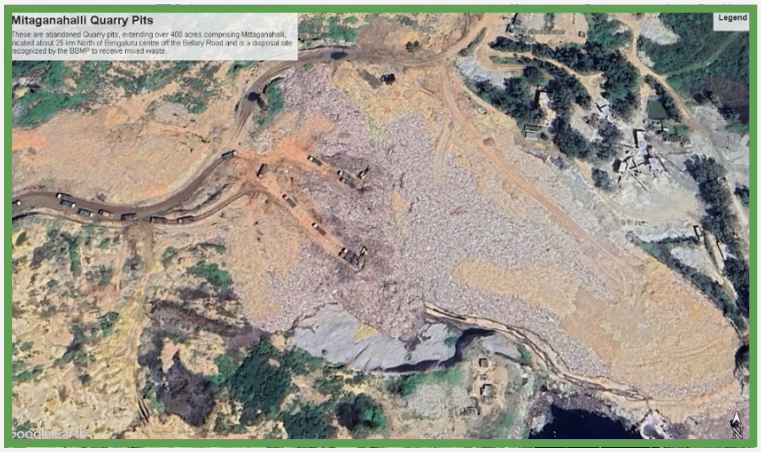


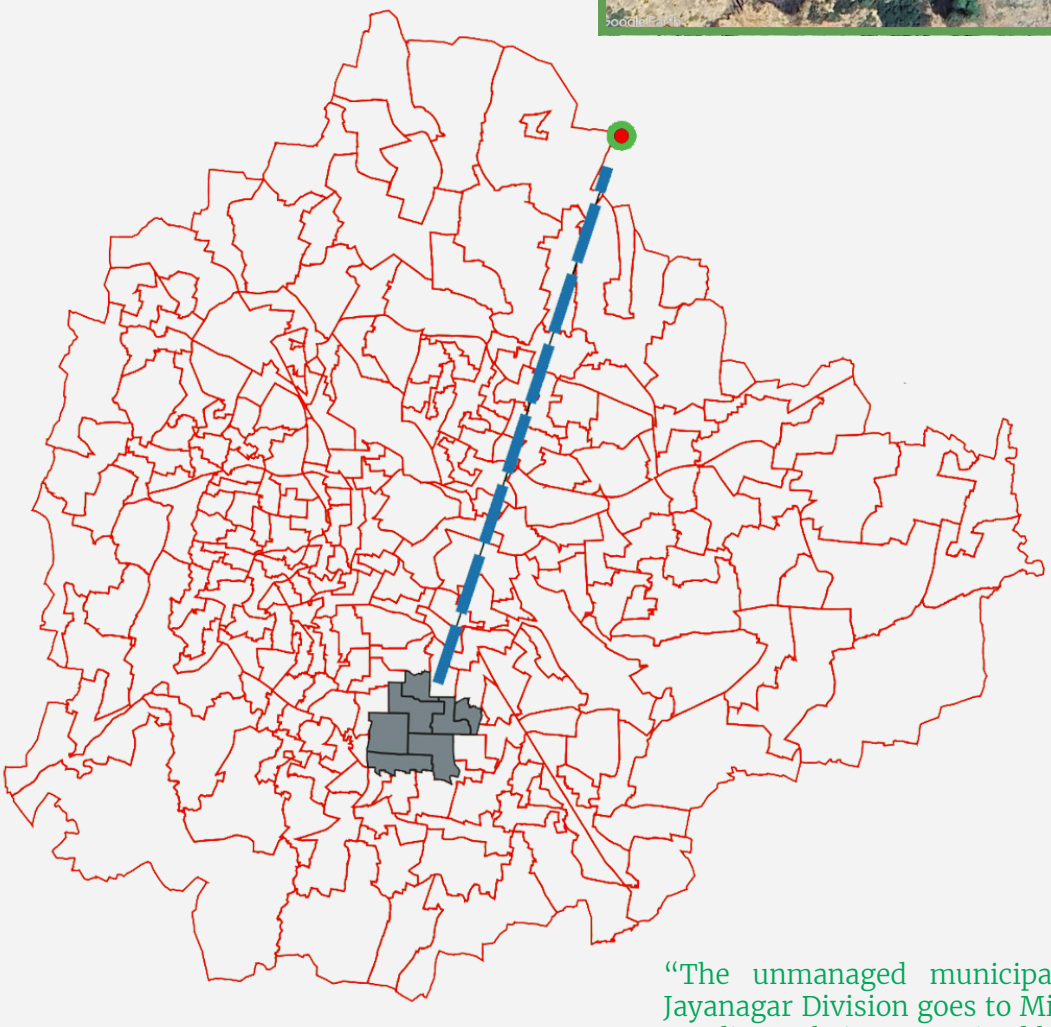
2.4 Mixed waste management

2.4.1 Lack of segregation and its consequences

Although BBMP urges its citizens to do source segregation of waste, a huge amount of mixed waste still ends up in the landfill, causing greenhouse gas emissions. Currently, the unmanaged municipal mixed waste from Jayanagar Division goes to Mittaganahalli Landfill – a disposal site recognized by the BBMP which comes under the landfill type of 'Unmanaged deep (>5m)'. These dumpsites extend over 400 acres comprising Mittaganahalli, located about 25 km North of Bengaluru centre off the Bellary Road. The Quarries were originally identified for receiving inert, later the proposal was changed to accommodate the mixed waste collected by the BBMP. Disposal sites are usually present at the outskirts of the city. Bengaluru city still depends on the landfills to dispose of its inert and reject waste.

Figure 6:
Where does the mixed waste from Jayanagar division reach





"The unmanaged municipal mixed waste from Jayanagar Division goes to Mitiganahalli Quarry pits - a disposal site recognized by the BBMP. These are abandoned Quarry pits, extending over 400 acres comprising Mittaganahalli, located about 25 km North of Bengaluru centre off the Bellary Road"

Figure 7:
Quantity of mixed waste dumped in Mittaganahalli landfill from Jayanagar division

2.4.2 *Composition of mixed waste: Evidence from pilot study*

The composition of the waste in the landfill or disposal site is one of the main parameters in the calculator to estimate the GHG emissions. The occurrence of mixed waste affects the decomposition process of waste in the landfills. This affects the emissions levels not to forget that the levels of greenhouse gas emissions keep gradually increasing over the years as the decomposition progresses. Due to the nature of the decomposition processes in the carbon stock in the landfill, the release of emissions continues even if dumping of waste in the landfill has stopped.
While the quantity of mixed waste dumped into the Mittaganahalli Quarry pits is established, the study team wanted to further understand its composition as the methane emissions are dependent on the decomposition of wet waste present in the waste, so the study team conducted a small study.

