INCLUSIVE HOUSEHOLD WASTE MANAGEMENT SOLUTIONS IN CONAKRY, GUINEA

MASTER OF SCIENCE IN SUSTAINABILITY MANAGEMENT
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EXECUTIVE SUMMARY

The Columbia University 2019 Spring Capstone team is pleased to present UNDP Guinea the following report on our work identifying sustainable waste management solutions for Conakry, Guinea.

Waste management in Conakry requires a multi-sectoral approach. Because it is a coastal city, improper waste management threatens its fishing industry, can exacerbate flooding, and increases potential spread of disease leading to long-term human, social, and economic concerns. Innovative solutions can derive value from waste, addressing the fact that women and youth are underemployed in Conakry, and often excluded from economic opportunity building. Sustainable solutions to waste management provide an opportunity to address these issues simultaneously.

Unlike other utility services such as water and electricity, municipal waste management in Conakry is decentralized and lacks infrastructural and administrative capacity. There is no coordinated federal government oversight, but rather piecemeal approaches from different branches. Each of the city's five municipalities manages waste management from its total operating budget, depending on how it sees fit.[1] As a result, public, private, and informal actors all play a role in waste management, but often without coordination. Privately contracted waste collectors pick up garbage from households and transport it to collection points via carts. Informal waste pickers salvage the most valuable materials to sell. Next, publicly operated garbage trucks haul trash from collection points to overflowing landfills, but often sporadically. Municipalities lack the funds to fuel trucks, capacity to run enough trucks, and locations for appropriate waste collection. The city's central landfill is well above capacity.

Conakry's waste situation will become more acute as population grows. The population has increased 150% in the past decade, while urbanization has grown 3.5% annually.[2,3] UNDP tasked us with finding innovative solutions to these problems.

To identify where our focus was best suited, our team took a research-based approach to understand the traditional approaches to waste management and the model in place in Conakry. We researched case studies covering four solution areas: centralized financing models, collection and sorting systems, artisanal value creation for non-organics, and community-scale value creation for organics. These covered

large and small scale, and top-down and bottom-up solutions.

To accurately depict the current situation, we assessed the organizations currently working to address waste management at varying levels and scales. These can be vital resources for UNDP to partner with for implementation of solutions, utilize organizations' existing data and work, or create a sustainable waste management working group to share resources and examples of success.

Given the existing challenges along the waste management chain, we decided the most valuable solutions we could put forth would be those that focused on diverting waste from the waste stream at or near its source, homes. Solutions located here can best involve women, who manage households, and youth, who would find employment near to the neighborhoods where they live.

We sought to address a few key areas:

- Collection and transportation are stymied by high fuel costs, equipment failure, traffic congestion, uncoordinated municipal oversight, and other variables.
- There are already vibrant markets for recyclables like metals and plastics, but waste is much more valuable when sorted at the source. Increasing sorting relies on incentivizing resident behavior change.
- Organic waste is the majority of Conakry's waste (by weight), so diverting this waste from the landfill represents a significant opportunity.
- Each alternative can create opportunities for women and youth. We considered this possibility for each suggestion we developed.

We have developed transparent models to estimate the capacity of the current system and cost of collection and how that capacity might translate to a waste fee. We added to that initial model a series of variable economic models for our proposed solutions: a mobile buyback program for recyclables, community cookers for organics and inorganics, and composting for organic waste. Community cookers and composting have physical land and social constraints, so we assumed each could deal with 1% of total waste by weight as a conservative and reachable target that can be scaled larger with the proper analysis tools. For the mobile buyback program, we assumed 20% of existing SMEs would add recycling to their operations and calculated potential waste diverted from that assumption. We recommend innovative applications of these solutions that engage multiple stakeholders in Conakry and create opportunities for women and youth. We used our tested diversion by each solution to determine a potential reduction in waste fee that could result. These models can be used to assess the funding needed for projects, as well as to justify these approaches to local governments.

Our findings point to next steps, which are also elaborated in this report.

We found other solutions that were promising but were not, for a variety of reasons, those we chose to highlight. This report includes case studies for those other innovative solutions which UNDP can explore further. Most notably, artisanal solutions provide the high value creation potential for post-consumer materials, as well as high-skilled jobs, which base material collection cannot. While we focused on solutions that diverted larger amounts of waste from landfill, recommendations for how artisanal solutions can be leveraged are included in the the report. We have also developed recommendations for spatial data analysis to better understand and scale application of our recommendations in Conakry.

We have structured this report as a toolkit to support UNDP's efforts to help build inclusive, sustainable waste management solutions in Conakry. Each chapter contains a different set of tools: an assessment of ways to approach waste management; economic models to understand system capacity, assess the costs and avoided costs of potential solutions; case studies for new, innovative solutions to waste management; and additional areas for further research. Each compliments one another, or can be viewed and used separately.

We hope our research will provide a solid foundation for UNDP's work in this area and want to thank UNDP again for this opportunity.

KEY TERMS & DEFINITIONS

ARTISANAL	Small-scale approach to waste management where waste, such as glass or plastic, is used to make products that can be sold in markets, like bags, jewelry, baskets, or others.
COLLECTION, SORTING, TRANSPORTATION	The stage of waste management in Conakry addressing one or more of the following activities: collecting unsorted waste from homes, sorting waste into valuable and not valuable materials, and transporting waste from home to collection points and landfill.
COLLECTION POINT	Predetermined locations that serves as an intermediary before waste is transported to the landfill. In Conakry, these are often overflowing and mini-landfills themselves.
COMMUNITY COOKERS	A stove that burns dried organic and non-organic waste, along with small amounts of water and recycled oil, in an environmentally controlled way to create heat and hot water.
COMPOSTING	The natural process of turning organic waste into nutrient-rich fertilizer or topsoil.
GEOGRAPHIC INFORMATION SYSTEM (GIS)	A framework for gathering, managing, and analyzing data, which analyzes spatial location and organizes layers of information into maps.
HOUSEHOLD WASTE	Garbage or waste produced by residents and collected at their homes.
MUNICIPALITY	Conakry consists of 5 municipalities: Kaloum, Dixinn, Ratoma, Matam, and Matoto, each with its own governing body.
ORGANIC WASTE	Material that is biodegradable and comes from either a plant or an animal.
SMALL-MEDIUM ENTERPRISES (SME)	Privately run businesses that collect waste from homes and transport them to the collection points for a monthly fee.
SOCIAL ENTERPRISE	A private company that uses traditional business practices to maximize improvements social or environmental well-being.
SPATIAL DATA	Data that uses geographic information to characterize features. It can be analyzed using GIS.
VERMICOMPOSTING	A method of composting organic matter using worms.
WASTESHED	Determined by a number of factors including population, density, and build composition, it signifies the amount and type of waste of a predetermined area.

ABOUT THE AUTHORS

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FOREWORD

Beginning in January 2019, our capstone team has studied the way household waste management, a difficult infrastructural challenge for all cities in the context of sustainability, plays out in the city of Conakry. To understand current conditions, we diagramed the information we received directly from UNDP and from other organizations in Conakry working on the problem; at the same time, we pursued research into alternative approaches that can transform waste into materials that are valuable through remanufacture, energy extraction or controlled decomposition. Recognizing that economic and social viability were limiting factors on any proposals for Conakry's waste infrastructure, we also collected case studies from comparable contexts and used those case studies to calculate cost and revenue for each alternative approach. Economic evaluation was not limited to alternative practices, however. We also calculated the volume, costs and bottlenecks in the current system to support ongoing efforts to fund waste collection at full capacity, ensuring that the city is free of the litter that clogs streets and storm sewers at present. The goal is to envision a system in which waste management is achieved in ways that are efficient, environmentally and materially appropriate and achievable at a cost that can be borne by households and government.

We also understand the complexity of UNDP's role in helping to address the problems at hand. As a partner and convener organization, UNDP will not be in a position of realizing directly any specific recommendation, but instead can locate itself in the gaps among organizations and individuals currently acting in the waste management sector to expose and support solutions for the important systemic disconnects that still exist. We hope that our work will offer UNDP the background information it requires, the references it can use to counter current misconceptions and the economic models it might need to move household waste collection in Conakry towards a functionality compatible with the city's reputation as "the Pearl of Africa."

We appreciate the opportunity to have collaborated with UNDP Guinea. Our thanks to the many organizations and people who supported our work appear at the beginning of this report, but we would like again to mention here our project contact Ousmane Bocoum.

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1:

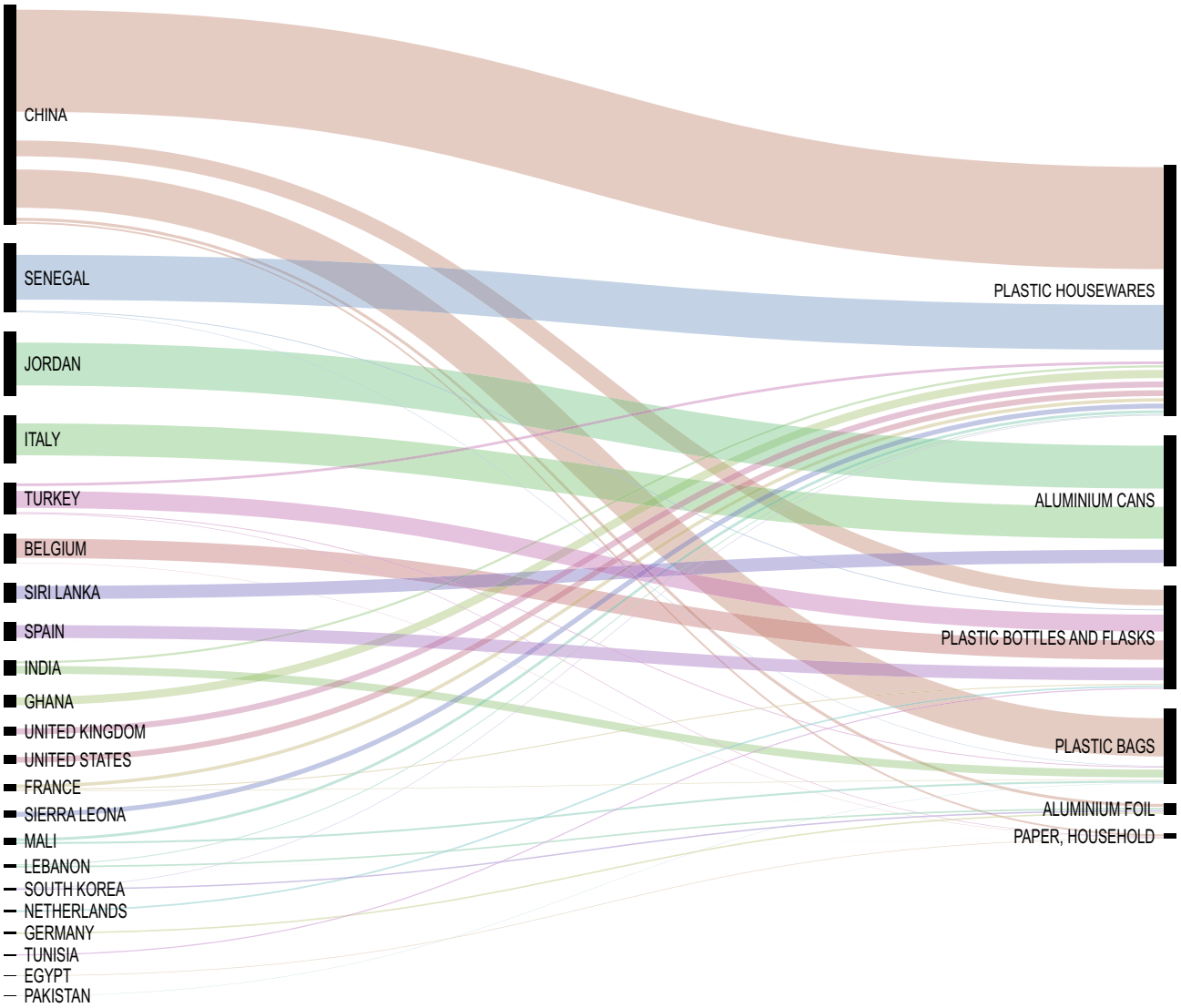
INTRODUCTION

Household waste management remains one of the most intractable problems of urban infrastructure. By virtue of their concentration on relatively small pieces of land, cities quickly outgrow the capacity of sites within their limits to absorb the ever-accruing waste of daily life. Inhabitants' daily need for food alone creates an enormous burden, even in a context where little processed food is consumed and frugality precludes food waste. With conventional economic development comes yet more household waste from plastic bags, bottled or packaged water, cans and other packaging. Each waste stream represents its own challenges and potential values. These generalizations also hold true in Conakry.

The city of Conakry, located on the Kaloum Peninsula, has grown in population from 1 million people in 1996 to over 2.1 million people[4]. This population growth, coupled with changes in consumer goods available and in how food is packaged and sold, has complicated its household waste management challenges. According to the République de Guinée Ministère de l'Administration du Territoire et de la Décentralisation, 0.4 kg of waste is produced per person per day, resulting in 25,388 tons of household waste per month[5] at present. As other pieces of infrastructure such as roadways, surface water management and open space management strain, so too does the waste collection system. As the African Union has spotlighted recently, the growing population of African nations such as Guinea can become a demographic dividend if the right investments are made in ensuring children's and young people's health, education and empowerment[6]. Building out such infrastructure as solid waste management is vital for future economic stability.

In addition to the stress of an ever-growing population, waste collection in Conakry also faces financial and governance challenges. Guinea's national GDP per capita in 2017 was $790 USD[7] but that number may be inflated by the value of the mining industry, whose financial gains may not trickle down to local populations. In the absence of governmental or municipal financing for solid waste management, individual households carry much of the burden for waste collection from households, often located on small, hard-to-access semi-paved or unpaved streets. The schism between waste collection at household scale and at city scale, the former dominated by small private entrepreneurs and the latter by government contracted companies, is one focus of this report.

Figure 1.1: Origins of Plastic and Aluminum Imported into Guinea



Plastic and metal packaging and consumer goods are increasingly part of Guinea's waste stream[8].

Unless action is taken, the prospects Unless action is taken, the prospects of Conakry will only worsen due to poor waste management that cannot keep up with the demographic trends. As cited above, rapid population growth has compounded the issue by increasing waste generation. This trend is likely to continue. Further, an increase in plastic imports, largely from China (as seen in Figure 1.1), had led to a boom in single-use plastic products, such as water sachets. The household waste generated by city residents has surpassed the city's ability to absorb it. Currently, the city's centrally located landfill, Concasseur, is filled to capacity and 40 official grouping points are themselves turning into mini landfills. This is a result of lack of municipal capacity, which includes both financial and administrative aspects. In conversations with the national agency that deals with waste, Agence Nationale de l'Assainissement et de la Salubrité Publique (ANASP) noted that its yearly budget of $185,000 is barely enough to cover salaries and overhead costs.

1.1:

PROBLEM AND OPPORTUNITY

THE PROBLEM

Conakry produces about 1,500 tons of waste per day and about 85% of this total comes from household waste. The models included in this study indicate that more than 22% of household waste is left unmanaged in the city, either abandoned on the streets by households unwilling to pay for collection or compounding at the official municipal waste collection points because government contracted haulers lack capacity or ability to move it to the city's landfill. There is nowhere for this waste to go, until the heavy rain that Conakry experiences for some six months of the year washes it off the streets and into storm drains, gulleys and, ultimately, into the bay that hosts Conakry's vitally important fishing industry.

The waste that collects in the city's stormwater gullies and ditches means increased flooding, especially during Conakry's rainy season. Surface water that has traditionally been part of the city's freshwater supply is polluted by plastic and other garbage. This pollution also increases the spread of diseases such as Cholera or Ebola.

The situation is equally difficult for those employed to remove waste. Waste collectors are often informally employed and not provided proper equipment to pick through or collect waste, increasing their susceptibility for vector-borne diseases, compromised respiratory health, dermatological conditions, and other public health issues. Trash is burned in open air at the city's landfill to recover materials, such as metals, that can be resold. This practice releases harmful toxins into the air, threatening the health of residents, as well as greenhouse gas emissions that lead to climate change.