The Study followed three steps:

The study initially was planned for three consecutive days in February 2023. In addition to the team of researchers, two waste workers were hired to sort the mixed waste. On the first day of this audit, the auto-tipper unloaded 560 kilograms of the mixed waste from KSRTC Layout blackspots in a designated place near the dry waste collection centre of Ward 177. Two women workers along with one researcher started segregating the mixed waste.

The mixed waste mostly consisted of: tender Vegetable peels, Kitchen waste, Coconut husks, food wrapped in plastic covers, food parcels metals, glass objects like bulbs/CFLs & tubelights, ceramic mugs, mud pots various types of single use plastic in the form of bottles, sachets, shoes/chappals, textiles, Sanitary waste, etc. The team encountered many challenges in the sorting process as the mixed waste is unsanitary and unsafe to handle. The workers also expressed hesitation in continuing with the exercise. Hence, the audit was stopped after the first day.

Findings of the Pilot study

After hours of segregation, the mixed waste is separated into different categories to measure the weight. Wet waste is the abundant type, making up to 58% of the total mixed waste. Followed by the dry waste which is 26 %. Within dry waste, the paper and plastics amounted to a large quantity. 19% percent consists of the reject and sanitary waste.
For more details of the pilot study, Please refer appendix A

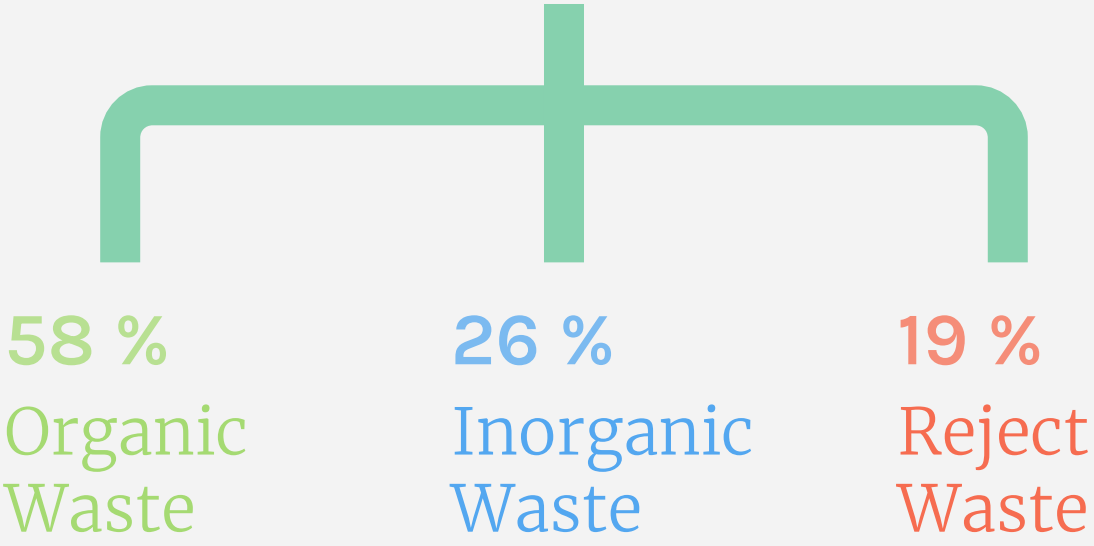


Figure 8:
Waste segregation guidelines

* **Excess garden waste** should be picked up separately or composted at source.
** Fused **tube-lights and bulbs, all e waste, should be stored in separate bin and handed over separately**
§ Hand over **sharp** items separately.
¤ **Construction debris** in large quantities will be not be picked up by BBMP service provider
Single Use Plastic items like cups and plates are banned according to Karnataka Plastic Ban Notification No FEE 17 EPC 2012, Bangalore dated 11th March 2016

2.5
Dry Waste Management

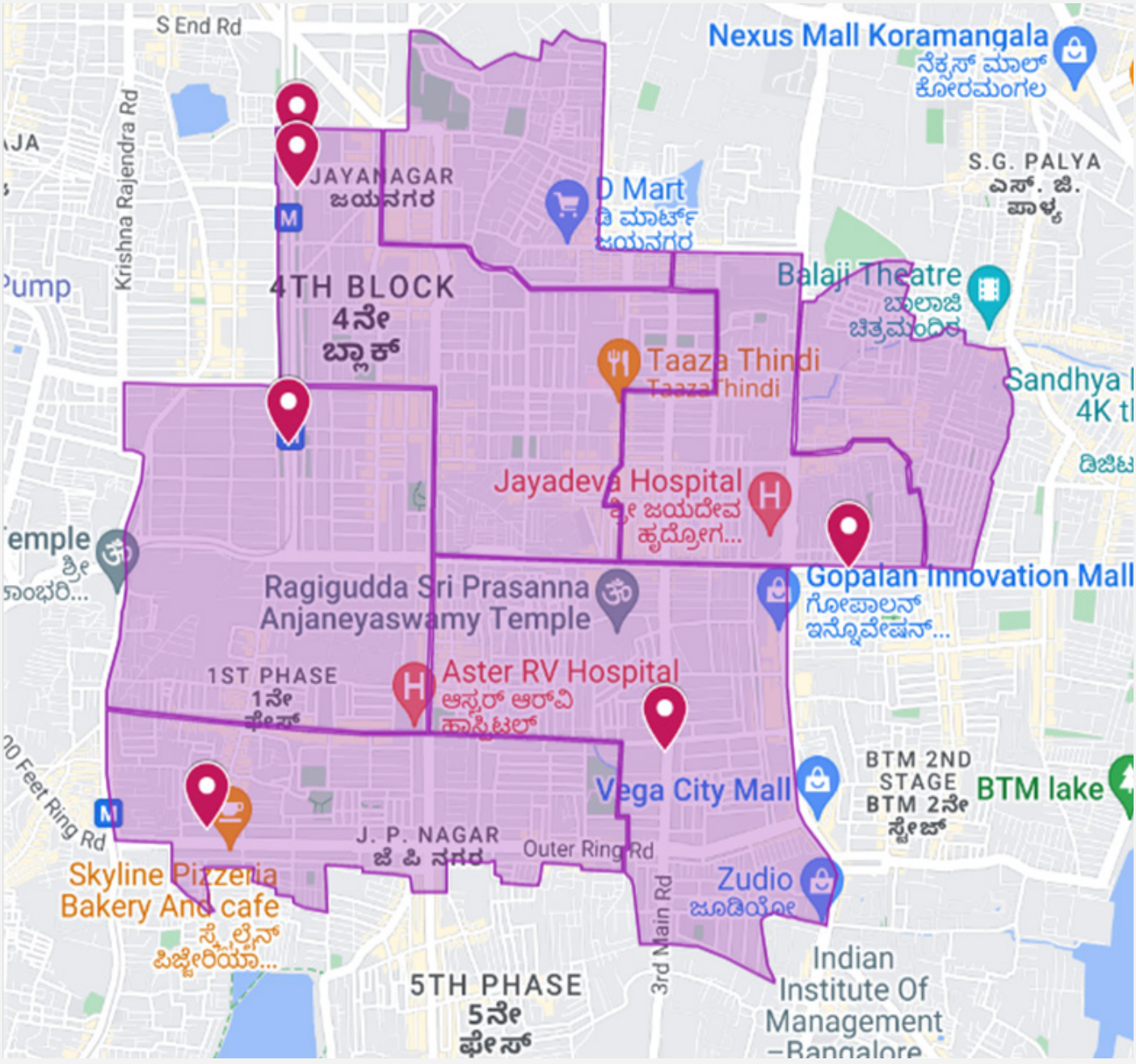
The BBMP has developed over 189 Dry Waste Collection Centres[14] (DWCCs) in Bengaluru. Dry Waste Collection Centres are the decentralised waste management system, commissioned by BBMP in the year 2011, whose primary function is capturing the recyclable dry waste and sending it for recycling. It is based on a tri-party agreement between BBMP, the operator and Hasiru Dala, in which the BBMP provides land, infrastructure, and assures the supply of dry waste, while the operator conducts everyday operations of collecting, segregating, recycling/ selling of dry waste.