Poor waste management also puts Conakry's economic development at risk. Weak public health leads to weaker opportunities for education, skills development and growth, threatening Conakry's human capital. Leaving household-scale waste collection unregulated and dependent upon individual willingness and ability to pay exacerbates polarized standards of living: in parts of the city where streets as well maintained, houses are less dense and inhabitants are wealthier, the streets are free of waste, but elsewhere in the city, where close proximity among buildings promotes faster disease spread, conditions are poor. Without proper municipal infrastructure, other economic development opportunities such as tourism or international business will remain elusive in Conakry.

THE OPPORTUNITY

If guided by a long-term vision for sustainability that includes alternative waste stream management practices, Conakry's household waste management problem could address several sustainable development issues: reduction of environmental and health issues caused by an overabundance of untreated waste such as flooding and the spread of disease; protection of existing economic sectors such as fishing; and new economic opportunities for women and youth who are marginalized in the existing job market. To capitalize on this opportunity, various stakeholders involved in household waste management must collaborate to find a multi-sectoral solution. The fact that small private businesses, including small-medium enterprises (SMEs); companies that depend upon post-consumer waste for the manufacture of their products, such

Street view from Conakry[10]

as Sodiaplast; and informal waste collectors have identified business opportunities in household waste management shows there is ample opportunity for further innovation to address the problem, either by deploying new approaches or operationalizing existing capacity in different ways.

Now is an opportune time for Guinea's public sector and international agencies like UNDP, to forge effective public-private partnerships in order to learn from the existing business models, strengthen public service capacity and promote knowledge exchange among those involved. ANASP, the government agency responsible for waste infrastructure, is near completion on an EU-partnered project. The Africa Cup of Nations will take place in Conakry in 2025, providing a specific date by which improvements must be made. At present, non-governmental aid actors as diverse as Enabel, the World Bank, the Islamic Development Bank, and OCPH – to name only a few whose work this report references – are all contributing expertise and resources to resolving Conakry's waste system. The landscape mapping portion of this report will provide an overview of these actors and their undertakings; there are opportunities even in this somewhat crowded field, many at the intersection of privately and publicly administered systems components. The area of alternate ways to capture value from waste – both organic and inorganic – is largely underrepresented in current undertakings and may offer another way in which UNDP Guinea can locate itself strategically to support change.

For the private sector, new innovative solutions should address safety standards, workers' rights protection, and ecosystem growth for various sizes and types of businesses. In addition to many other health hazards attributed to poor equipment, tetanus is not uncommon in those who work at collection points and landfills[9]. Further, there is social stigma associated with waste picking, although there are a number of success stories of people whose entrepreneurship in this area has improved their economic status. There are also numerous innovative, cost-efficient household waste management schemes that are being tested and implemented around the world, many of which do not carry either the stigmas or risks of waste picking.

To this end, UNDP and its partners can play a crucial role in assessing the trends of current practices and improving the operational landscape to become more sustainable, effective, and inclusive.

1.2:

PROJECT OBJECTIVE & STRATEGY

PROJECT OBJECTIVE

The United Nations Development Programme (UNDP) in Guinea has pledged to support Guinea's national sustainable development agenda that emphasizes youth and women's empowerment, biodiversity, coastal resilience, sustainable livelihoods, and urban development. Our team was tasked with providing UNDP with an understanding of household waste management issues in Conakry and providing initial recommendations for innovative waste management solutions that can be implemented into the current system. We structured our research to focus on solutions that add value to materials in the waste stream, and create economic opportunities for entrepreneurs, women, and youth through that value capture.

A woman collects waste materials at La Miniere Landfill in Conakry, April 2019[11].

PROJECT STRATEGY

Our project consisted of three phases: research, analysis, and deliverable development.

RESEARCH & CASE STUDIES

The first phase focused on assessing the household waste management system in Conakry to understand the current situation, roadblocks to success, and potential intervention areas. At the same time, our team researched successful waste management solutions at small- and large-scales in comparable cities to develop an array of options that could be applied to Conakry. Case studies were examined to understand their business model, government involvement, potential upfront costs from equipment or infrastructure requirements, and financial and social benefits. The case studies focused on five areas: large-scale integrated waste management; artisanal solutions; transportation, collection and sorting; waste-to-energy; and education. The case studies we reviewed can be found in Chapter 5 of this report.

Conversations with UNDP and other stakeholders identified through our research, helped us identify the variables limiting implementation of innovative solutions. Our research started out broad but we narrowed our focus areas as we understood what solutions were feasible in Conakry.

Halfway through our project, our academic advisor and two of our teammates travelled to Conakry to meet with organizations, government agencies and academics working on waste management. They helped the team to understand how many people are currently working on this issue and to narrow our focus even further. This information ensured the recommendations we provided to UNDP would not duplicate efforts that are already underway in Conakry. Our team's meetings allowed us to identify potential partners and resources for UNDP when considering our recommendations. An analysis of the current players and where UNDP's work is best suited can be found in Chapter 4 of this report.

ANALYSIS & ECONOMIC MODELING

Through our conversations with UNDP and stakeholders in Conakry, we identified three viable waste diversion solutions: a mobile buyback program integrated into the current SME system to incentivize waste sorting and recycling; community cookers to burn organic and inorganic waste to create heat and hot water; and composting to add value to organic waste. We used data available about these waste management solutions to build economic models outlining the potential costs, revenues, and waste diverted for each solution.

At the same time, we built a model of the current household waste management system in Conakry to understand capacity and costs at varying scales. These two sets of models helped us quantify the value of our proposed solutions based on potential waste diverted from landfill, which will save SMEs and municipalities money while creating additional social and economic benefits. More information on our economic models can be found in Chapter 3 of this report.

DELIVERABLE DEVELOPMENT

The team's findings are presented in three deliverables: this capstone report, our suite of economic models, and an appendix of base materials and back-up information. The final report outlines the team's findings and provides UNDP with research areas for future consideration. Our economic models serve as a tool for UNDP to assess the viability, added value, and financial sustainability of each. Based on our overview of the concept note format used internally by UNDP, we have formatted our findings to serve as a basis for concept note development, should UNDP pursue our recommendations.

The recommendations put forth in this report are not meant to be exhaustive, but rather should be seen as a starting point for additional research and feasibility testing for application in Conakry.

2: APPROACHES TO WASTE MANAGEMENT

EXISTING APPROACH TO WASTE MANAGEMENT IN CONAKRY

Conakry's existing system of waste management is fragmented and largely dysfunctional. It is divided into two segments of waste collection that are paid for and administered by separate parties, as illustrated in Figure 2.1[12]. Household waste is collected door-to-door by Small Medium Enterprises (SMEs) that are privately run and use hand carts to transport waste from households to collection points throughout Conakry. SMEs finance their operations through monthly waste collection fees paid for by individual households that can afford their services.

From collection points, garbage trucks haul waste to Conakry's landfill, which is overflowing. The second part of the system is by and large run and operated by Conakry's five separate municipalities. However, we know that some SMEs and organizations operate their own trucks as well.

Both of these systems are currently undersized, and underfunded. With households unable to afford waste collection, SMEs are unable to scale to collect all of the household waste produced. As a result, each month a portion of the waste is not collected and is left behind on streets. Additionally, due to lack of funding at the municipal level, garbage truck collection is irregular, leaving waste at collection points. This is compounded by a lack of road infrastructure that strands waste at collection points, many of which are becoming their own miniature landfills.

The current system, in addition to capacity and funding issues, relies largely on a linear approach to waste management, in which all waste is treated as valueless through the system and sent to landfill. Private companies like SMEs or manufacturers using recyclable material such as Sodiaplast, as well as informal waste pickers who pick and sell waste that can be sold on a secondary market are the exceptions.

Figure 2.1: Depiction of Conakry's Current Waste Collection System

Internally developed by team member Rafaela Behrens based on research and conversations with stakeholders.

RECOMMENDED APPROACHES TO WASTE MANAGEMENT

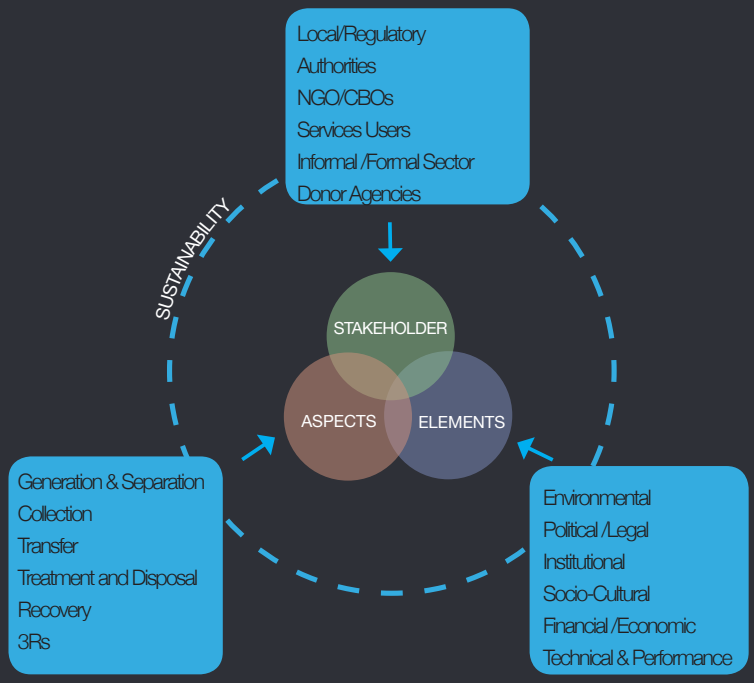
An integrated waste management approach, which focuses on reducing waste from the onset and adding value to waste through reuse, recycling, and recovery, is much needed in Conakry. While many organizations are working on waste management in Conakry, few are focused on the intersection between the two parts of the system, where such an integrated approach might be implemented. Given UNDP's role in creating systemic change through partnerships, our recommendations throughout this report are focused on this intersection.

Our recommendations borrow elements from two accepted approaches: **a waste hierarchy** and an **Integrated Solid Waste Management (ISWM)**. A waste hierarchy evaluates the most and least favorable actions in waste management while aiming to protect the environment and consumption of resources, as seen in Figure 2.2 Additionally, an Integrated Solid Waste Management system incorporates both public and private stakeholders, as seen in Figure 2.3. Both approaches advocate to limit the amount of waste sent to landfill, and to keep waste in landfill once it is there. Our waste diversion solutions outlined in Chapter 3 can remove waste from the stream before it is transported to collection points, decreasing strain on the system. These solutions will also create economic opportunities and improve the health of the community and environment by reducing the waste stream. Additionally, our system-wide economic modeling (also outlined in Chapter 3) addresses system capacity building to sustain the remaining waste that is sent to landfill.

With waste management and collection services largely underfunded and understaffed, the incorporation of private stakeholders has proven to be successful in other cities similar to Conakry. In Conakry, we propose this private sector capacity take the form of the following waste diversion solutions:

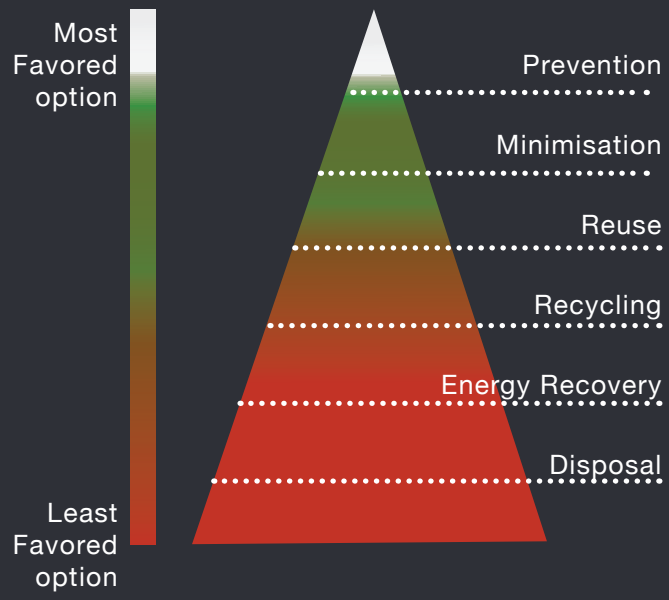
A mobile buyback program to increase profits for SMEs by selling these products directly to recyclers, adding value to waste and diverting it from landfill.

Figure 2.3 Integrated Solid Waste Management Framework Diagrama



An Integrated Solid Waste Management (ISWM) system incorporates both public and private stakeholders.[13]

Figure 2.2 Pyramid of Waste Hierarchy



A waste hierarchy evaluates the most and least favorable actions in waste management.[14]

Community Cookers to produce energy, heat, and hot water used for cooking through the environmentally controlled burning of organic and inorganic waste. Food produced through this process can be sold for a profit by women or youth groups.

Composting to turn organic waste into a product that can be sold on secondary markets.

These approaches would add value to Conakry's waste through reuse and recycling while reducing the amount of waste entering the waste stream. The secondary markets created would add value and generate jobs while incorporating women and youth by developing skill sets such as cooking and small-scale post-consumer waste quality control. We outline in the following chapters how these approaches can be applied to Conakry and how UNDP can serve as a convener between the public and private sectors to ensure successful implementation of innovative waste management solutions.

3:

ECONOMIC MODELS

Once our team identified three waste diversion solutions best suited for Conakry, a mobile buyback program, composting, and community cookers, we sought to understand their potential impact on the current system. Using data from the research phase of our project, our team built an economic model of the current system to understand the main drivers of capacity under various scenarios, as well as models of our three proposed solutions to understand potential project scaling, costs, and revenues. Through this process, we observed a lack of consistent quantitative data on the two distinct parts of the waste management system in Conakry. We explain throughout this chapter how we built our models,both of the current system and of our waste diversion solutions, and how UNDP can use and change them with updated data.

3.1:
ECONOMIC MODEL OF CURRENT AND OPTIMAL SYSTEM IN CONAKRY

Given Guinea's goal of collecting 90% of all household waste by 2020, as outlined in the Plan National de Développement Economique et Social, our team sought to understand the constraints of the current system and how this goal could be reached through capacity building, waste diversion, and a proper waste collection fee.[15]

Our models address the aforementioned issues our team identified in the current waste management system to help UNDP understand roadblocks and opportunities for new waste management solutions. We also provide recommendations for issues that could not be solved through our models.

QUALITY OF DATA ON WASTE MANAGEMENT

From our research, conversations with experts, and trip to Conakry, we found inconsistent data on the composition of waste, the amount of waste produced, and the waste management system in Conakry, making it difficult to accurately analyze the situation and potential solutions. For example, the reported total daily amount of waste produced in Conakry varies from 0.4 kg/capita to 0.75 kg/capita, based on the reports by ANASP and OCPH respectively.[16] The difference between these two numbers spans an 87.5% range, which can create two very different baseline scenarios in our economic modeling. Our model assumes 0.40 kg/capita.[17] Multiplied by the current population of Conakry, this waste production amounts to 25,338 tons per month.

Currently, on average, 19,848 tons of household waste is collected each month by SMEs in Conakry,[18] which is 78% of the 25,338 tons total monthly waste produced , as cited in ANASP's waste production data. However, the specific collection rate at different stages of waste collection, from household to collection point and from collection point to landfills, has not been monitored or tracked. Additionally, as observed on our trip to Conakry, collection rates at

collection points vary based on access to major roads and other factors. Without measurement of these different factors, it is hard for the city and SMEs to learn how and where to improve the waste collection process.

Given the limitations of the existing data, government agencies and organizations working on waste management are hesitant to analyze it. However, this further limits the amount of analysis available about the waste situation and how the current system is addressing it. As academic partners, our team had greater flexibility in cross-referencing data from various sources, as well as making reliable assumptions based on research of comparable cities. We recommend updating our models with credible data from Conakry once available. However, our models serve as a good starting point to understand system capacities and constraints and provide the tools to assess various solutions.

DESIGNING A WASTE FEE

Waste collection fees from households are the main income for Conakry's SMEs, so calculating an adequate waste fee is crucial to covering the system's costs of operation. However, SMEs in Conakry have not developed a consistent and reliable way to calculate their monthly collection fees. Organizations we spoke with, including UNDP and OCPH, reported different waste fees ranging from $2 to $3 per household and the variables that make up their calculations are opaque. Because SMEs manage the first half of the waste management system in Conakry, calculating an adequate waste fee will ensure cost recovery so that SMEs' businesses can increase revenue, achieve financial sustainability, and grow to better handle growing waste production. According to OCPH, increasing SMEs' profitability is an important goal that had not been fully reached in 2018.

WASTE FEE COLLECTION

In most cases, SMEs in Conakry collect waste fees on a door-to-door basis and in cash. This informal way of collecting fees, though preferred by many subscribed households, causes an inefficient system for SMEs and the city. This issue is not uncommon in regions similar to Conakry. In Dar es Salaam (DES), Tanzania, the majority of households self-reported that they paid their waste fee to their local service providers, but those service providers often complained about inefficient fee collections, including overdue and insufficient payments[19]. In fact, service charge is one of the main challenges in the waste management sector, especially in low and middle income countries.[20]

There are two ways to improve the current system. First, frequent and engaging communications between SMEs, households and government agencies tailored to local cultures and contexts have proven effective in increasing fee collection. For example, holding regular community meetings between households and waste management contractors to discuss waste collection service design in a low-income area in DES increased the fee collection by 20%.[21] Building and maintaining a positive relationship between SMEs and their customers is crucial to sustaining the profitability of SMEs and improving their services. In Conakry, although there are informal conversations between communities and SMEs, communications can be strengthened through formal meetings. Household surveys can help SMEs and capacity building organizations like OCPH and UNDP to understand why residents are not reliably paying their waste fees, answer questions about the fees or collection services, and arrive at motivations for increasing their payments. By addressing this challenge, both SMEs and their subscribers will benefit from a higher level of transparency about waste collection fees.

Secondly, collecting the waste fee through more reliable ways, instead of cash, is the next step to solve the challenge of low-efficiency fee collection. For example, Maputo, another comparable city, has started to charge a waste collection fee through electricity bills. By introducing the combined payment system, the city now has a wide and efficient waste management system. It also associates the waste fee with electricity consumption, which is a good design for a progressive solution which sizes the fee to household capacity to pay. Details on Maputo's successful integrated waste fee system is detailed further in Chapter 5 of this report.

Phone service booths that be potentially used for collecting combined payment of waste collection and phone bill in Conakry[22]

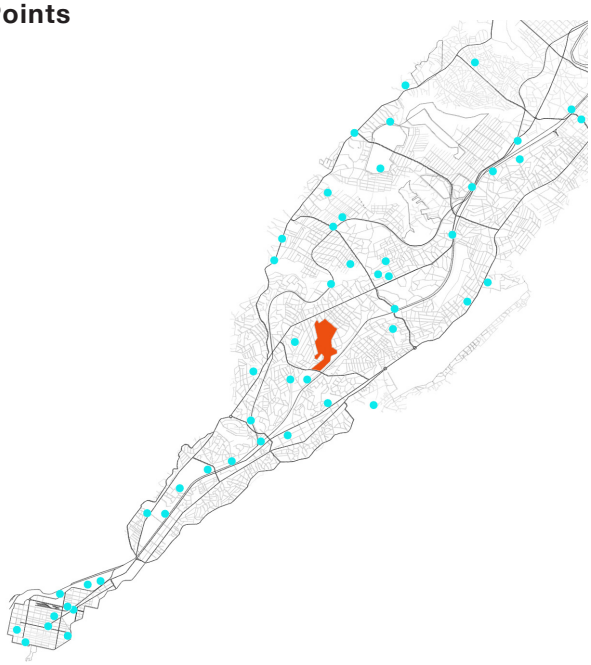
TRANSPORTATION AND INFRASTRUCTURE LIMITATIONS

The current transportation system in Conakry is inadequate for high-capacity garbage trucks transporting waste from collection points to landfills. Many roads, especially within neighborhoods, are unpaved and narrow, so only carts or bicycles can navigate them to collect trash from households and move them to collection points. This infrastructure challenge has created the need for SMEs to operate the first half of the waste management system, and it results in high labor costs from the reliance on low-efficiency vehicles. Additionally, similar road infrastructure limitations near collection points has resulted in the inability for trucks to collect waste to haul it to the landfill. This situation has led to some collection points becoming small-scale landfills themselves. Additionally, the cost of purchasing and maintaining a fleet of garbage trucks can be costly. We address the costs of transporting waste by truck later in this section.

ECONOMIC MODEL OF CONAKRY'S WASTE MANAGEMENT SYSTEM

The economic model our team developed examines three scenarios: the current waste management system, a system in which 100% of waste is collected from homes and at collection points with all making it to landfill, and a fully optimized system in which 100% of waste is collected but a percentage of that waste is diverted from the system before it is collected, as described in our solutions report sections later in this chapter. The model calculates the capacity of each system (or waste serviced), truckloads and cartloads necessary to service this waste, overall system cost and the household collection fee required to sustain the system. While current cost breakdowns and the cost recovery rate for SMEs are mostly unknown, this model serves as a starting point to understand how SMEs can achieve full cost recovery. With more accurate and detailed data on the costs of SME operations, the model can become more useful.

Figure 3.1.1: Conakry Landfill and Collection Points



A map designed by our team member Geoffrey von Zastrow shows Conakry's current landfill, La Miniere, in and the city's collection points as blue dots[28] .

GENERAL ASSUMPTIONS AND BENCHMARKS

The key assumptions and benchmarks used in all our economic models are listed as follows:

POPULATION AND POPULATION GROWTH

The total number of inhabitants of Conakry was estimated at 2,000,000 in 2017,[23] with a yearly growth rate of 2.75%. As our models seek to explain the current and optimized household waste management system of Conakry in 2019, we used the 2017 population and the growth rate of 2.75%[24] per year to estimate a 2019 population of 2,111,512. We then used this number to estimate the number of households in Conakry, by assuming seven people are in each household based on household composition data from the UN.[25] We estimated the total household waste production per month from these numbers.

NUMBER OF PEOPLE PER HOUSEHOLD

Dividing our estimated population with the average number of people per household, seven, gives us the number of households in Conakry, amounting to 301,645. Estimating the number of households in Conakry allowed us to design a monthly household waste collection fee.

TOTAL HOUSEHOLD WASTE PRODUCTION

We calculated the total amount of household waste produced by multiplying 0.4 kg of waste per capita per day[26] by the population and an average of 30 days per month. This provided a total of 25,338.15 tons per month.

CURRENT WASTE COLLECTION

To understand the current collection capacity of the system, we calculated the amount of waste collected based on monthly collection rates at the landfill La Miniere. In 2017, the landfill collected 238,176 metric tons of waste.[27] Assuming the same collection rate each month of the year, we calculated a monthly collection of 19,848 metric tons and a corresponding collection rate of 78.33%. This number is slightly inflated compared to other rates presented in literature specific to Conakry, but this can be explained by other factors of the model, such as our assumption of 0.4 kg per capita per day of waste production, and our assumption that no waste is left behind at collection points.

ASSUMPTIONS AND BENCHMARKS FOR THE CAPACITY MODEL

VEHICLE (CARTS AND TRUCKS) CAPACITY

To model the capacity of the current system, we estimated the capacity of two types of vehicles used in the system. Carts are used by SMEs to collect and transfer waste from households to collection points while trucks are used to transfer trash from collection points to landfills. In our models, we assumed the capacity of one truck load and one cart load to be 18 tons[29] and 250 kilograms,[30] respectively.

OPERATION AND TRANSPORT COST

Estimating the cost of the household waste management system in Conakry was a challenging exercise. As mentioned above, Conakry has a household waste management system that is split into two segments: collection by SMEs (by carts) from households and transportation by municipalities

(by trucks) to landfill, separated by collection points. The SMEs are given specific zones to operate in, and are themselves responsible for collecting the waste fee necessary to cover their costs. As we assumed the same equipment, such as 250 kg capacity carts, for all SMEs in Conakry, we could also assume the same cost per ton of waste collection. Our estimated cost of waste collection is retrieved from a case study of Maputo, Mozambique, amounting to $22.5 per ton,[31] which is an average of the range given in this study. It is important to note that this is only representative of the cost of SME collection from households, with costs of truck transportation assumed to be covered by municipalities.

RESULTS

In our baseline model, we estimate the daily cart loads and truck loads needed to sustain an average collection of 19,848 metric tons per month, reflecting the existing system in Conakry. With the assumptions listed above, we find that sustaining the current capacity requires 2,646.40 cartloads per day and 36.76 truckloads per day. In order to cover the cost of this capacity, the SMEs would have to charge a flat waste fee of $1.48 per month.

In our optimal model, which examines 100% of waste collected and 1,532.48 metric tons diverted from landfill, we find that 3,174.09 truck loads and 44.08 cart loads are needed to achieve an optimal system. With increasing collection, the SMEs will have to charge a flat waste fee of $1.78 per month. This fee will be 5.82% lower than the waste fee charged without any waste diversion, which is $1.89 per month. In other words, our solutions on waste diversion will add value to the system by reducing the waste collection costs for both households and SMEs. Our optimal result includes three primary diversion strategies, which have also been modeled separately for their economic viability. More on these strategies, how they were modeled and their potential for expansion may be found in the following three sections of this chapter.

Figure 3.1.2: Sankey Diagram of Waste Flows in Conakry with Diversion Solutions in Place

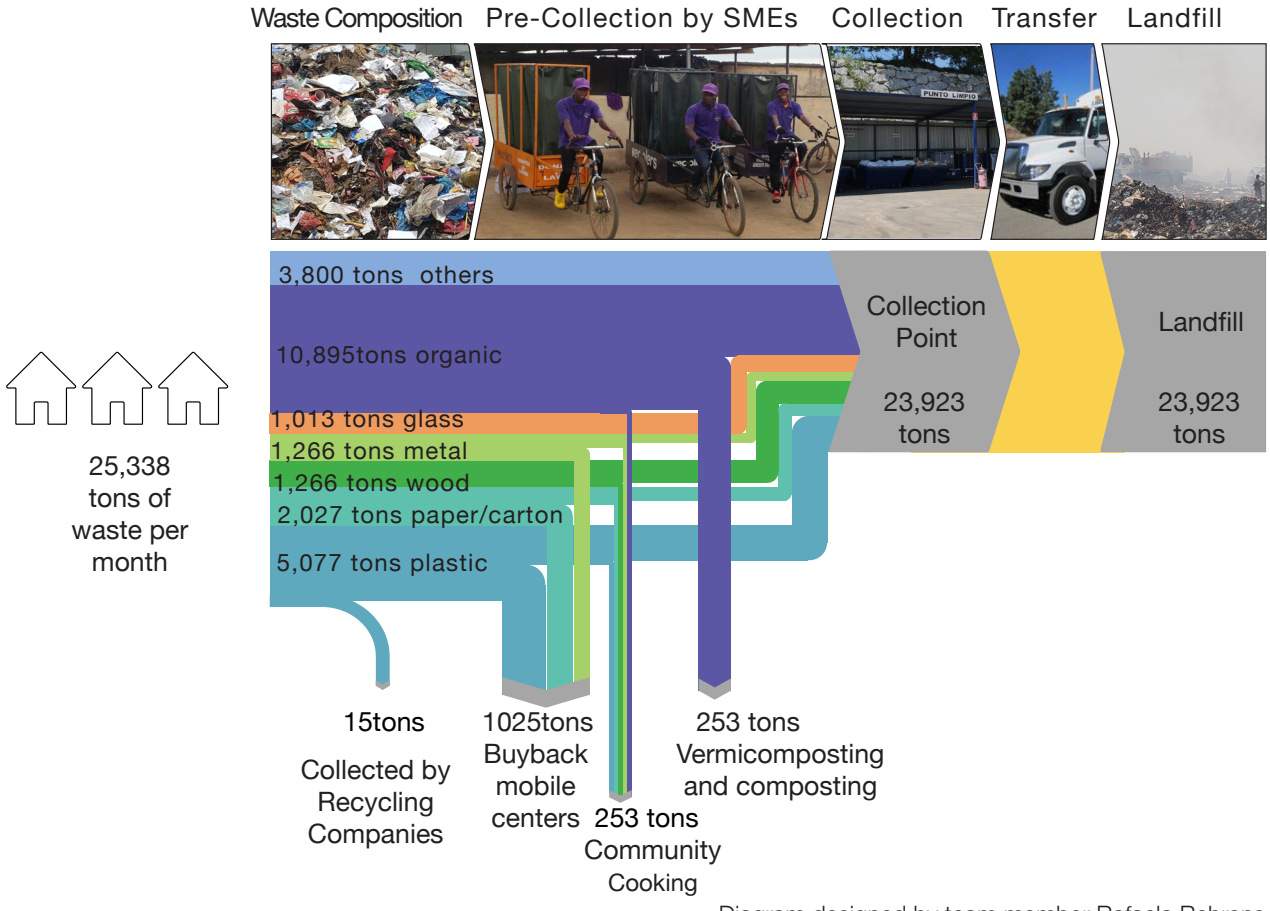


Diagram designed by team member Rafaela Behrens

HOW TO USE THE SYSTEM MODEL TO CALCULATE OPTIMAL CAPACITY AND APPROPRIATE WASTE FEE

We want to ensure our system model can be used once improved data becomes available, so we've included a step-by-step explanation of how to use the model.

First, to calculate optimal system capacity, include available data and informed assumptions in the first tab, titled "Assumptions". On the second tab, calculate the capacity of the optimal scenario. The following cell references are linked to our "no solution" scenario as an example and the same should apply for "With Solutions" scenario. Under Excel's "Data" menu, select "Solver." Use the Solver tool to target a "100%" collection rate (cell BC19), which will calculate the amount of truckloads (cell B17). The amount of cartloads will adjust automatically based on this change. If data is adjusted in the Assumptions tab, the optimal capacity must be calculated in the second tab following these instructions.

To calculate the household waste collection fee, open the third tab, "Waste Fee." Use the "Solver" tool and set "Recovery Rate" to "100%" and solve for the value of "waste fee per household." The household monthly waste collection fee will adjust accordingly to understand the minimum flat fee necessary for SMEs to reach a 100% cost recovery. Again, recalculate each time changes are made to the data in the Assumptions tab.

COLLECT NEW DATA

Our models serve as a solid foundation for understanding the current system and its drivers. However, improved data will improve the accuracy and usefulness of the model. The following paragraphs explain what types of data should be updated.

Table 3.1.1: Economic Models of the Current Household Waste Management System in Conakry

CURRENT CAPACITY			
Scenario	Baseline		Unit
Total Waste	25,338.15		tons/month
Mode	Trucks	Carts	
Number	**36.76**	2,646.40	loads/day
Amount Collected	**19,848.00**		tons/month
Collection rate	78%		percent of total
Waste Difference	5,490.15		tons/month

FOR OPTIMIZATION EXERCISE IN SOLVER	
Color	Description
Red	Objective function
Baseline	set to current capacity
no solutions	set to 100%
w/solutions	set to 100%
Blue	Decision variable
Truck loads	depending on assumptions

OPTIMAL SYSTEM					
Scenario	No solutions		With solutions		Unit
Total Waste	25,338.15		23,805.67		tons/month
Mode	Trucks	Carts	Trucks	Carts	
Number	**46.92**	3,378.42	**44.08**	3,174.09	loads/day
Amount Collected	25,338.15		23,805.67		tons/month
Collection rate	**100%**		**100%**		percent of total
Waste Difference	0.00		0.00		tons/Month

Economic models developed by our team to understand and calculate the capacity of the current waste management system.

Data related to SMEs, such as cart capacity and the costs of collecting and transporting waste, can be validated through conversations with multiple SMEs and organizations that work closely with SMEs, such as OCPH. Equipment and cost variables may change from company to company, so calculating a strong average from data collected by multiple sources is acceptable. When data is not available through these means, relying on data from comparable cities can serve as a proxy. For example, we used collection costs from the city of Maputo as a proxy data point in our model because it was the most valid information we could find for cities in Africa. The need to collect accurate data specific to Conakry versus using solid proxy data can be prioritized.