Dry Waste Collection Centre runs as an enterprise where the operator manages the DWCC. Waste pickers holding the Occupational Identity Card and Self Help Groups (SHG) can become DWCC operators. Hundreds of waste pickers in the city of Bengaluru have found dignified work opportunities in the DWCC, also becoming climate mitigators. They have taken up roles of sorters who help in segregation of the dry waste that is collected from door to door collection, driver and helper do door-to-door waste collection and get the dry waste to the DWCCs. Dry Waste is collected only from individual households, small commercials and standalone apartments and apartments which have less than 50 units. The vehicle goes for collection twice a week to each house. The BBMP provides the operator with the infrastructure and cost of 2 vehicles. The sorted dry waste in the DWCC is baled and sent for recycling through which the operators earn income with which they also pay the sorters in the DWCC.

DWCC in Jayanagar division

The DWCC centres in the Jayanagar division are the focus of our study. Jayanagar has 7 administrative wards namely Pattabhiramanagar, Byrasandra, Jayanagar East, Gurappanapalya, JP Nagar, Sarakki, Shakambari Nagar. Almost all the centres are operated by waste pickers and Hasiru Dala supports them as a resource organisation. There are 67 waste pickers who work in the DWCC centres across Jayanagar division. Out of which, 36 are men and 31 are women. The below map shows the locations of the DWCC's in the Jayanagar division.

Figure 9:
Location of the 7 DWCC in the Jayanagar division



Chapter 3: Methodology and Assessment

3.1 Tool for calculating CO2 emissions saved by waste pickers

The greenhouse gas mitigation for this study was quantified using the tool, the GHG Emissions Calculator 2.0, developed by Green Partners environmental consulting in partnership with Women in Informal Employment: Globalizing and Organizing (WIEGO), which is methodology and calculator tool enabling the estimation of greenhouse gas emissions that waste picker groups prevent. The tool, which was developed for waste picker organisations and their supporters, allows for the measurement of greenhouse gas emissions avoided through the following waste treatment methods: diversion of waste from decay in landfills and dumps; recycling; manual sorting and transportation; and diversion of materials from open burning.

This tool was selected because it rely on the internationally recognized methodologies and also pays attention to the specificities of waste management activities. This tool was tested by organisational members of the Global Alliance of Waste Pickers. Through the methodology of analysis provided by this tool, Columbia's Association of Recyclers of Bogota (ARB) quantified the GHG emissions mitigation of over 407 thousand tons of CO2 equivalent (eCO2) in 2020 and SWaCH Cooperative in Pune mitigated emissions of more than 211 tons of CO2. The GHG Emissions Calculator 2.0 is a concrete tool to generate evidence of the mitigation of greenhouse gas emissions through waste pickers' activity[15]. As mentioned above, mixed waste landfills are a major source of greenhouse gas emissions and through the WIEGO tool, the study team first identified our local landfill to calculate our mitigation numbers. Mitigation is calculated by the amount of waste diverted from landfills.

3.2 Data sources

Accurate and reliable data source is important in the GHG calculation. In order to perform the GHG analysis, we utilised the combination of both primary and secondary data collection methods. Primary data were collected using the pilot survey, while the secondary data were obtained through contacting the DWCC data team, which has Centralised data system (CDS), and Urban local bodies.

Parameters and variables

- Landfill data
- Quantity of recyclables diverted from the landfill by the Dry waste collection centres (DWCC)
- Composition of different categories of dry waste in the DWCC
- Transportation data w.r.t Collection of the Dry waste in the DWCC's.
- Wet waste data w.r.t Composting

3.3 Waste management data:

The waste management data such as landfill type, landfilling rates, recycling rates of the DWCC's and wet waste composted are collected from the following Secondary sources: Urban local body (BBMP) , the Hasiru Dala data team and the community organisations.

2.5 Dry Waste Management

Landfill Data

The WIEGO tool calculation is based on the local landfills; there are four main categories they have used to classify landfill type. The waste diverted from landfills is what accounts for the abatement, so it is accurate to each locality. In order to gather information pertaining to the landfill, the study team contacted different ULB representatives of the Jayanagar division.

Dry Waste Data

The Dry Waste Collection Centres (DWCC) consistently records and maintains the incoming and outgoing of dry waste and uploads it daily to the BBMP portal. The BBMP also puts the DWCC data on their website. The Study team contacted the Livelihoods vertical and Data team of Hasiru Dala to get relevant data points from the DWCC of the study area as required for the study.

Wet Waste Data

The members of WoW (Women of Wisdom) group in Ward 177 recorded the amount of wet waste for composting for a period of two months.

3.4 Waste Composition Analysis

In order to understand the types and quantity of different categories of the sorted dry waste in the DWCC's, a dry waste audit is conducted.