Collecting high-quality data on waste management can also be addressed through cross-sector collaboration and review. For example, UNDP can organize conference and review sessions with researchers from different organizations that are working on collecting data on the amount of waste and waste composition in Conakry, such as Université Gamal Abdel Nasser de Conarky (UGANC) Centre d'étude et de recherche en environnement (CERE)'s PhD program on GIS data (more information on how to use spatial data is included in Chapter 6 of this report). Opportunities to discuss and compare data and research approaches will allow researchers to integrate and standardize their processes. With an improved data foundation, future data analysis and economic modeling will be more efficient and accurate, providing unified insights on the waste problem and potential solutions.

Additionally, economists usually conduct household surveys to collect first-hand information, especially in developing countries. The survey can be designed and conducted to ask specific questions, such as households' habits producing and sorting their waste.

Table 3.1.2: Waste Fee Calculations for Current and Integrated Systems

WASTE FEE SYSTEM FOR SMES			
Cost	BASELINE	NO SOLUTIONS	WITH SOLUTIONS
Waste (tons/month)	25,338.15	25,338.15	23,805.67
Marginal cost (per ton)	$22.50	$22.50	$22.50
Total Cost	**$570,108.38**	**$570,108.38**	**$535,627.49**
Revenue			
Number of Households	301,644.64	301,644.64	301,644.64
Waste fee (per household)	$1.48	$1.89	$1.78
Total Revenue	**$446,434.07**	**$570,108.38**	**$535,627.48**
Recovery Rate	78.31%	100.00%	100.00%

INTEGRATED WASTE FEE SYSTEM - CURRENT & NEW LANDFILL			
Cost	CURRENT LANDFILL - BASELINE	NEW LANDFILL - NO SOLUTIONS	NEW LANDFILL - WITH SOLUTIONS
Waste (tons/month)	25,338.15	25,338.15	23,805.67
Marginal cost (per ton)	$28.10	$36.41	$36.41
Total Cost	**$712,006.15**	**$922,553.73**	**$866,756.49**
Revenue			
Number of Households	301,644.64	301,644.64	301,644.64
Waste fee (per household)	$1.84	$3.06	$2.87
Total Revenue	**$555,365.34**	**$922,554.64**	**$866,755.62**
Recovery Rate	78.00%	100.00%	100.00%

Economic models developed by our team to calculate a waste needed to sustain the current waste management system and a fully integrated system.

The data collection and analysis process can be a long-term project and the survey results will build up context-specific waste data in Conakry.

We recommend UNDP use these economic models to advocate for innovative waste diversion solutions (our three recommendations are included in the following sections of this report). Our models provide greater clarity on the total system costs, so the model can also be used to understand how to optimize the businesses of SMEs by properly scaling their operations and cost recovery. Finally, understanding the number of truckloads needed to serve an optimized system will help ANASP and local municipalities understand how road infrastructure and other equipment will be acquired and maintained to sustain the system to assist in proper budgeting.

CHALLENGES AND OPPORTUNITIES

A major assumption in our model is that the capacity of both parts of the system is equal. We assume that the amount of waste collected at households by SMEs is also collected at collection points by municipality-run garbage trucks. We know this is not true. On our field trip to Conakry, we observed bottlenecks at certain collection points, where the waste picked up by SMEs is not picked up by trucks and transported to landfill. This imbalance may be a factor of infrastructural limitations, such as road quality, land use and location of collection points. We know that a series of new collection points are planned, and that several existing points can be relocated to account for infrastructural and population discrepancies. The location of these points should account for these factors to ensure bottlenecks are solved for the ideal scenario would provide for a consistent and comprehensive flow of waste from households to end-of-life, with waste with post-consumer value captured.

Furthermore, we make a clear distinction between waste collection at households and at collection points in that the collection methods used are mutually exclusive. In our models, household collection is only done by carts, and transfer point collection is exclusively done by trucks.[33] What this means for the results of our models is that the waste fee will only be attributed to SMEs for waste collection by carts. Based on our understanding of the system in Conakry, the financing of waste removal from collection points to landfill is not included in the waste fee. However, we know that some SMEs are also operating trucks. This complicates the system, as the distinction between the collection activities is not as clear as we assumed in the model. On the other hand, it argues persuasively for an integrated system where the waste fee is attributed to the entire chain of waste management activities, from household collection to disposal at landfill.

Understanding the benefits of an integrated system, and that a new landfill is being planned 60 km from the current landfill, we created another tool to estimate the cost of transporting waste by garbage trucks from collection points to the landfill. This helped us understand how our waste collection cost estimate of $22.50 might increase in a fully integrated

Collection point filled with waste, creating a bottleneck situation[32] .

Table 3.1.3: Transportation Costs for Each Municipality

MONTHLY EXPENSES ON TRANSPORTATION IN FIVE COMMUNES					
	DIXIN	**MATAM**	**KALOUM**	**RATOMA**	**MATOTO**
Distance between communes and La Miniere (km)	*4.5*	*3.5*	*8*	*9.5*	*8.5*
Fuel costs ($/liter)	1.04	1.04	1.04	1.04	1.04
Liters of fuel per km	1.53	1.53	1.53	1.53	1.53
Distance from transfer centers to La Miniere (km)	4.5	3.5	8	9.5	8.5
Distance from transfer centers to new landfill (km)	64.5	63.5	68	69.5	68.5
Total trips per month	441.07	441.07	441.07	441.07	441.07
Total Fuel Costs ($) current landfill	3,158.21	2,456.39	5,614.60	6,667.34	5,965.51
Total Fuel Costs ($) new landfill	**45,267.73**	**44,565.91**	**47,724.12**	**48,776.86**	**48,075.03**
Labor costs ($)	1,142.86	1,142.86	1,142.86	1,142.86	1,142.86
Truck costs ($)	1,142.86	1,142.86	1,142.86	1,142.86	1,142.86
Truck maintenance ($)	75	75	75	75	75
Total O&M costs per truck ($)	23,60.71	23,60.71	23,60.71	23,60.71	23,60.71
Amount of trucks	10	10	10	10	10
Total O&M Costs ($)	23,607.14	23,607.14	23,607.14	23,607.14	23,607.14
Total Cost current landfill ($)	26,765.36	26,063.53	29,221.75	30,274.48	29,572.66
Total Cost new landfill ($)	68,874.87	68,173.05	71,331.26	72,384.00	71,682.17
Cost Increase New Landfill per ton	8.31$/ton				

Total Cost current landfill	141,897.77	$/month
Total Cost per ton current landfill	5.60	$/ton
Total Cost New Landfill	352,445.36	$/month
Total Cost New Landfill per ton	13.91	$/ton
Cost Increase New Landfill per ton	8.31	$/ton

Economic models developed by our team to calculate the costs of transporting waste to the landfill in each municipality.

system, as well as the cost impacts of the new landfill site. In order to estimate the additional cost per ton of waste in a fully integrated system including transportation to the new landfill, we had to make a set of assumptions on fuel costs, truck fleet, and distance. These assumptions are laid out in Table 3.1.3 above and in the "Transportation Costs" tab of the excel sheet, and should be updated with more accurate numbers.

For fuel costs, we assume $1.04 as the price per liter,[34] and a fuel efficiency of 1.53 liters per kilometer for all trucks.[35] Furthermore, we calculate the 60 kilometer distance to the new landfill as an addition to the distance from each municipality's collection point to the current landfill. We also make assumptions on the amount of trips per month by multiplying the daily truckloads needed by days of the month (30) and then multiplied again by two in order to account for each return trip from the new landfill.

In addition to fuel costs, we make assumptions on operating expenses of the truck fleet and the corresponding labor costs related to this service. We assumed a truck fleet of 50 trucks in total distributed equally between the five municipalities of Conakry. Based on the case study on waste management's financial sustainability from a comparable city, Bahir Dar, Ethiopia,[36] we estimated the labor cost and acquisition cost for each truck is $1,142.86, which is then used to calculated the total O&M cost per truck, equal to $23,607.14.

Assuming the aforementioned costs related to transportation of waste, we estimate an average addition of $5.60 per ton for transportation to the current landfill. This would be added to the current cost of $22.50 per ton and would increase the waste fee accordingly. As fuel cost is a big component of our cost breakdown, we find that the average cost per ton to the new landfill will be an addition of $13.91. As such, the waste fee would have to be increased significantly in order to sustain operations. The new landfill located 60 km outside of the city center will in our models increase the cost per ton of waste removal by the difference of the costs mentioned above, which amounts to $8.31 per ton.

In a fully integrated system, operating at 100% collection rate and with 100% cost recovery, the flat rate household waste fee would be $2.87, corresponding to a 61.23% increase from the previous $1.78. In our initial capacity models we solve for the optimal number of truckloads, which is intended to serve as a basis for municipal decisionmakers to allocate their available resources accordingly. Allocation of loads will be decided depending on truck fleet, cart fleet, traffic congestion, distance requirements, and workforce, among other things. It is important to note that in order to get to these numbers, we had to make assumptions on truck fleet. Hence, these are only preliminary findings and we decided to only include them as opportunities and not necessarily as results of our models.

Equity is an issue that needs to be solved for when designing a waste fee scheme. A progressive fee would be the solution to this issue, but how to design it properly is a challenging exercise. In the case study on Maputo, Mozambique, we find that each household would be willing to pay up to 1.5% of available income for waste management service[37] . However, in the context of Conakry, it will be difficult to link the waste fee with available income, as a large portion of household income is informal and thus hard to account for. Furthermore, it is not necessarily the case that waste production and available income is positively correlated for all levels of income. At some level of income, there might be a tipping point where households start to produce less waste than before. Another way to charge a progressive waste fee would be to link it to consumption of a utility service, assuming that consumption of utilities is positively correlated with production of waste.

In order to integrate the waste management system with a progressive waste fee that is attributed to the entire chain of services from household collection to landfill disposal, we need to identify the best suited channel to collect such a fee. In Conakry, electricity and water services are not reliably available to customers, making it difficult to integrate waste collection payments into these utility systems. Waste fees in Conakry could be integrated into cell phone bills, or another reliable utility service, though this would require coordination with various public or private stakeholders.

A third way to design a progressive fee collection system would be by charging the households directly based on how much waste they produce. In a perfect world, this would be the fairest solution of them all. However, a big risk with this method would be that households would be incentivized to dump their waste elsewhere (e.g. at their neighbors' houses). Naturally, this is not a desired outcome, and thus a fee based on waste production would have to be designed carefully in order to reach the desired outcome of equity.

Lastly, we want to make the point that an integrated system need not be a fully public system nor a fully private system. It could be a public-private partnership with a similar breakdown of operations as in the current system, however an integrated approach to the collection and attribution of the waste fee can increase the efficiency of the system significantly.

3.2:

MOBILE BUYBACK PROGRAM

The mobile buyback program is a business model that helps Small Medium Enterprises (SMEs) that currently collect waste in Conakry to increase their household subscriptions through incentives. This model increases the awareness of the value of recyclable waste in the community and promotes sorting at the household level. It also increases capacity for removing waste from the city and diverting it from landfill, keeping the city clean and saving municipalities money from transportation costs.

Currently, the waste collection system is largely based on 112 registered SMEs and over 100 unregistered ones, which are responsible for picking up waste from houses and taking it to collection points, where it is collected by trucks that take it to the landfill. In order to improve the work of the SMEs, the "Solid Waste Management Project" run by USAID-OCPH has focused on the first stage of the chain, pre-collection and sorting in households. OCPH bought 20,000 household waste bins[38] , which were sold to SMEs at a very low-cost. SMEs sold pairs of bins to the household they serve, earning a small margin.[39] The purpose of these bins is for residents to sort their waste into recycling and non-recycling streams before it is collected by SMEs. Recyclable waste is more valuable because it can be more easily sold when it is cleaned and sorted near its source, such as at homes. According to the OCPH annual reports, despite the fact that 8,000 homes were made aware of these efforts through different strategies, only 3,000 households subscribed, and there are 10,045 bins still in stock. Clearly, there is a barrier to incentivizing residents to sort their waste and a system, like a mobile buyback mobile program, could support the efforts of OCPH.

At the present, there are 40 collection points distributed throughout the city of Conakry, however, their capacity has reached the limit, becoming small landfills themselves.

On the other hand, private companies that buy recycling have their line of operation completely in parallel to the aforementioned system. For example, Société Dia Plastique (Sodiaplast) is a company that operates regionally, with factories in Guinea and Senegal and collection points in Sierra Leone, Liberia, Senegal, and Guinea. Its products are sold throughout the region, including Burkina Faso, with washboards and

Handcart carried by an SME worker at a collection point near Donka Neighborhood[41]

buckets as bestsellers. To ensure a steady supply chain, Sodiaplast uses its own collection points and requires 25-tons per day at its Conakry factory to make around 6,000 products.[40] In order to reach its daily goal and supplement its supply from Conakry, Sodiaplast buys film plastic from Freetown in Sierra Leone, as well as in Liberia and Senegal. Another similarly-envisioned company is Topaz, which makes products from recycled rigid plastics and also uses vertical integration: it has set up its sources and does its own pickup and quality control.

WASTE COMPOSITION IN CONAKRY

According to the report "Stratégie de professionnalisation de la gestion des déchets solides de la ville de Conakry" by the EU Commission and Louis Berger, the waste produced in Conakry per day is 845 tons,[42] which is characterized by waste type shown in Table 3.2.1 below. In general, garbage in Conakry consists of 37% of recyclables, 43% of organic matter and about 20% of other materials. If we look closely, Conakry produces around 169 tons of plastics per day, enough to supply Sodiaplast and Topaz entirely. Therefore, there are enough materials to create a business model that values recyclable trash and helps the SMEs increase their revenues.

Table 3.2.1 Waste Composition in Conkry

Type	%	ton/day
Plastic	20%	169
Organic	43%	363
Paper/Carton	8%	68
Metals	5%	42
Wood	5%	42
Glass	4%	34
Others	15%	127
Recycling Waste (plastic, paper, carton, metal and glass	37%	313
Organic Waste	43%	363
Others (includes wood)	20%	169

As described above, it is observed that waste management relies not only on the SMEs but also on the subscribed households. The number of households that subscribe and pay for SME service determines their profits and financial sustainability. Therefore, an incentive model is proposed for households that deliver their clean and sorted waste to SMEs. This model will help SMEs increase the number of houses they serve, increase the quality and quantity of waste collected and sold, and ultimately reduce the amount of waste left at collection points and landfills in Conakry. For households, waste is tranformed into a source of income rather than a cost to be carried.

From conversations with Sodiaplast, we know there is a vibrant market for recyclable materials, and the estimated market prices for each material is shown in Table C2 below. From the waste audit information from Enabel, at least $59,122 worth of plastic film, hard plastic, and metals are available in Conakry's household waste stream per day.[48,49] To redistribute this value to SMEs and households, we propose an incentive-based model that rewards households for sorting these materials from their waste and providing them to SMEs who can sell them for additional revenue.

Table 3.2.2 Price per kilogram of Recyclable Materials in Conakry

Plastic Film	GNF 2000	$0.22	$/kg
Flexible Plastic	GNF 2000	$0.22	$/kg
Hard Plastic	GNF 2500	$0.28	$/kg
Aluminum	GNF 7000	$0.77	$/kg
Steel	GNF 1000	$0.11	$/kg

Data from Sodiaplast and Enabel

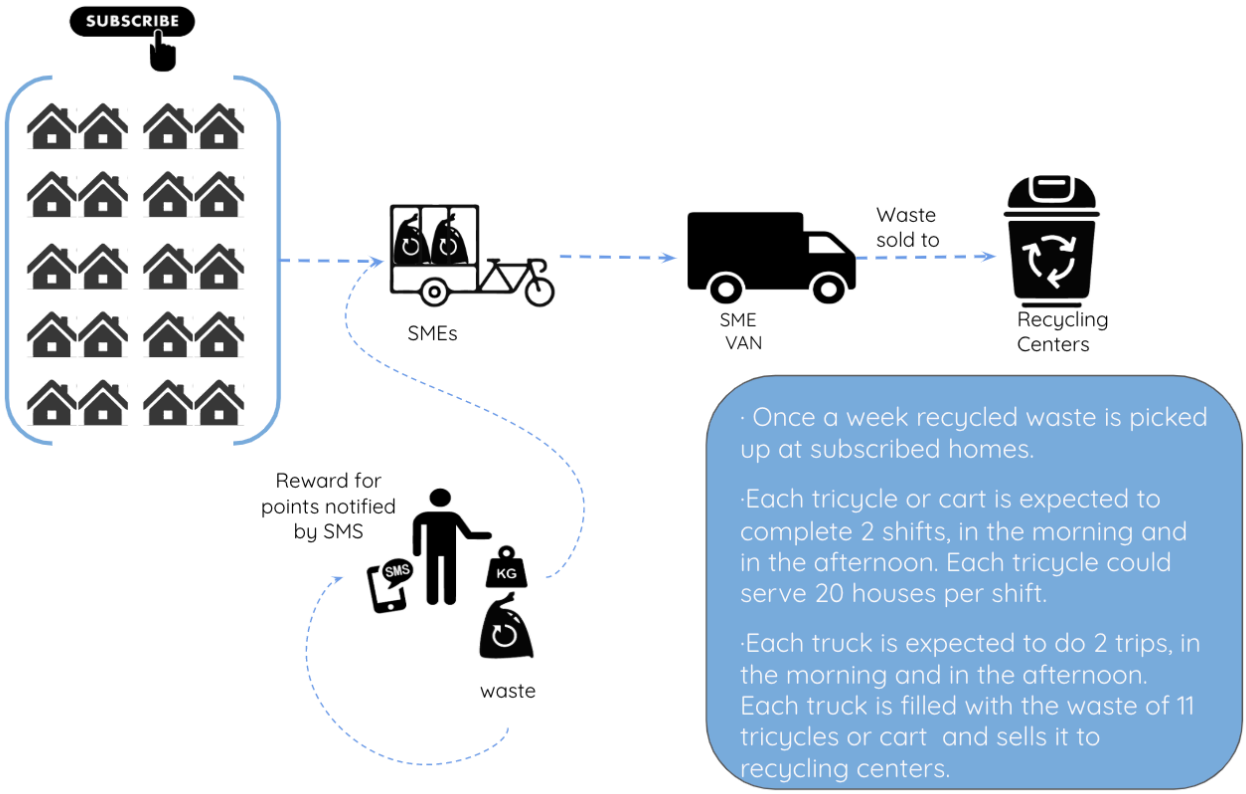
HOW THE MODEL WORKS

Bicycles with an attached cargo load (bike-cargos) or carts pick up clean, sorted recyclable materials at each household subscribed once a week. The households are rewarded with points based on how much sorted waste is collected. The material collected by bikes or carts is collected by vans and delivered directly to the recycling centers, which buy these materials (See Figures 3.2.1 and 3.2.2 below). The benefits of a mobile rather than traditional stationary system include greater flexibility, just-in-time servicing and mitigated land use demands.

Points can be used for cell phone minutes, household items, or debit cards and could be distributed by a cellphone platform or manually. Wecycler, a buyback company based in Lagos, uses a manual point counting system per kilogram of recycled material received. Each recycling collector manages a spreadsheet with a cell phone number for each house, where he notes points of each house subscribed. These data are transferred to a software, where the points are stored. Each household receives a text message with the number of points accumulated and the next collection date. After a considerable sum of points, the subscribers can exchange them for products or a cellular minutes card. Alternatively a manual system could rely on a "punch card", where each punch represent a kilogram of recycling waste. After a number of punch cards are collected, the subscribers could exchange the points for a product. Chapter 5 contains details of these Transportation, Collection & Sorting case studies.

The model is based on the assumption that SMEs own the vans and have them available, that they can collect 11 bikes-cargo or cart material loads daily, and each bike-cargo can serve 20 households per day. Assuming that each person in Conakry produces 2.8 kg of waste per week (0.4 kg/day x 7 days per week) and that 7 people live in each house on average,[43] the amount of waste per house per week would be 19.6 kg. Using the composition percentage from Table 3.2.1, 19.6 kg of waste is comprised of 7.252 kg of recyclable materials, 8.428 kg organics, 3.29 kg of others. Hence, we used 7.252 kg of recyclable materials per week to evaluate the model, because these materials have the potential to be sold in the current system.

Figure 3.2.1: Illustration of a Mobile Buyback Program



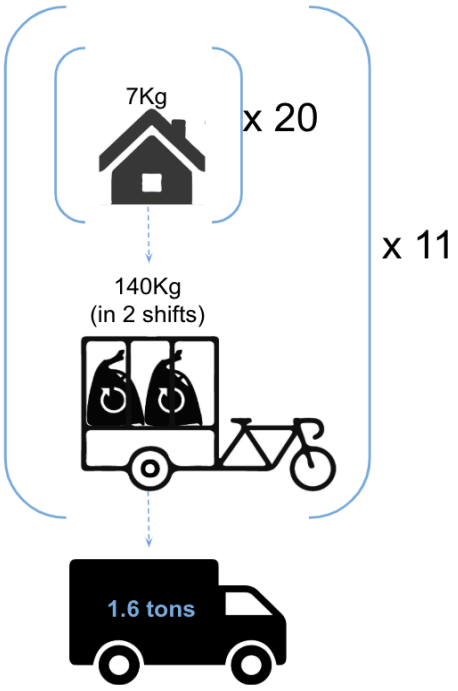
Bike-cargos managed by SMEs pick-up recycled waste door-to-door of households subscribed which are rewarded by points. Then the materials collected are delivered directly to the recycling center by small trucks or vans, also manages by the SMEs[50].

Therefore, each house produces about 7 kg of recyclable materials per week, and we assumed that a bike or cart pick up this load once a week from 20 houses, for a total of 140 kg. Each van can carry the loads from 11 bikes, bringing the daily total amount diverted from the collection point and the landfill to 1.6 tons per van, valued at $14,872 dollars[44] (see Figure 3.2.2).

If at least 20% of the SMEs implement the recycling program with incentives, we can assume that they would have to dedicate 22 vans and 242 bikes which would collect 33.9 tons per day from 4,840 household bins.[45] In one month, 1,025 tons of recycled material from 33,880 households would be collected. We are aware that this number seems large, but it represents only the per capita waste produced by 13% of the population.[46] We believe this level of participation could be possible due to the fact that the current program of the USAID-OCPH has already sensitized 8,000 houses about recycling, and enrolled them in a program in which they had to buy the bins and pay a monthly fee for waste pick-up.

Looking at a timeline of 12 months and a discount rate of 6%, a buy-back program requiring one van and 11 bikes used by an SME for the recycling program has a net present value of $24,999, this means that in the end of the period each SME can double it capacity acquiring another Van and 11 bikes without a loan. This value is based on the assumption that the subscription in the first month is 210 households, and it increases by 15% each month for the next 5 months until reaching a target of 1,500 households on the 6th month. The number of bikes, workers and the amount of recyclable waste are related to this increased growth. The costs for implementing this model are $350[47] per bike and $10,000 per van required for vehicle purchase, paid

Figure 3.2.2: Figure 3.3: Illustration of Mobile Buyback Program Model Depicting Capacity



Daily capacity of the combinations of each van and 10 bike-cargo[51]

through a yearly loan with 3% interest; $125[12] per month per person in salaries; and reward points valued at $6 per month per household subscribed to pay for the pre-sorted waste. The revenue is estimated to be $330 per ton of recyclable waste collected.[52] Finally, a 25% tax on profit is considered.

We have seen successful implementation of an incentives-based recycling system in different recycling waste systems in West Africa and South Africa (for more information, see Chapter 5, Transportation, Collection & Sorting Case Studies). Wecycler in Lagos, Nigeria rewards their household subscribers through points that are saved in a software platform and sent to the representative of each house via cell phone text message. The points can be used to purchase groceries and cell phones minutes. Pack-a-ching in Cape Town, South Africa operates a mobile kiosk where residents deposit their recycling in return for a cash card loaded with money, like a debit card. Finally, the iRecycle Program in Nigeria offers Recycling Points to residents in exchange for their recyclable items which can be redeemed for household items from the iRecycle Store. We believe the success of these models can be applied to Conakry.

We recommend UNDP work with SMEs, organizations like OCPH, and L'ong Femmes, Pouvoir Et Développement (FEDEP) to implement a mobile buyback program in Conakry. Consulation with Sodiaplast and Topaz on their post-consumer waste supply chain organization and management can also offer important insights. This model will build off of the previous success of OCPH by further incentivizing residents to sort their waste before it is collected. It will increase revenue for SMEs by providing them pre-sorted, clean (and therefore, more valuable) recyclable waste to sell on the market, and divert a significant amount of waste from Conakry's collection points and landfill. This waste diversion will save the municipality money as well, distribute the benefits of waste sorting across the economy, and reduce the amount of waste transported from collection points to landfill, a benefit that is especially important once the new landfill is operating further outside of Conakry.

CASH FLOW FOR ONE VAN WITH 11 BIKES (12 MONTH)

	Months											
	1	2	3	4	5	6	7	8	9	10	11	12
% Penetration	0.15	0.3	0.45	0.6	0.75	1	1	1	1	1	1	1
Houses subscribed	225	450	675	900	1,125	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Bike Cargo needed	2	3	5	7	8	11	11	11	11	11	11	11
Workers needed	5	9	12	15	19	24	24	24	24	24	24	24
Recycling material (tons)	6.99	13.99	20.98	27.97	34.97	46.62	46.62	46.62	46.62	46.62	46.62	46.62
Cost												**TOTAL**
Trucks loan	-$858.33	-$858.33	-$858.33	-$858.33	-$858.33	-$858.33	-$858.33	-$858.33	-$858.33	-$858.33	-$858.33	-$10,300.00
Bike-Cargo Loan	-$360.50	-$360.50	-$360.50	-$360.50	-$360.50	-$360.50	-$360.50	-$360.50	-$360.50	-$360.50	-$360.50	-$4,326.00
Salaries	-$666	-$1,083	-$1,499	-$1,915	-$2,331	-$3,025	-$3,025	-$3,025	-$3,025	-$3,025	-$3,025	-$28,669
Household rewards	-$1,398.6	-$2,797.2	-$4,195.8	-$5,594.4	-$6,993.0	-$9,324.0	-$9,324.0	-$9,324.0	-$9,324.0	-$9,324.0	-$9,324.0	-$86,247.0
Operating cost (20%)	$446	$892	$1,338	$1,785	$2,231	$2,974	$2,974	$2,974	$2,974	$2,974	$2,974	$27,513
Total Cost	**-$2,838**	**-$4,206**	**-$5,575**	**-$6,944**	**-$8,312**	**-$10,593**	**-$10,593**	**-$10,593**	**-$10,593**	**-$10,593**	**-$10,593**	**-$102,029**
Revenues												
Waste sold (ton)	$2,231	$4,462	$6,692	$8,923	$11,154	$14,872	$14,872	$14,872	$14,872	$14,872	$14,872	$137,564
TOTAL REVENUES	**$2,231**	**$4,462**	**$6,692**	**$8,923**	**$11,154**	**$14,872**	**$14,872**	**$14,872**	**$14,872**	**$14,872**	**$14,872**	**$137,564**
Total Earnings	-$607	$255	$1,117	$1,979	$2,842	$4,278	$4,278	$4,278	$4,278	$4,278	$4,278	$35,535
Taxes 25%	0	$64	$279	$495	$710	$1,070	$1,070	$1,070	$1,070	$1,070	$1,070	9035.44
Net Profits	-$607	$191	$838	$1,485	$2,131	$3,209	$3,209	$3,209	$3,209	$3,209	$3,209	$26,500
NPV	24,999.59											
IRR	120%											

Assumption

Item	**Value**	**Coments and Source**
Salarie	$125	Wecycler/Small is Powerful
Bike Cargo Price	$350	Wecycler/Small is Powerful
Dicount rate	6%	Assumption
Bike Cargo Loan interest	3%	Assumption
Conakry Taxes	25%	
Operating cost	20%	maintenance and gasoline Assumption
Bike-cargo per house	19	
Bike-cargos per trucks	11	assuming that each truck can transport 1.5 tons a day (15000/120)
Truck Capacity	1.5 tons	
Bike-Cargo Capacity	140 kg	kilograms, assuming two shifts (60kg each)
Worker per bike	2	assuming two shifts per bike (60kg each)
Worker per truck	2	
Total recycling material per month per house	31 kg	ssuming 0.4kg of waste per person per day, where 37% of it is recyclable, plastics, paper/carton, metals, glass. In each house live 7 people average. Rapport de Caractérisation des Déchets en saison humide – Louis Berger – Septembre 2017
Price of Recycling materials	$0.32	per kilo, considering an average from sodiaplast prices Sodiaplast/Enable
Rewards	$6.2	monetized points (monthly) Wecycler/Small is Powerful

3.3:

COMMUNITY COOKERS

A Community Cooker is a simple waste-to-energy structure developed by the Community Cooker Foundation, a not-for profit organization in Nairobi, Kenya. The foundation advocates to promote sustainable waste management by encouraging institutions, communities, and individuals to transform environmental waste into energy to clean up the rubbish, improve health, and create other social values. Community Cookers burn organic and inorganic waste in an environmentally controlled way to create heat that can be used for cooking or baking food and boiling water, thereby diverting waste that would otherwise be landfilled and adding value to the waste inputs. Community Cookers also reduce the need to burn trees or use electricity traditionally used for cooking, prevent environmental and health issues from the burning of waste in open air, and can create economic opportunity for community groups like women and youth.

A Community Cooker that burns waste at 880-1,200 degrees centigrade can achieve 90% of combustion efficiency, meeting European Environmental Standards and United States Environmental Protection Agency standards for hazardous substance emission.[53] It also exceeds the WHO minimum standards for incineration in developing countries.[54] In addition to cooking, future potential uses of cookers include brick and pottery baking, soft metals smelting, and electricity generation. Additionally, the Community Cooker Foundation, estimates that 3,721,600 tons of waste have been incinerated in Community Cookers since 2008, the equivalent of burning 126,000 mature trees.[55]

Table 3.3.1: Community Cooker Emissions Compared to EU Emission Standards for Municipal Solid Waste

POLLUTANT	UNIT USED	EU EMISSION STANDARD	COMMUNITY COOKER VALUE	
(SO2) SULFUR DIOXIDE	MG/M3	50	0	PASSED
(NOX)OXIDES OF NITROGEN	MG/M3	200-400	215	PASSED
DIOXINS AND FURANS	NG TEQ/M3	0.1	0.0114	PASSED
(CO) CARBON MONOXIDE	MG/M3	50-150	63.4	PASSED

Because of the high burning temperature, Community Cookers limit harmful particulate matter and are a safer way to burn waste than in open air.[59]

Burning waste in a Community Cooker requires five steps. Community Cookers can be managed and operated by an individual or a group of individuals.

WASTE COLLECTION: A group of individuals collect waste on-site or throughout the community, that will be burned in the Community Cooker.

SORTING WASTE: Community members managing the cooker are trained to sort waste so items such as rubber, glass, metal, plastic foam and batteries are removed from the collected waste. The rest is dried and once dry, shoveled into the chute which feeds the fire.

INCINERATION: To ensure the fire reaches 880-1,200 degrees Celsius, drops of water and recycled engine oil (which is optional) are allowed to drip onto a heated steel plate located above the fire. As the waste burns and the temperature of the fire increases, heat is distributed to the two ovens located along the sides of the cooker, and to the 8 cooking plates located at the top of the cooker. Additionally, a system of steel pipes that pass throughout the cooker generates hot water. Once ignited, depending on the amount of waste supplied, the Community Cooker can operate up to 24 hours a day with few additional costs[56].