Dry Waste Audit

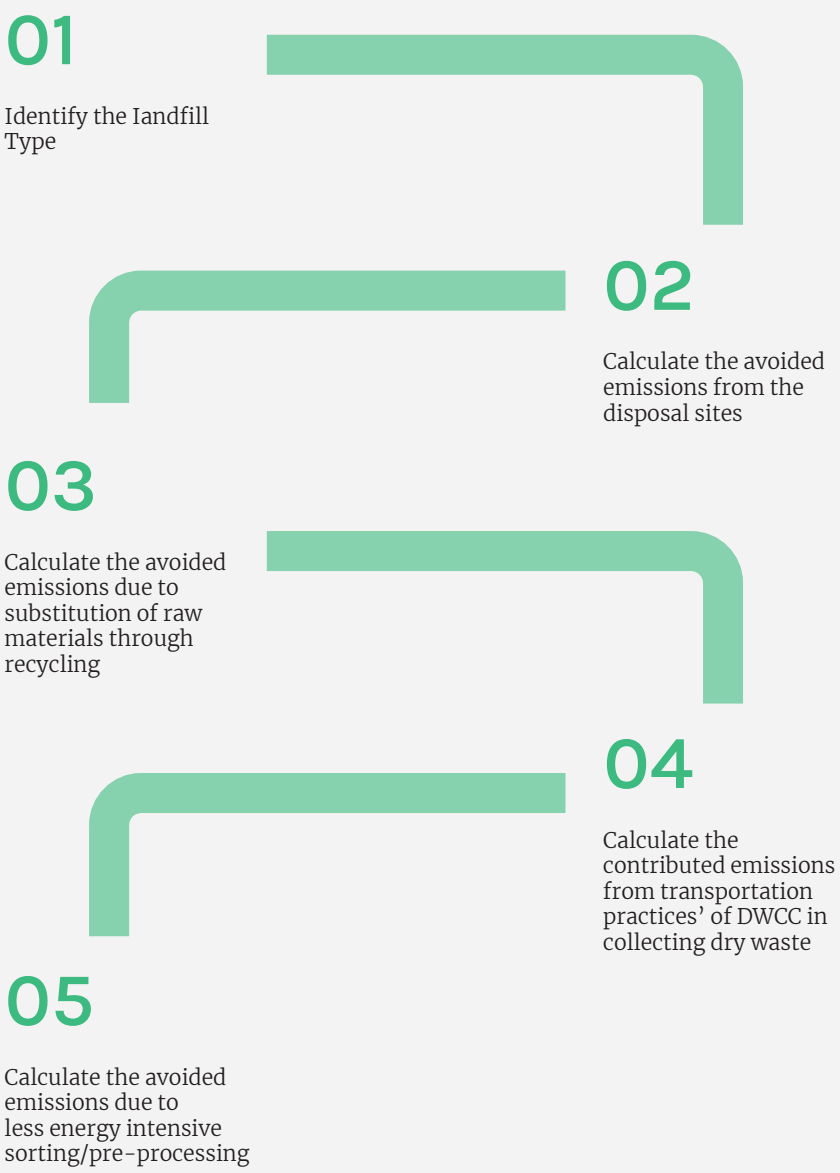
The dry waste collection centres use a different kind of categorization of plastics which is different from the tool. Hence, the study team conducted the pilot study to basically have a better understanding of percentages of different plastic categories. Readers who are interested in the pilot study can refer to the appendix(B) for more details.

Chapter 4: Data Processing and Calculations

4.1 Measuring the contribution of the DWCC Centers of Jayanagar Division in GHG Mitigation

4.1.1 Steps involved in calculating GHG mitigation for DWCC

The GHG Calculator 2.0 tool allows to calculate the GHG emissions from different sources and Thus, the steps of the calculation are divided into five:



4.1.2 Step 1

Identify the landfill type

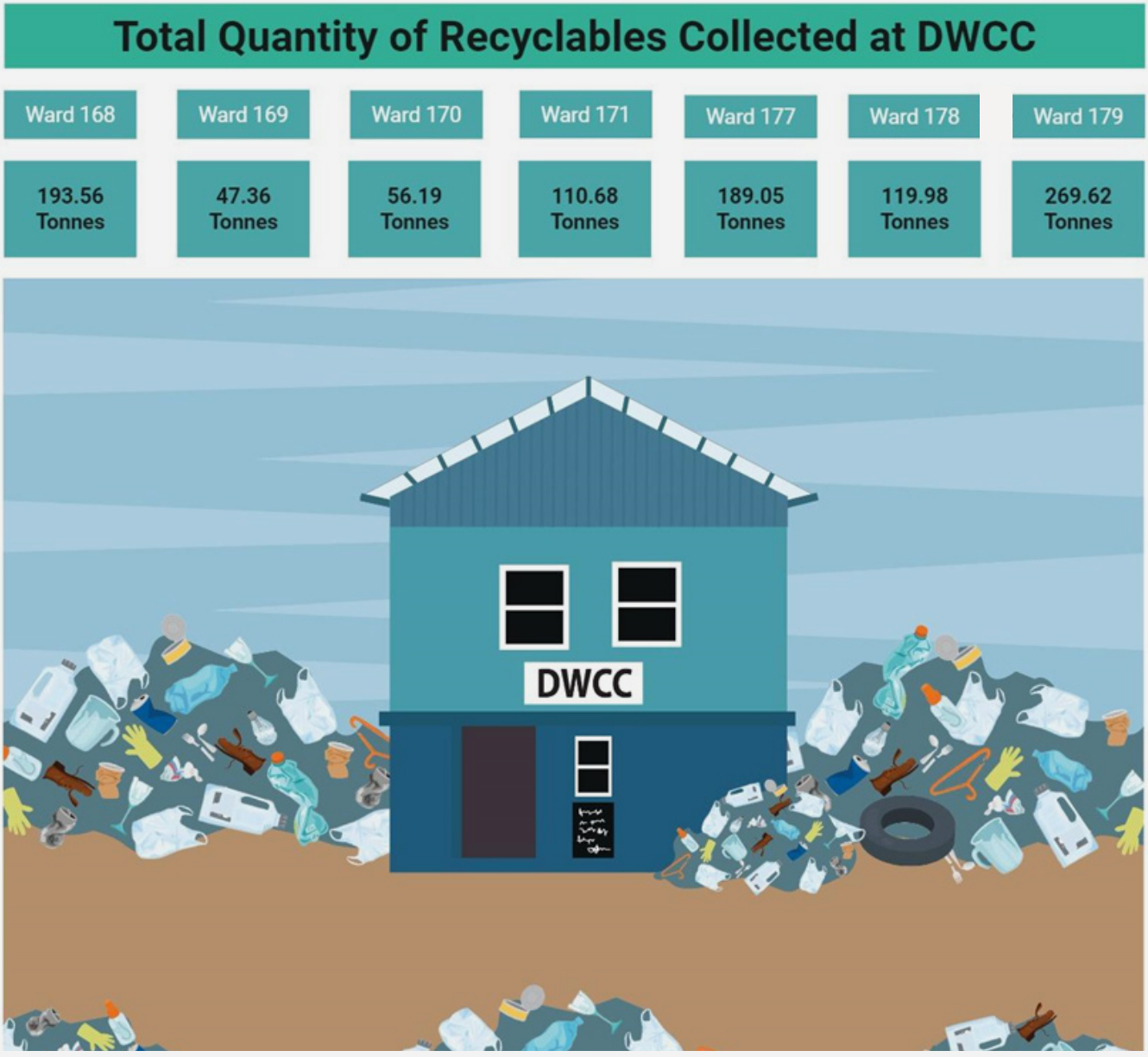
The Mixed waste from the Jayanagar division goes to Mittaganahalli landfill, which meets the category of Unmanaged deep (>5m) type. Unmanaged deep (>5m) type is a solid waste disposal sites lack the specification of a managed site and have depths of greater than or equal to 5 metres and/or high water table at near ground level.