COOKING: Once the fire has reached a suitable temperature for cooking, the cookers' two ovens each have the capacity to bake up to ten loaves of bread or roast a full sized goat. The cookers' 8 cooking plates make up an area of 1.7 square meters of usable cooking surface. The cooker has the ability to heat and store 2,000 liters of water in its water tank, with the option of adding a second water tank doubling that capacity.[57]

MAINTENANCE: Once the supply of waste from the chute is stopped and the fire has gone out, the operator should use a shovel to remove ash that has collected below the firebox and combustion chamber. The residual ash can be mixed into bricks and clays to be used for maintenance.[58]

FIGURE 3.3.2: Design Drawings of Community Cookers

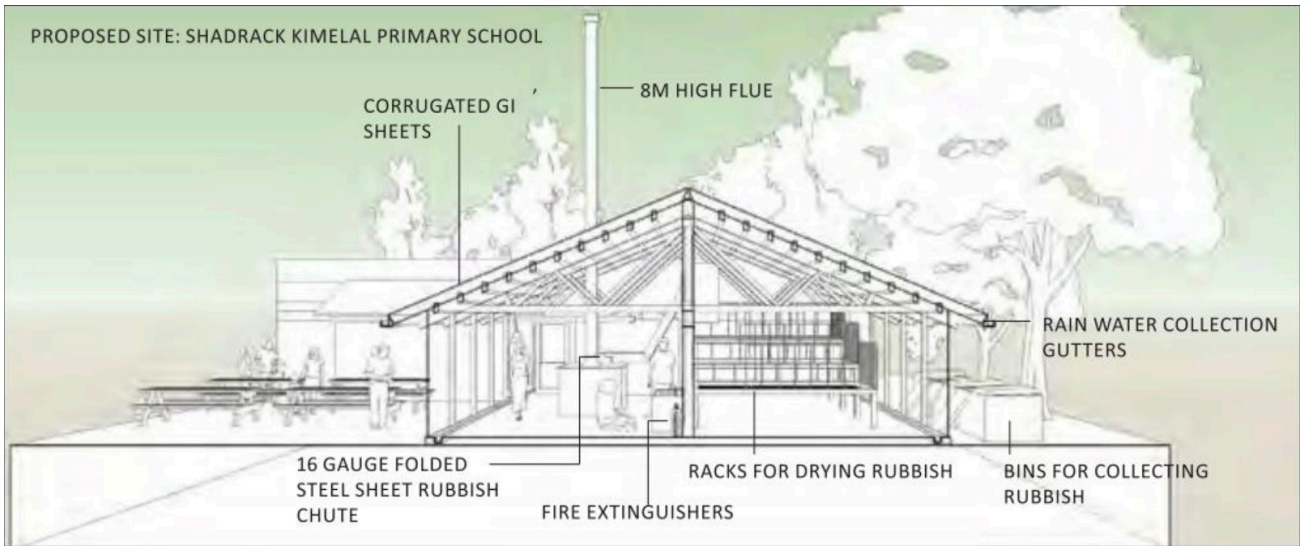


Image 1: Section of a Community Cooker Site[62]

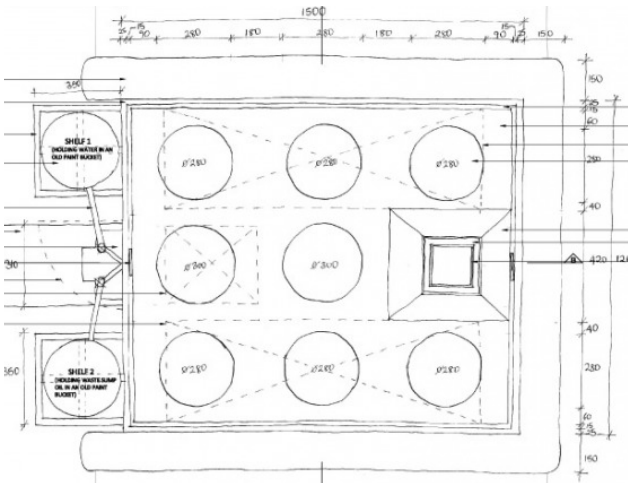


Image 2: Plan view of a Community Cooker[63]

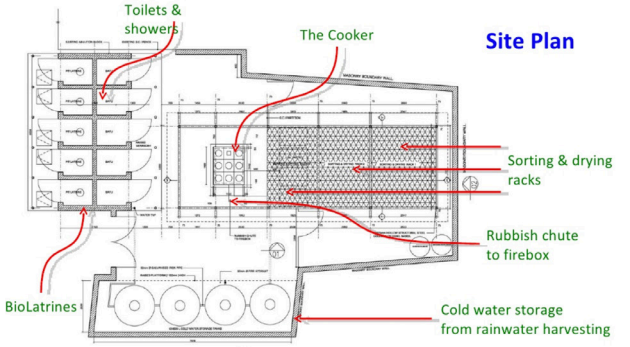


Image 3: Site Plan of a Community Cooker[60]

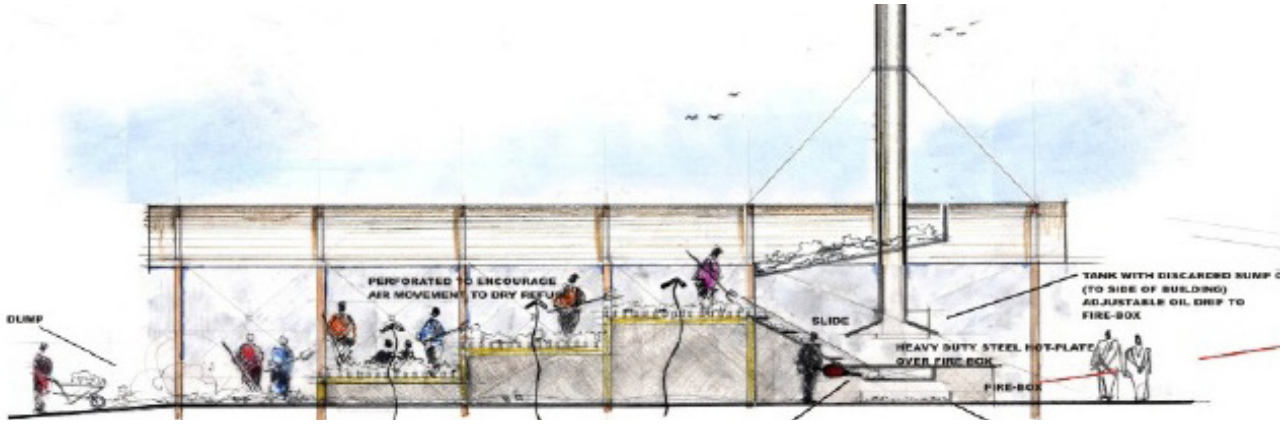


Image 4: Section of a Community Cooker, looking at the sorting process[61]

A Community Cooker typically contains eight cooking plates and two ovens and can be installed in open areas near buildings, such as schools.[64]

APPLICATIONS OF COMMUNITY COOKERS

Community Cookers have proven successful at addressing waste management issues throughout Kenya while providing added benefit to nearby communities. The Kibera Silanga Community Cooker is one example. The Silanga community lacked clean water and waste disposal facilities. This situation created a significant problem, as the polluted Nairobi river flows through the Kibera neighborhood, Africa's largest urban slum, depositing large amounts of waste at the Nairobi Dam and Kibera Park.[65] The park is home to an urban farm that produces crops for market, a primary school that houses an ablution block with toilets and washing facilities, and a small shop.

A Community Cooker was installed in 2015 and is managed by the community organization, New Nairobi Dam Community (NNDC).[66] Not only has the Community Cooker provided a sustainable waste management solution for the Silanga community, but it provides hot, clean water to the toilet and washing facilities, where people pay to take baths.[67] Additionally, the Community Cooker is able to provide a livelihood to the unemployed women in the community, through the small restaurant that was started, and value to the youth who serve as waste collectors.

Additional examples of successful Community Cookers applications can be found in Chapter 5 of this report.

In Conakry, Community Cookers have the potential to divert organic and inorganic waste from landfill, reduce the cost of cooking fuel or firewood, and create stable revenue-generating activities for women's groups.

COMMUNITY COOKER MODEL

Using the information gathered from examples of Community Cookers in Kenya, our team developed an economic model to identify the potential costs, revenue streams, and waste diversion if applied in Conakry.

A Community Cooker can operate up to 24 hours per day. If operated for the full 24 hours, it can burn about 500 kg of waste[68], as shown in Table 3.3.2 below. Therefore, each Community Cooker can burn up to 15,000 kg of waste per month. Because the number of Community Cookers that can be installed in Conakry is dependent on land availability, proper facilities that can house and manage the cookers, and other social and spatial constraints, our team measured the impact of diverting 1% of Conakry's total monthly household waste through Community Cookers. The number was chosen as likely achievable, but potential for much greater implementation exists.

Conakry currently produces 25,338 tons of household waste per month, based on ANASP's waste production data. So 1% of this is about about 253 tons per month. In order to process 253 kg of waste per month, we calculated Conakry will need at least 17 Community Cookers. Based on examples from Kenya, we know that the cost of each Community Cooker is $25,000 for initial installation costs[69]. In the case study showed in Chapter 5, projects are funded by some international organizations and projects can being funded through crowdfunding[70]. Under proper operation and maintenance, there should be no additional costs. In the model below, our team assumed all upfront costs are paid at the onset of the project and do not account for alternative financing methods or depreciation. Additionally, we assume the institution who runs the cooker will be responsible for daily operation costs such as labor.

Table 3.3.2: Total Waste Processed by Community Cooker & Upfront Investment Cost

Total Units	17	
Per unit area cooker size*	6	M2
Total area of cooker	102	M2

Cost per unit	$25,000
Total Upfront Cost	$425,000
Total area of cooker	102

FULL DAY SCENARIO		
Per day waste to burn	500	kg/day
Per month waste to burn	15,000	kg/month
Monthly Total Waste	255	tons/month
Yearly Total Waste	**3,060**	**tons**

HALF-DAY SCENARIO		
Per 0.5 day to burn	288	kg/day
Per month waste to burn	8640	kg/month
Monthly Total Waste	146.88	tons/month
Yearly Total Waste	**1,762.56**	**tons**

* This is the land use by the cooking unit, and does not include the ancillary spaces around, such as water storage tank and waste collection point.

Economic model created by our team calculating costs and potential revenues from Community Cookers in Conakry assuming 1% of waste diverted from the waste stream.

To evaluate the viability of a site for a Community Cooker, the Community Cooker Foundation estimates the potential waste streams, community interaction, and energy output from the site. After the site is selected, the Community Cooker Foundation will train the local operator to sort waste, burn the waste, maintain the equipment, and understand all functions of the cooker.

In addition to diverting waste from landfill to reduce strain on Conakry's waste management system, a Community Cooker has the ability to provide 2,000 liters of hot water in a 24-hour period and to cook 300 liters of food every 1.5 hours. This can serve up to 2,100 community members every 12 hours.[71] Additionally, our team calculated the avoided cost of electricity used for cooking or baking through a Community Cooker, as shown below in Table 3.3.3 below. The electricity rate we used is based on an electricity bill shared by UNDP from Côte d'Ivoire.

Table 3.3.3: Avoided Cost of Energy

FOR HEATING WATER		
Time	8	hr/day
Power use	400	W
Price	0.01	$/kWh
Cost	116.8	$/year
Total Cost	**9.73**	**$/month**
Total Cost	**116.8**	**$/Year**

FOR BAKING		
Time	8	hr/day
Power use	2400	W
Price	0.01	$/kWh
Cost	70.08	$/year
Total Cost	**5.84**	**$/month**
Total Cost	**70.08**	**$/Year**

Model created by our team calculating the amount of electricity a Community Cooker's heat can replace and the corresponding saved costs.

RECOMMENDATIONS

We recommend that UNDP work with the Community Cooker Foundation in Kenya, which has expressed its intent to expand to other African cities, and local NGOs such as Femmes, Pouvoir et Développement (FEDEP) and other active women's employment NGOs to construct a pilot Community Cooker in Conakry. We believe that placing a Community Cooker near a public market would be advantageous as a proof of concept since the market would provide a steady supply of waste for use in the cooker. In addition, the market would be a logical consumer of hot water produced, for use onsite at the market to clean market stands or for other purposes; bread baked or food cooked could be sold immediately. This proof-of-concept location would provide an excellent control to measure the value of waste reduced, and the ecological and environmental benefit of offsets to waste that ends up polluting streets and waterways tangent to the market. The measurable success of a strategic proof-of-concept such as this application could ensure replicability, and could also be used to train operators for other sites as the community cooker program is expanded. Establishing a track record for community cooker technology in Conakry will lower the cost of financing and improve uptake.

In specific terms, local nonprofits, such as FEDEP, can work with women or youth groups to train them to operate and maintain the Community Cooker. The plates of the cooker can serve as normal cooking service, and the ovens could be utilized to bake "Tapalapa" bread to be sold at the market, providing a revenue stream for the women or youth groups charged with managing the cooker. There is a new Community Cooker model specifically designed for bakeries that is currently in development that can also be explored.[72,73]

Depending on the success of the pilot, we recommend the installation of Community Cookers throughout Conakry. From our conversations with stakeholders in Conakry, we understand that most schools do not provide meals for students, so widespread application of Community Cookers in public schools is unlikely, although this model has been highly successful in East Africa. However, there are a number of other institutions where Community Cookers could be feasible, including orphanages, hospitals, local clinics, religious institutions, private or parochial schools and government buildings. All of these locations generate waste and also provide hot water or food, so they can benefit from reduced fuel or electricity costs, while providing a steady supply of waste for the Community Cooker. In cases where demand for waste exceeds on-site production, these institutions can become consumers of waste produced in their immediate neighborhoods, reducing the need for that waste to be transported elsewhere.

Community Cookers in Conakry can solve not only the issue of excessive waste generated in the area but can also empower youth and women groups by providing them revenue-generating opportunities. By additionally using Community Cookers in Conakry as educational and community outreach opportunities, programs for education on site can raise awareness about waste sorting and collection, the impact of unregulated waste, and provide opportunities for women and youth.

CHALLENGES & LIMITATIONS

There are a number of considerations for the installation and operation of Community Cookers. Each community cooker has an upfront cost of $25,000, which must be funded through public, private, or nonprofit partners. Examples of successful projects are further detailed in Chapter 5. Sites need to assessed based on a number of factors: viability of the site, supply of waste to fuel the cooker, assessment of the community's needs and ability to manage the Community Cooker, and identifying the proper partners to ensure maximum social, economic, and environmental benefits.

Once in operation, the Community Cooker needs to be maintained properly by the community members in charge to avoid additional maintenance cost and ensure the cooker is operating optimally. This includes proper waste sorting and removal of waste items that cannot be burned in the cooker. As discussed in Chapter 6 of this report, we believe spatial analysis can be used to assess and properly scale the application of Community Cookers in Conakry.

3.4:

VERMICOMPOSTING & COMPOSTING

Compost, or decomposed organic matter, is an effective method for adding value to household organic waste. Compost is used to enhance the quality of soil because it contains micronutrients necessary for the healthy growth of plants, including nitrogen (N), phosphorus (P), and potassium (K), as well copper (Cu), manganese (Mn), magnesium (Mg), iron (Fe), sulphur (S), and other trace elements. Compost has an increased capacity to hold water and carbon dioxide, both of which are vital for healthy plant growth.[74] In addition to fertilizer for plant growth, compost can be used as topsoil and to rebuild areas where topsoil has been lost.

The following brown and green materials can be used to make compost:

- Weeds, grasses, old leaves, dead flowers, small twigs and other plant materials
- Waste from cleaning grain, cooking and floor sweepings, food, coffee grinds, used tea leaves, fruit juice pulp, and spices
- Stems, leaves, straw and chaff from horticultural plants
- Dry grass, hay and straw left over from feeding and bedding animals
- Shredded cardboard and shredded paper
- Good quality manure from cattle and fowl.

It is important that the ingredient components of compost include both dry “brown” materials such as crop straw, stalks, leaves, floor sweepings, and paper and cardboard which are rich in carbon, as well as “green” materials such as kitchen waste, green leaves and grasses, coffee and tea leaves which are all rich in nitrogen. Given 43% of Conakry’s household waste consists of organic waste, our team recommends compost as a viable waste diversion solution to reduce the strain on Conakry’s waste system. We examined two different methods of composting at varying scales for UNDP’s consideration.

VERMICOMPOSTING

Vermicomposting uses earthworms to improve the conversion of organic waste to compost. During the process, earthworms ingest soil and organic waste which are processed through their digestive system and result in vermicompost.[75] Soil and organic waste are broken down by the chemical secretions in the earthworm's digestive system and the resulting soil has more nutrients available for immediate use by crops or plants.[76] Apart from adding nutrients and micronutrients to soil, vermicomposting is an effective way to increase soil productivity without fertilizers and chemical additives.

Though there are different species of earthworms that can be used for vermicomposting, the African night crawler is best suited for Conakry's climate because the species can tolerate a temperature range of 12 to 30 degrees Celsius. Conakry has a high average temperature of 27.5 degrees Celsius and a low average temperature of 25.2 degrees Celsius.

Vermicomposting can be done in a dug-up pit or in composting bins.[77] Composting bins can be customized according to the needs and requirements of the composter.[78] Because of this versatility, vermicomposting can be done at different scales,[79] ranging from individual households to large, commercial scale. At the small-scale, it can support the requirements of individual farmers or gardeners and at the large-scale it can process large volumes of organic waste for commercial use of compost.[80]

Image of vermicomposting[87]

Image of vermicomposting[86]

PROVEN SUCCESS OF VERMICOMPOSTING

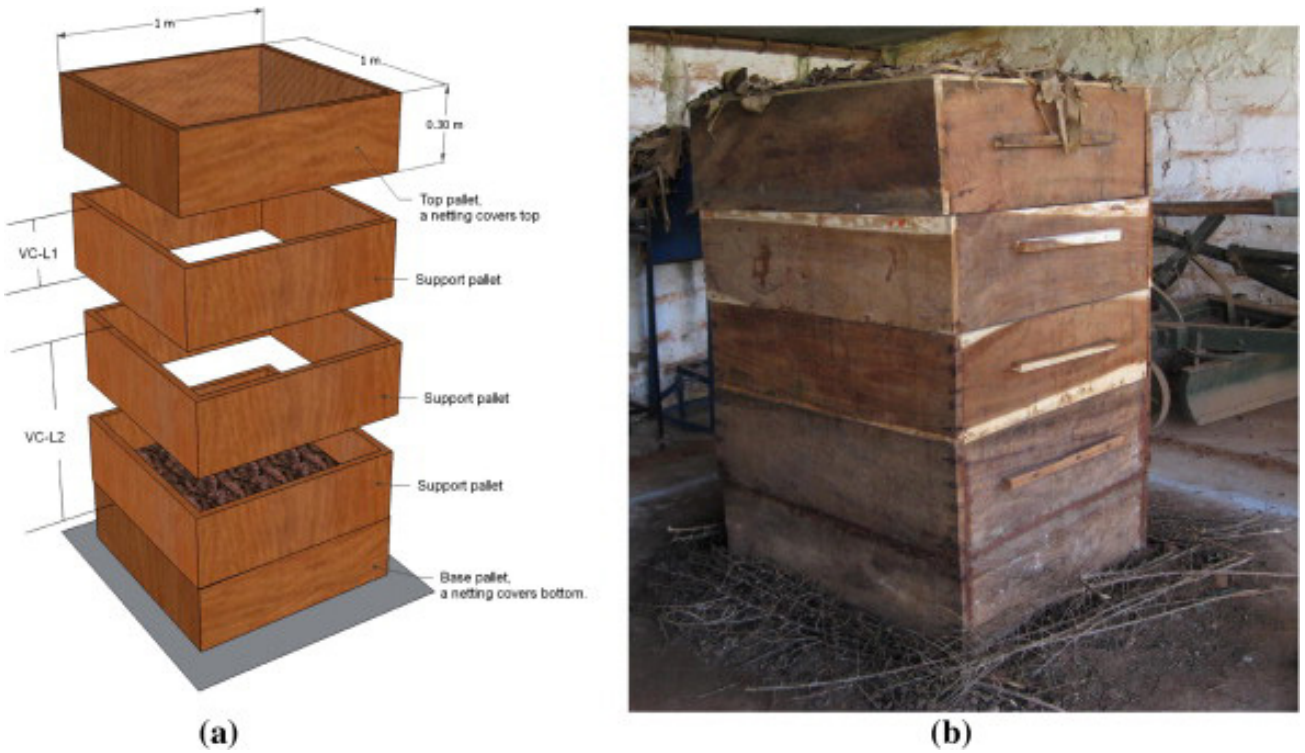
Our team explored vermicomposting because of its successful application in Kampala, Uganda and India. With a lack of effective waste management in Kampala, Uganda, due to lack of infrastructure and economic capacity, vermicomposting serves the dual purpose of waste management and revenue generation for residents.[81] Kampala faces a waste management issue similar to Conakry's, with about 1,500 tons of waste generated each day and only 40% collected and brought to its landfill, which has turned into an open dump.[82] Additionally, livestock in Kampala produce manure, but 59% of it is wasted. Vermicomposting makes use of this manure and other organic waste to produce compost which can help restore

the soil fertility degraded over the years due to intensified farming.[83] Although livestock is not kept within Conakry city limits to the same extent, waste from chickens and goats, which are not uncommon even in central Conakry, can be utilized.

In Kampala, African night crawlers are used to produce compost. These worms have a reproduction rate of 3.5 cocoons a week and from each cocoon, 2 hatchlings are produced.[84] Composting is done in bins that are easy to make with local, anti-termite wooden pallets. The dimensions of the wooden pallets are 1 m x 1 m x 0.3 m, and pallets can be stacked, allowing for increased composting even though land is limited. Worms are added initially to the bedding material, on top of which manure and waste are added. Fresh waste is added every 1 to 3 days. The amount of waste, manure and earthworms added throughout the process are 90.4 kg of manure and organic waste along with 0.6 kg of worms. The end result included 48.9 kg of vermicompost and 3.8 kg of worm biomass.[85]

The initial investment costs for vermicomposting include the local cost of materials and labor. The expected lifetime of each unit is 5 years. Revenue generated has been shown to provide support to communities such as the smallholder farmer population, 40% of which lives under $1 per month in Uganda. They can profit from selling either the vermicompost or the earthworms in the market. Although there is no inner city farming in Conakry, there may be other uses which can make small-scale distributed farming at the accelerated rate provided by the addition of worms viable.

Our team spoke with people directly engaged in vermicomposting in India. These conversations confirmed that vermicomposting is used to manage waste at different scales throughout the country. Most common are small-scale, decentralized composting units, using pits dug in the ground with dimensions of 3 feet x 10 feet x 1.5 feet. This is equivalent to 45 cubic feet or 1.27 m^3 of land per pit. Each unit is covered in layers of soil, organic waste, and worms to



Images of simple construction of vermicomposting bins.

begin the process of vermicomposting which is sprinkled with water and turned over every 3 days to maintain favorable conditions for the earthworms to break down the waste and grow. Based on our conversations, we know that each unit takes 150 kg or 0.15 tons of waste per cycle and uses 1.5 kg of earthworms to produce 100 kg of dried compost. The entire cycle takes an average of 40 days, with an average of 5 fewer days during rainy season and 5 additional days during the dry season. Eisenia foetida is one of the species of earthworms used for vermicomposting in India. In a month, a single worm can process 0.1125 tons of waste.

Table 3.4.1 Time and Waste Requirements for Vermicomposting

VERMICOMPOST		
Total Unit	2,253	
Volume per unit	45	m^3
Organic Waste Input	150	kg/unit/cycle
Time Required for Each Cycle	40	days
Cycles	9	per year
Organic Waste Input per unit per year	1,350	kg/unit/yr
Total Compost Input	**253**	**tons/month**

Economic model developed by our team showing the time and organic waste inputs for vermicomposting.

ECONOMIC MODEL - VERMICOMPOSTING IN CONAKRY

Using the information from these two case studies, we examined the potential impact of waste diverted from landfill using vermicomposting in Conakry. Calculating the total amount of vermicomposting possible in Conakry requires a comprehensive analysis of land and social constraints throughout the city. We've provided recommendations for how UNDP or other partners can undertake that in a second phase of the project in Chapter 6. For now, our team focused on two scenarios we believe are easily achieved: to test the impact of 1% of total household waste or of 1% of total household organic waste diverted from landfill through vermicomposting. We also examined the costs and potential revenue from this scale of implementation.

Assuming a decentralized vermicomposting network where each composting unit requires 1.27 m^3, similar to the model in India, 2,253 units of vermicomposting are needed to divert 1% of monthly household waste in Conakry. This implementation scale totals 253.5 tons of waste per month and requires about 1,000 m^2 of land assuming the standard height of 2.5-3 meters for the stacked vermiculture frames shown earlier in figure on vermicomposting bins. Table 3.4.1 below details the amount of waste diverted with the 1% of total waste diversion assumption and the amount of time required for 1 cycle of vermicomposting.

Table 3.4.2 below outlines the equipment and initial investment costs required for vermicomposting based on 1% of total household waste diversion. These costs are based on estimates from vermicomposting in India and are meant to be illustrative. In order to understand the full costs and potential revenue of vermicomposting in Conakry, it would need to be updated with local material and labor costs in Conakry. Equipment is required, but it is not costly or specialized. Gloves and a spade are recommended to sift and mix soil, organic waste and worms. A sieve is used to sift compost and a sack is needed for storage and transportation of compost. A weighing scale can be used to measure the amount of compost and a stitching machine can be used to stitch sacks for sale and storage purposes. Labor can be hired as needed, as the compost should be turned every 3 days for optimal results. Vermicomposting benefits from economies of scale. Once initial investment costs are covered, the model can become self-sustaining as long as there is a market for compost and the earthworms generated through the process. The compost can be sold for use as fertilizer or topsoil, while the earthworms can be sold for further vermicomposting efforts and other purposes including using them as fishing bait. As the demand increases, the market for both compost and earthworms develops and it helps to sustain vermicomposting either at the household scale or at the larger scale.

We calculated the cost and potential revenue from vermicomposting in Conakry, seen below in Table 3.4.3. Cost primarily comprises the cost of materials required for vermicomposting and revenue is generated from compost sold at $5.70 for 50 kilograms and worms sold at $4.30 per kilogram, based on the example from India. On average, transforming one cycle of waste to

compost takes 40 days. Worms regenerate from 1.5 kilogram to 25 kilogram in of 90 days, so 8.3 kg of worms would be generated per month. A total of 7.5 kg of compost would be generated each month and at the given market price, each unit can generate a total revenue of $36.50 and a total of $82,335.8 for 2,253 units used for a total of 1% waste diversion each month.

Table 3.4.2: Vermicomposting Equipment Costs

Equipment/variable	Cost (in $)
Weighing machine (Recommended)	43
Sack stitching machine	35.75
Sieve	28.57
Labour	7.14/day
Worms	6.45
Spade	4.28
Pair of gloves (Recommended)	0.85
Sack (50 kg size)	0.24
TOTAL	126.28

Economic model developed by our team showing the upfront costs of vermicomposting based on data from case studies in India.

Table 3.4.3: Revenue from Vermicomposting

	Per month generation (kg)	Market price ($/kg)	Revenue ($)
Worms	8.3	4.3	$35.69
Compost	7.5	0.114	$0.86
Total for 1 unit	$36.55		
Total for 2,253 units	$82,336.00		

Economic model developed by our team showing the potential revenue from vermicomposting based on data from case studies in India and the assumption of 1% of Conakry's waste diverted.

CONCLUSION AND RECOMMENDATION

Solutions that reduce the amount of waste entering the waste stream and transported to landfill will help the waste management problem in Conakry. Vermicomposting is one solution that can divert waste from Conakry's landfill[88].

Although we calculated the impact of one vermicomposting unit requiring 1.27 m^3 of land each, vermicomposting can also be done in composting bins or water tanks of varying sizes. This option can help mitigate land constraints if vermicomposting is deployed at a household level. The bins would need to be filled with soil, organic waste and worms in the same manner as pits and custom bins made out of wood can be made and stacked to increase the amount of composting in limited space.

Vermicomposting can be implemented at varying scales in Conakry, each with its own set of benefits and constraints. A decentralized model, where single households or small community composting centers are implemented in neighborhoods allows each household to contribute directly to a waste solution. This model would deeply engage community members around waste management issues and would create a clear role for women and youth, as they play an important role in each household. It would also eliminate the need for SMEs to collect and transport waste to collection points. However, if the resulting compost is sold or used in locations outside of where it is produced, transportation will have to be designed and considered.

Alternatively, a large-scale composting model where organic waste is collected and transported to a centralized location requires an organization to manage the collection, process, and sale or use of compost. Transportation of organic waste would need to be coordinated (one possibility is through the mobile buyback program explored in Chapter 3.2), but this model could benefit from economies of scale for reduced upfront costs. It also may be easier to find end-users of the compost, such as mining companies (for topsoil and mine site remediation), municipalities (for stormwater absorption or shoreline and mangrove creation), or farmers outside of the city at this scale.

SOURCE OF REVENUE GENERATION FOR COMMUNITIES IN NEED

Vermicomposting can be a source of income generation for those groups in need in Conakry. In Guinea, the youth unemployment rate is around 60% and the Peacebuilding Commission of Guinea has

youth and women's employment listed under top priority[89]. The youth and women are important social stratum of the population. Vermicomposting can help generate revenue and a steady source of income for those groups that are chronically underemployed. In Guinea, 55% of the population lives below the poverty line and youth and women have an especially difficult time finding employment[90]. A revenue generation model can be effective in helping these groups secure basic necessities and support themselves. Although a market for compost in Conakry must still be cultivated, the success of vermicomposting in Uganda and India shows that once a market is developed, the demand for compost and worms becomes a reinforcing loop. We've included a set of recommendations at the end of this section for creating markets for compost in Conakry.

COMPOSTING

Composting can also be done without the use of earthworms. As is the case with vermicomposting, in order for this method to be effective, household waste must be free of non-organic contaminants such as plastics, rubber, batteries, metal, as well as human waste. The latter could potentially contaminate waste with viral and bacterial agents that make it unusable in agricultural applications or cause cross-contamination through storm water run-off if used in cities for topsoil creation or stormwater absorption. Therefore, quality waste will only include food waste, plant detritus, and dung from healthy cattle, goats, sheep and fowl[91].

Composting also requires sufficient amounts of oxygen and water. For this reason, compost needs to be aerated by means of turning and watering if it becomes too dry especially during the dry season. Rainwater and wastewater from washing pots and pans, clothes, or floors can be used. Alternatively, compost cannot become too wet, as this will cause the compost to rot and smell, rendering it unusable. Aerating usually prevents this problem.

The decomposition of the waste produces heat, which has the additional benefit of destroying most of the weed seeds, fungal diseases, pests and parasites. For this reason, compost needs to be kept warm and moist so the plant and animal materials can be broken down quickly.

Compost can be made using either the Indor or Bangalore methods, named for the regions in India where they were developed and perfected. The Bangalore method is preferable for areas where composting materials, water, and labor are limited resources. The materials are piled in layers of "brown" and "green" ingredients until the heap is about 1 to 1.5 meters tall. This method works well in areas with large amounts of household waste and with small numbers of domestic animals, as is the case in urban and peri-urban areas of Conakry.

PRIOR TEST CASES OF COMPOSING IN CONAKRY

Composting efforts in Guinea prior to 2005 were focused on large-scale composting plants, and these efforts failed largely because of improper waste sorting, leading to the contamination of compost with inorganic waste. Other failures were due to inadequate training and education about composting. Seasonal variation limited organic materials that could be used in the wet season, a lack of funds for maintenance, and a lack of public prioritization of composting efforts also undermined the success of composting in Conakry[92].

Decentralized composting is the preferred method of composting for Guinea according to a research project performed by the Austrian Academy of Sciences. Decentralized composting can be done with minimal start up and maintenance costs and with a small number of people. However, even these minimal costs were necessary to start the project. The proof of concept project also relied on land provided by the Ministry of Agriculture[93].

COMPOSTING IN CONAKRY

As was assumed in the vermicomposting case, the model our team developed for composting assumes that 1% of the total household waste stream would be diverted - in other words, from the 1% of total waste by weight, organics would be removed and used for composting. The economic model for decentralized composting also assumes that there are minimal or nonexistent transportation costs. It is preferable for the composting to take place both near the source of waste and the location of compost use. Since this is not always possible, and likely not to be the case in Conakry, where little urban farming occurs, either of the two locations will be chosen based on land availability and willingness of the community to be involved. The economic model detailed here can produce 253 tons of compost per month, provided that organic waste inputs are free of contaminants and pollutants. Waste must be properly sorted at the household level to ensure success.