Photo Credit: K. MURALI KUMAR
(https://www.thehindu.com/news/cities/bangalore/bengalurus-trash-is-no-mans-treasure/article66119445.ece)

4.1.3 Step 2

Calculate the avoided emissions from the disposal sites

Data needed: Amount of Recyclable dry waste collected at DWCC of Jayanagar Division in the year 2022:



Description:

The total quantity of waste sent for recycling to different aggregators and manufacturers from January 2022 to December 2022 was collected from the 7 DWCC centres. Thus, the recyclables are Paper and Cardboard, Glass, High value plastic, Low Value plastic, Multi-Layered plastic (MLP), Thermocol, Tetra Pack and metal, whose total quantity is 978 Tonnes.

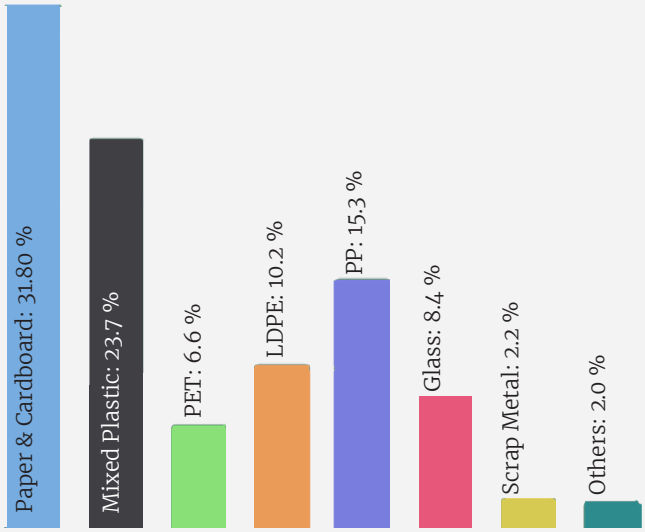
GHG mitigated:

The amount of Greenhouse Gas mitigated by diverting the recyclable dry waste from the disposal site is 928 tonnes Co2 equivalent/year.

4.1.4 Step 3

Calculate the avoided emissions due to substitution of virgin raw materials through recycling (i.e) dry waste sent for recycling from DWCC after sorting.

Data needed: Percentage of the Types of dry waste sent for recycling from DWCC



Description:

In Dry waste collection centres of Bengaluru, the recyclable dry waste are categorised as: Paper & Cardboard, Metal, High value plastic, Low value plastic, Tetrapack, Thermocol, and Glass. From certain centres, a little quantity of Multi-layered plastic (MLP) is sent for making MLP boards. The data team of Hasiru Dala records all such data points.

GHG Mitigated:

Substitution of virgin Raw materials through recycling 876 Tonnes Co2 equivalent/ year.

4.1.5 Step 4

Calculate the Avoided/ Contributed emissions from transportation

Data needed: Transportation practices of dry waste collection centres

Description:

Jayanagar division has 7 wards and 16 vehicles are used to collect the Dry waste from the households daily. Most used vehicle is the TATA Ace which has a dry waste volume of 0.5 tonnes. Almost all vehicles are Diesel engines, except one vehicle at ward 169, which is a CNG vehicle.

GHG emitted:

After entering the necessary data in the calculator, the GHG emission because of the motorised transport practices by the DWCC is 64.98 Tonnes Co2 equivalent/ year.

4.1.6 Step 5

Calculate the avoided emissions due to less energy intensive sorting/ pre-processing

Data needed: Sorting practices of the Dry waste collection centres

Description:

DWCC Centers in the Jayanagar division do not use any energy consuming sorting methods for sorting the dry waste. The operator of the centre employs workers to sort the waste manually by hand, creating livelihood opportunities. Currently, there are 67 waste pickers works in the DWCC centres across Jayanagar division. Out of which, 36 are men and 31 are women.

GHG Mitigated:

The GHG emissions saved through waste picker intervention by adopting manual sorting practices is 3.39 Tonnes Co2 equivalent/ year.

4.1.7 Total Contribution of DWCC towards GHG mitigation:

In this study, Hasiru Dala applied the WIEGO GHG Calculator 2.0 tool to calculate the contribution of the 7 Dry Waste Collection Centres as a pilot, and calculated the GHG savings to be 1,743 tonnes per year. DWCCs saved GHG emissions in 3 main ways: By diverting waste from landfill,, Substitution of virgin raw materials through recycling, and less energy intensive recycling value chain i.e. Manual sorting of the dry waste. This was made possible due to the integration of the waste pickers in the management of the DWCCs by the BBMP, the ULB of Bengaluru. As the city recognised the role played by the waste pickers in the decentralised management of the MSW and leveraged their skills and knowledge in resource recovery to improve the recycling levels.

JP Nagar (Ward 177) , Dry waste collection centre

4.2 *Additional Practises in Ward 177 Mitigating Greenhouse Gas*

In addition to its regular functioning, the DWCC in Ward 177 has been piloting some interventions to handle other streams.. This Chapter talks about two such existing models/programmes which helps in reducing the Greenhouse Gas emissions.

4.2.1 Case Study 1: GHG mitigation Impact of Textile Project from DWCC in ward 177

Textile waste releases toxins and it takes years to decompose. Hasiru Dala was able to identify gaps in textile waste management concerning textile waste dumping in landfills. In 2018, Hasiru Dala noticed that almost all textile waste given to the dry waste collection system could be repaired or reused if collected separately, preventing it from ending up in landfills and open dumpsites (Hasiru Dala, 2018).

The project leverages the existing Dry Waste Collection Centers and their connection with the citizens in the ward.n. It is carried out by establishing a separate collection and sorting system for textiles, rather than collecting it with the daily dry waste in order to obtain better quality textiles/old clothes that are relatively clean. Next, Clothes are collected and sold to second-hand buyers(as part of the initiative alternate livelihood of waste pickers) which will be some 8-10 % of the collection while 70% goes for recycling.In addition, it provides employment to a new group who are working in collection, segregation, repair and management of these textiles. Collecting it frequently in large quantities, will also help us talk to recyclers and cloth aggregators to take the non-reusable clothes.

Methodology

- The Study team used the GHG Emissions Calculator 2.0 for calculating the GHG mitigation.
- The required data points for the last year 2022 was collected from the Textile team of Hasiru Dala.
- In the last year 2022, the Dry waste collection centre in ward 177 collected 7.8 MT of textile waste in less than seven months, diverting it from reaching the landfill.
- This collection was done from residential areas as door to door collection from 15000 households in the 177 wards. Around 1585 kgs of textile waste was again sent back to market for reuse in the second hand market.

Findings

In the year 2022, the textile waste management project through the operations of the DWCC at ward 177 was able to divert 7.8 MT of textile waste from reaching the landfills. This is equivalent to the mitigation of 17.11 tonnes CO_2 equivalent/year.

Kumudha, operator of JP Nagar (Ward 177) DWCC

4.2.2 Case Study 2: Effectiveness of Lane Compostors in GHG mitigation in Ward 177

Hasiru Dala piloted the Zero Waste Initiative in Ward 177. Zero waste is a concept of processing the wet waste and dry waste within the ward itself, and only sending the reject and inert waste to appropriate co-processing units. The main objective of this concept is to reduce the amount of waste that ends up in the landfill and to promote the reuse and recycling of the waste.

As a part of this initiative, residents set up a lane composter to compost the wet waste from all 69 households on the lane. A small group called 'Women of Wisdom' (WoW) was identified to operate the lane compositing. A leaf litter composter was set-up in the ward as a part of the project, which has the capacity of 25 kilograms. In the first batch, 365 kilos of compost were harvested. Currently, the residents of the Ward 177 themselves run the programme and the wet waste generated from the households is being composted in the lane compostor.

Methodology

- The study team used the GHG Emissions Calculator 2.0 for calculating the GHG mitigation.
- The study team asked the members of WoW group to record the amount of wet waste put in for composting for a period of two months, since there were no mechanisms set up to collect the same
.
- The data was recorded for the months of February and March in 2023, whose average is 230 kilograms per month.

Findings

Through the data recorded from the pilot, we calculated the quantity of wet waste composted by the lane composter to be around 2.8 Tonnes/ year. This contributes to a GHG mitigation of about 3.03 Tonnes CO_2 equivalent/ Year.

Lane composter in Ward 177

Chapter 5: Findings

Findings

1,743

Tonnes CO2 equivalent/ year is mitigated by the 7 waste pickers' run Dry Waste Collection Centres in the Jayanagar Division of Bengaluru.

17.11

Tonnes CO2 equivalent/ Year is mitigated by the Textile project in the DWCC of Ward 177 of Bengaluru.

3.03

Tonnes CO2 equivalent/ Year is mitigated by the lane composter functioning in one of the streets of Ward 177 of Bengaluru as a part of a Zero Waste Initiative.

According to the United States Environmental Protection Agency's (EPA) Greenhouse Gas Equivalency Calculator this 1,763 tonnage is the equivalent of removing 392 passenger cars from the road per year[16]. This offset is a significant indicator of the contribution of the waste pickers and the decentralised model of solid waste management i.e the Dry Waste Collection Centres towards mitigating climate change.

Chapter 6: Conclusion

6.1 Way forward

Implementation of the Zero Waste system is an equitable approach to the climate crisis, especially when waste pickers are at the centre of it. The United Nations Intergovernmental Panel on Climate Change (IPCC), the world's leading scientific body on climate change says, "Prioritising equity, climate justice, social justice, inclusion and just transition processes can enable adaptation and ambitious mitigation actions and climate resilient development. For the first time ever, Hasiru Dala has identified and calculated greenhouse gas (GHG) abatement through interventions for the year 2022. Not only is HD working exclusively with vulnerable communities, but these very waste pickers are off-setting carbon emissions– benefiting the entire city of Bengaluru. In this paper, HD demonstrates the data for the first time. By collecting and segregating the recyclable materials from the dry waste, DWCCs and waste pickers help in preventing the volumes of waste that goes to landfills and thereby reduce the emission of methane. Simultaneously, the waste picker also contributes in recycling and substitution of virgin raw materials which is another important way to reduce GHG.

Zero Waste implementation is key to climate adaptation.

According to a 2021 paper from The Institute for Social and Economic Change, "Karnataka is one of the most vulnerable states to climate change...65% of sample households in four Karnataka districts were highly vulnerable, 30% moderately vulnerable and 5% were less vulnerable to climate change and weather related events. It was found that climate change affected the income and livelihood of the vulnerable groups on account of declining wage rates and rising food prices. Due to climate extreme events, monthly wage loss was estimated to be between Rs 10,000 to 15,000 on account of the loss of employment. Nearly 69% of the vulnerable households reported a rise of Rs. 500 to Rs. 1,250 in food prices after the climate change related disasters. About 65% needed emergency help to recover from vulnerability to climate change in Karnataka.[17] Adaptation outcomes are enhanced by increased support to regions and people with the highest vulnerability to climatic hazards. Integrating climate adaptation into social protection programs improves resilience." Thus, Zero Waste implementation and the inclusion of waste pickers are key to mitigating risks associated with the loss of employment and livelihood.

Zero Waste implementation has a huge potential in both diverting waste from landfill and preventing greenhouse gas emissions.

In India, around 70–90% of Municipal solid waste (MSW) generated is disposed of in open dumps or landfills (Kumar and Sharma 2014). The unscientific way of MSW disposal may cause air, soil and groundwater pollution. As per the Intergovernmental Panel on Climate Change (IPCC), 30% of the methane in the atmosphere is emitted from landfills. Karnataka is the seventh largest State in India and the total waste generated per day is around 8,825 tons and Bengaluru alone generates around 4,500 tons of MSW per day (EMPRI 2012). A major portion of the generated MSW is landfilled directly without any processing".[18]

Zero Waste implementation has a strong potential to divert waste from entering landfill. From our Study, it is found that roughly 2.5 tonnes/day of dry waste is collected at the Dry Waste Collection centres in the jayanagar division, diverting it from reaching the landfill.

Putting waste pickers at the centre of the solution allows for a significant reduction of greenhouse gas emission in the waste management sector by preventing and reducing waste from ending up in landfill.

This was the first time in HD's history that GHG abatement numbers were calculated, and given that the approach to data collection was new, HD has been conservative in its' estimates. However, given that the data collected was only from 7 DWCCs out of the 33 that HD operates, there the opportunity is large to implement more rigorous data collection methods. In Bengaluru, the physical and social infrastructure of Dry Waste Collection Centers (DWCC) contribute to both social and economic inclusion. At the same time, the decentralised system of DWCCs helps to capture the dry waste of a ward and manage most of it inside the ward. Landfills are the significant sources of methane, a potent greenhouse gas which is produced when dry and wet waste are mixed and decomposed.

6.2 Recommendations

- Investing in GHG emissions reduction infrastructure such as the DWCCs which incorporates the informal waste workers in the formal structure of Solid Waste Management is a cost-effective opportunity. The stakeholders and relevant sectoral actors involved in the SWM should demand that the ULBs and State Government expand the existing system by setting up Dry Waste Collection Centres in all the wards of Bengaluru, other ULBs as well as in the rural areas to gain benefits of climate change mitigation.

- As the DWCCs manage the Dry waste generated by the city, the ULBs should look into incentivising the upgradation of the physical infrastructure including provision of fire insurance for the DWCCs. This will not only ensure safe working conditions for the workers but also increases the efficiency and capacity of the centres for processing. This will ensure that the DWCCs can perform their role effectively for GHG mitigation at a decentralised level.

- Collecting accurate data on local landfills is vital especially in all the locations that HD has DWCCs. While the local authorities did speak with HD, it is very difficult to get specific data on landfill compositions. This study suggests that HD could collaborate with the Municipal Corporation to offer training to BBMP, local civic groups and waste pickers to implement better methods of data collections.

- Begin to publicly acknowledge the role of the waste worker in the GHG abatement and fully integrate them into the waste management system.

- Incorporate zero waste goals and policies into climate mitigation and adaptation plans.
- Advocacy campaigns should be done prioritising food waste prevention and single-use plastic bans.
- Both local and union governments should invest more in the waste management systems, recycling and composting capacity. They should also create the necessary institutional frameworks for zero waste including regulations, educational and outreach programs, and provide financial incentives through subsidies to recycling and composting.

6.3 Limitations

- Although this study has not incorporated the GHG emissions from the transportation of mixed waste because of various reasons, this study indicates that Zero Waste has a huge potential in minimising the GHG emissions from transportation of waste due to the nature of decentralised and short-ranged transportation required in a Zero Waste system."
- Although open burning is a significant source of GHG emissions, there was no data available for this variable. Hence, was not included in the calculation used in this study.
- As part of the Mixed Waste Audit a mixed waste vehicle was hired, thereby making it unavailable for service for the duration of the study (one day). The vehicle is otherwise used for collection of mixed municipal waste from the blackspots.

Appendices

Appendix A: Pilot Study for Mixed Waste

Objective
The objective of this pilot study is to understand the composition of mixed waste from ward 177.

Background and context
Hasiru Dala is researching to calculate greenhouse gas mitigation by the Dry waste collection centres. The tool called GHG Calculator 2.0 developed by WIEGO and Green Partners, RWA has been used. To substantiate more for the study, the composition of mixed waste that goes to landfill is required. Owing to the data limitation, the study team conducted the pilot study to understand the composition of mixed waste in one ward from the sample of 1 tonne.

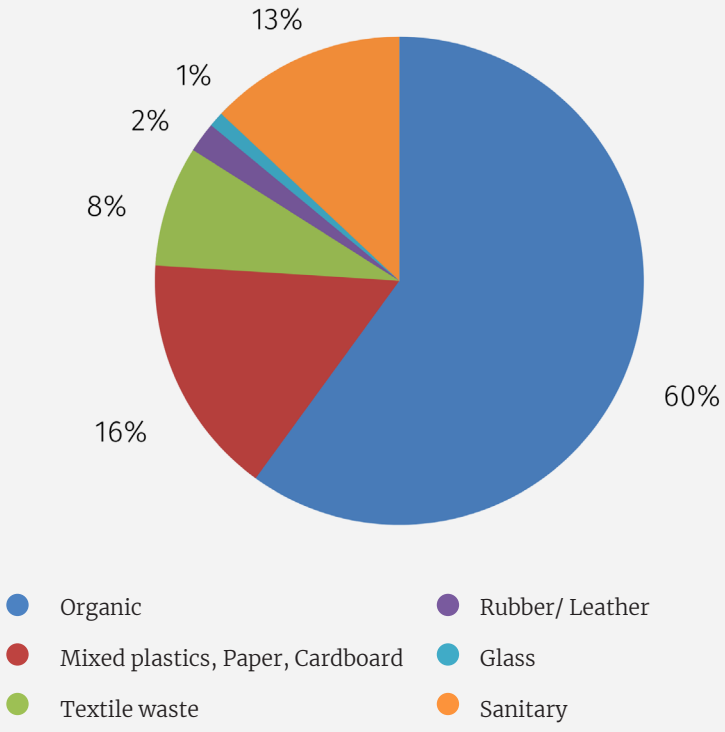
Methodology
Primary data Collection

Time Period
The study initially planned for three consecutive days from Feb 28, 2023. Unfortunately, this exercise happened for only one day as the workers showed severe hesitation towards sorting the mixed waste.

Quantity of waste taken for audit
500 Kilograms

Findings

Composition of the mixed waste



Challenges

The study stopped with the first day itself, as no workers came forward to sort the mixed waste which in itself is a finding to vouch stronger for the source segregation because when the waste gets mixed, it definitely ends up in the landfill.

Mixed waste collected from black spots for the study

Appendix B
Pilot Study for Dry Waste

Objective

The objective of this pilot study is to understand the percentage of plastic categories percent in the total quantity of the sorted dry waste.

Background and context

In Dry Waste Collection Centres of Bengaluru, the dry waste is categorised/sorted into following 13 categories/compositions: Reject, Sanitary, Paper & Cardboard, Metal, High value plastic, Low value plastic, Tetrapack, Thermocol, Textiles, Glass, E-Waste (Electrical Waste), Furniture, Others. DWCC centres have their own rationality in cumulating different materials into one category which might be dependent upon the market forces. For instance, the High value plastic category consists of materials such as toys, milk cover, bottles, drum, Nice cover, etc which comes under the different plastic categories LDPE, PP and HDPE.

Methodology

Primary data Collection

Time Period

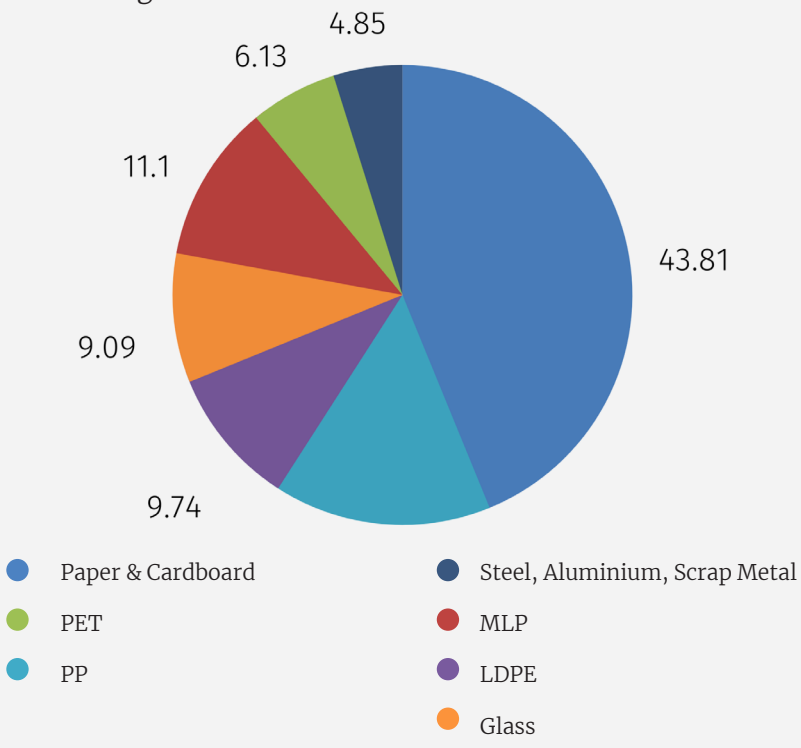
The study was conducted for three consecutive days from March 6 to March 8, 2023.

Quantity of waste taken for audit

The study was conducted for three consecutive days from March 6 to March 8, 2023. The frequency of the dry waste sorted is not controlled due to various reasons especially because of the availability of the waste sorters. Thus on the first day around 400 kilograms was sorted, correspondingly 1,100 kilograms and 500 kilograms in the next two days.

Findings

Dry Waste Categorization



Composition of the different Plastic categories

The tooL provides 5 options to input the plastic data. They are Mixed plastics, PET, HDPE, PVC, LDPE, PP. Additionally, it also mentioned in the manual that for a more comprehensive estimation of GHG emissions, data on the different subcategories of plastics is recommended. So, the study team used this pilot study data to understand the percentage of different types of plastics incoming in the dry waste collection centre.

Type of Waste	First day percentage	Second day percentage	Third day percentage	Average percentage
PET	8.07	5.79	6.13	6.6
LDPE	9.12	11.94	9.74	10.2
PP	14.56	12.38	15.28	14.1

The above pilot sets a mark to understand the percentage of plastic categories present in the High value and Low value plastic categories. Despite this, the study team also are aware that the sample size is very small to make any generalised statement for a year, also the composition of incoming waste is affected by several external factors such as season, area, time, etc. Nevertheless, considering the above percentage as the minimum value for each plastic category, which means, there is at least 6.6 percent of PET in the total plastics. Thus the percentage of different categories of dry waste in the Jayanagar division is calculated accordingly.

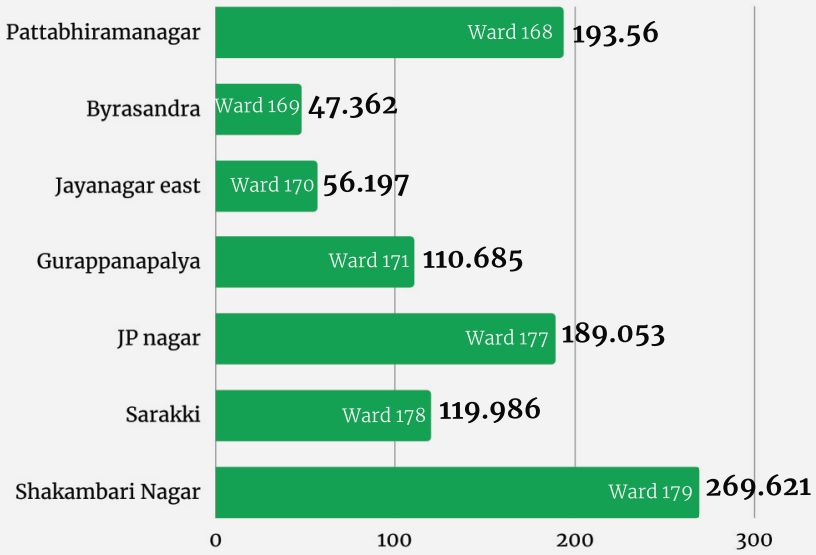
Dry Waste incoming

Worker's sorting

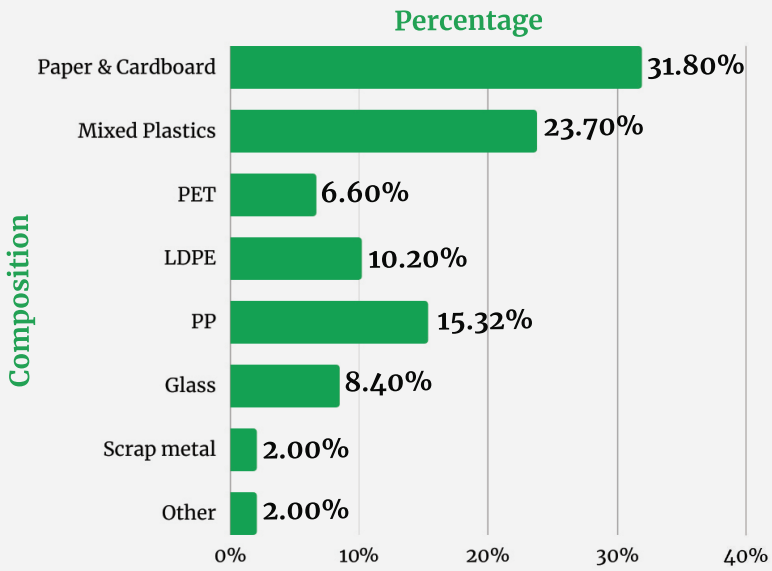
Weighing the sorted Dry waste

Appendix C
DWCC Dry Waste Data

I. Quantity of recyclable dry waste collected in the DWCC



II. Percentage of different categories of dry waste



Appendix D
Chronological Order of evolution of the DWCC

2011

- DWCCs established
- Public notice inviting NGOs & informal traders to manage DWCC.

2013

- NGO & Waste pickers were offered to operate DWCC. NGOs to pay Rs. 25,000 returnable deposit & wastepickers to deposit Rs. 5000 in 5 installments.
- BBMP signed MoU's with NGOs to manage DWCC.
- First triparted MoU with wastepickers (Kempama- Harichandra ward) & Hasiru Dala as third party to support DWCC operation.

2014

- Hasiru Dala provided probono technical support to BBMP & NGOs to implement the project of integration of waste pickers.

2016

- ULB obligation: Issuance of occupational Id & integrating waste pickers to operate decentralised waste management including door to door collection in SWM Rule 2016

2017

- Cancellation of all MoU's for DWCC & make tri-party agreement between BBMP, Wate pickers & NGOs (Resource Organisation) to hand hold waste pickers.
- Cotinuation of the work order for 4 more months.

2020

- Inclusion of Waste pickers in BBMP byelaws for door to door collection & to run dry waste collection centre.

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