Composting can transform 400 kg of "clean" waste into 253 kg of compost. The process takes 18-30 days, resulting in 12-22 complete cycles of composting per year. However, composting is more complicated to perform during the rainy season because too much moisture will impede the composting process and increase rotting. Therefore, in our model, we only account for 6-12 cycles of composting per year, assuming most is done during the 6-month dry season.

The quantitative assumptions in our economic model were based on a research project titled "Recirculation of Local Organic Waste in Urban and Rural Agriculture - the impact on soil functions in Guinea" which was implemented at the Institute of Waste Management and the Service National des Sols in Guinea in 2005 and 2006. The project was funded in part by the Austrian Academy of Sciences and Guinean Ministry of Agriculture which provided free land.

The composting area was set up with eight naturally aerated windrows. The dimensions of the windrows were as follows: 5 m (length) x 2.5m (width) and 1.2 m (height). The total volume of this setup was 120 m3 which resulted in 400 pounds of waste. Every 1 to 2 weeks the contents of the windrows were turned manually and water was added, if necessary. This work was performed by a local women's group which consisted of forty women who were trained to maintain the compost heaps.

ECONOMIC MODEL OF COMPOSTING

As with vermicomposting, our team focused on the 1% of total household organic waste diversion from the landfill through composting, as well as anticipated costs and potential revenue of composting activities.

The model assumes that 400 kg of waste free from contaminants takes about 30 days and 12 cycles to become 4,800 kg of waste on a yearly basis. This waste can be transformed into 3,120 tons of compost as a 1% waste diversion from the landfill.

Based on a model extrapolated from the Austrian Academy of Sciences described above, the costs of building and operating a compost facility are relatively low, at $6,736.83 (in real dollars) for 8 windrows. Initial investment costs for these eight windrows which, amount to approximately 70% or $4,715.81 (in real dollars) and consist of labor and materials. The remaining $2,021.02 (in real dollars) are maintenance costs for the 6 month duration of the project. The costs are low because of the minimal need of compost maintenance and relatively cheap labor force. The maintenance costs are expected to stay around the $2,000 threshold and may be recovered through the selling of compost to local residents who may have small-scale farms in the peri-urban areas of Conakry, or to governmental agencies that are responsible for the upkeep of the Botanical Garden and the city parks. Other potential uses for compost include mine remediation, stormwater management, and artificial wetlands creation as described in more detail below.

The input material consists of waste generated at households or within the local community and therefore, aside from what is needed to incentivize good waste sorting practices, has no cost associated with it. Since this model relies on decentralization,

Table 3.4.4: Costs of Various Fertilizers Sold on Local Markets

Cattle manure	$0.06
Chicken manure	$0.09
Chemical fertilizer	$0.67
Compost	$0.46

Costs of various fertilizers based on data from the Austrian Waste Management Institute.

Table 3.4.5: Time and Waste Requirements of Composting on Local Markets

COMPOST		
Volume per unit	120	m3
Organic waste	400	kg
Time required	30	days
Cycle per year	12	cycles
Total organic waste	4,800	kg/unit/year
Total organic waste	3,120	tons/year
Compost Produced	253	tons/month
Total Waste	304,058	tons/year

Economic model of composting developed by our team assuming 1% waste diverted from landfill in Conakry.

we have not accounted for the cost of transporting organic waste to composting sites or compost to final use sites.

Compost is much less expensive than chemical fertilizer sold on local markets, as seen in Table 3.4.4, although the cost of manure is significantly lower than both. The cost of compost was determined based on 4 tons of compost produced with the Austrian Waste Management Institute and the above-mentioned yearly maintenance costs.

In our composting model, 400 kg of organic waste is converted to 253 tons of compost in 18-30 days, resulting in 35% loss of material due to evaporation and/or non compostable waste that was present in the input waste material. We assume that compost can be created 12 times per year during the dry season.

The revenue that can be generated from this production can amount to $77,740 on a yearly basis.

Taking into consideration women's SME who was trained for the Austrian Academy of Sciences composting project were paid in aggregate $8.42 per day, labor for entire daily production of the 1% diversion will amount to $5,473[94]. This will translate into $72,267 profit to the composting SME from yearly composting operations, if the compost is sold at $0.46 per kg

Table 3.4.6: Potential Revenue Generated per Month from Composting

Compost generated per month (kg)	253
Market price per kg ($)	0.46
Revenue per unit ($)	119.6
Total for 650 units	77,740

Our team calculated the potential revenue generated from composting based on estimates from the case studies we reviewed.

COMPOSTING AND VERMICOMPOSTING WASTE DIVERSION RECOMMENDATIONS

Composting and vermicomposting both produce compost that can be used for similar purposes, so we recommend UNDP choose to focus on one method for Conakry based on potential benefits of either method, scale of composting implemented, and the needs of the residents most impacted. Although similar, one clear benefit of traditional composting is that other than land and minimal labor, composting requires nothing else, while vermicomposting requires purchasing and maintaining the worm population and ensuring the health of the colony so that it can perform at its best. On the other hand, though, labour is required to turn and aerate the waste in vermicomposting, it is minimal and the earthworms do the work of turning waste to compost.

Composting, if implemented properly, can create new economic opportunity for women and youth, as outlined previously in this chapter.This is because households tend to be run by women and they could incorporate composting into their daily routine. As they cook and clean their dwelling, they could gather compostable materials and bring them to composting sites where they could then provide any needed maintenance for the composting in progress. Similarly, for vermicomposting, household organic waste can be used by women who primarily run households to incorporate vermicomposting as a regular routine. Vermicomposting as compared to composting has a wider potential for revenue generation through two streams of income. Revenue can be generated by both the sale of compost as well as the sale of earthworms for further vermicomposting efforts and/or other purposes including using the biomass as fishing bait. In order to maximize these benefits, we suggest that a need assessment is carried out to identify community leaders interested in composting efforts, identify the best locations for composting based on environmental, social, and economic benefits, and understand what social or community issues need to be addressed to ensure new composting efforts are successful.

During the course of our study, we were told on several occasions that there is limited agricultural activity near Conakry's city center where composting will take place, and currently there is not a viable market for compost. In response, our team has tried to imagine alternative uses of compost which can create a local market for compost, add value to organic waste, and provide additional social and environmental benefits.

WATER RETENTION AND ARTIFICIAL WETLANDS

Apart from increasing soil fertility, compost can be effective in water retention. Soil to which compost has been added significantly lowers runoff volume due to its improved water holding capacity.[95] Compost blankets can help restore soil fertility and improve water holding capacity to reduce erosion in the region. Conakry receives more than 133mm of rainfall from May to November, with average rainfall rising to over 44mm of rainfall in July and August.[96] Heavy precipitation causes landslides and flooding in the city. A lack of infrastructure and effective waste management exacerbates flooding as storm drains become clogged.[97] Because compost blankets can improve the infiltration rate of soil up to 90%[98], a study of all open land in Conakry including unpaved streets, road medians and other marginal land may yield locations for composting application that can enhance the city's storm water management program. This approach to "green infrastructure" has gained increasing traction in the US state of Minnesota,[99] for example, and has proven a low-cost, environmental solution to stormwater management. A blanket of compost can be an effective solution to the problem by increasing water retention capacity of the soil, reducing the impact of heavy rainfall, flooding and drainage problems in the city.

The ability of compost to retain water can be used to restore functionality of the city's riparian zones and create artificial wetlands. Wetlands, natural or constructed, act as water treatment facilities for rivers and can protect shorelines while also enhancing local biodiversity. Compost can serve as the foundation for these systems and in addition, encourages plant growth and acts as filtration systems. For example, acidic water or water that contains high levels of ferric iron, aluminum or dissolved oxygen can be successfully treated with compost.[100] In Conakry, the waterways have become so polluted that many of them within the city limits are unsafe for consumption. Creating artificial wetlands could aid in the purification of local rivers and ponds with flowing water.

REHABILITATING MINING SITES

Mining is a robust industry in Guinea, as the country has the largest bauxite reserves in the world. The mining industry makes up 17% of the country's GDP and accounts for over half of its exports[101]. Bauxite is generally extracted using surface mining that begins with the removal of vegetation and topsoil at the mining sites[102]. The most significant impact of mining can be seen in the landform changes that occur due to removal of vegetation, topsoil and disposal of large quantities of waste. Dust from this process has been shown to negatively impact farming, especially in the Boke and Kandia regions. Compost produced in Conakry might be used for land remediation and increasing soil water retention at former mining sites and near current sites where red dust is a byproduct of mining activity. Using compost is a relatively inexpensive mine waste mitigation method and is non-destructive to surrounding environments compared to the use of topsoil transfer from nearby sites. Use of vegetative compost can increase microbial activity and protect against erosion and compost decreases the concentration of contamination within the soil and creates a more suitable growing environment for plants. Application of compost seems to be most effective in "reducing the uptake of heavy metals and their negative impacts on plant fecundity.[103]" The strong infrastructural ties that connect Conakry to the bauxite mining regions for the transportation of bauxite ore might also be effectively used to bring compost to those regions.

The mining industry boom in Guinea is a good source of revenue for the government and mining companies.[104] However, the mining industry has received criticism for the impact it has on the lives of the rural communities living near mining sites[105]. A general feeling of discontent amongst the locals demands greater investment in the remediation of mining sites. Financial support from mining companies to start composting projects in Conakry and transport compost to mine sites could be attractive in the face of growing discontent. UNDP, working with the national government and mining companies might develop methods to scale composting to be used for mine remediation.

LANDFILL RETIREMENT

Compost can be used as a cap for a landfill cell when the landfill is taken out of commission in order to encourage vegetation and reduce erosion. Capping a landfill with compost reduces methane emissions from the landfill because of methanotrophic bacteria that are present in compost. As mentioned previously, because of compost's ability to hold water and nutrients, its presence helps increase vegetation and thereby reduces erosion and sediment run-off.[106] Because it is scheduled for retirement in the near future, the Concasseur landfill is an excellent candidate for the use of locally produced compost. It can be capped precisely in this manner. Additional details on landfill retirement can be found in Chapter 6 of this report.

4:

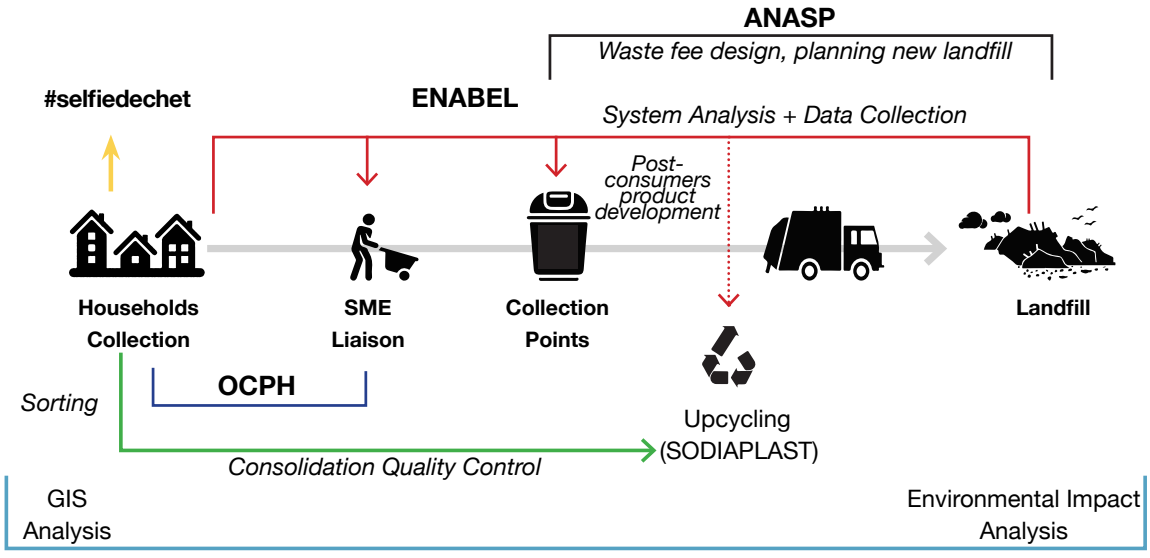
LANDSCAPE MAPPING

Currently, the waste management landscape in Conakry encompasses a number of different stakeholders working on the issue at varying levels. Our team observed direct funding agencies such as the World Bank, the Islamic Development Bank and the European Union, among others; international development organizations such as Enabel and Organisation Catholique pour la Promotion Humaine (OCPH); the national government agency Agence Nationale de l'Assainissement et de la Salubrité Publique (ANASP); entrepreneurs such as Societé Dia Plastique (Sodiaplast) and Topaz; local nonprofits such as Femmes, Pouvoir et Developpement (FEDEP); and educational institutions such as the Université Gamal Abdel Nasser de Conakry (UGANC) and the American International School of Conakry.

CONAKRY'S CURRENT WASTE MANAGEMENT STAKEHOLDER LANDSCAPE

In order to cross-reference the analysis offered elsewhere in this report with the actors and agencies whose work we have consulted during our research, we have developed the diagram below. It identifies the efforts – as we understand them – of these actors and agencies relative to the current two-waste management system, as in Figure 4.1 below. The goal of this diagram and the section that follows is to assist UNDP in optimizing its efforts, avoiding duplicative work, and pursuing partnerships.

Figure 4.1: Landscape Map of Household Waste Management Stakeholders in Conakry



UNIVERSITÉ GAMAL ABDEL NASSER DE CONAKRY (UGANC)

Designed by team member Rafaela Behrens based on conversations with stakeholders."

AGENCE NATIONALE DE L'ASSAINISSEMENT ET DE LA SALUBRITÉ PUBLIQUE (ANASP)

Description: ANASP is the official governing body overseeing waste management in Guinea. During our meetings, we heard on several occasions that this government agency has a limited budget and thus limited capacity to realize change or to deploy waste management strategies single-handedly. The goals of the agency are nonetheless ambitious.

Current involvement in waste management: As a government agency, ANASP is responsible for moving waste from collection points to landfill. Both the collection points and the landfill are under its jurisdiction. ANASP subcontracts with privately-run waste haulers to transport waste and seems to be considering increasing private contracts to build capacity. The World Bank, the Islamic Development Bank and the EU all have current projects with ANASP.

Activities/Goals: ANASP's biggest priority as of March 2019 is to clean up the city. It has recently been the recipient of 40 new garbage trucks gifted by President Erdogan of Turkey. Also of interest to ANASP are innovations in waste fee collection methods, which might include new taxes or tariffs into which waste fees are embedded. ANASP is working with the European Union on a plan to build a new landfill 60 km away from Conakry.

Opportunities for UNDP: Given ANASP's interest in pre-collection interventions, it could be a useful partner in building capacity of SMEs to integrate mobile buyback programs that incentivize waste sorting and recycling at the household level (outlined in Chapter 3 of this report). The desire for a reliable waste fee may also be an opportunity for UNDP to contribute to ensuring equitable collection solutions, such as a progressive fee, are considered. Our team has outlined considerations for a progressive fee in Chapter 3 of this report.

FATOUMATA CHERIF, ACTIVIST AND FOUNDER OF FEDEP

Description: Fatoumata Cherif is a blogger and activist in Conakry known for creating the #SelfieDéchets social media campaign to raise awareness and action around waste problem in Conakry. She is also the founder of the nonprofit Femmes, Pouvoir & Development (FEDEP), focused on women's empowerment and opportunity building.

Current involvement in waste management: Ms. Cherif is well-connected and well-respected in Conakry, and extraordinarily knowledgeable about waste management system as a whole, including all players involved and their strengths and weaknesses. She is also an expert on women's empowerment issues. She provided invaluable information about the current system in Conakry, including the ways in which quality control remains a major obstacle to recycling and to accessing secondary markets for waste. She has developed innovative concepts about waste collection fees and how households might be paid for their sorted waste. Her input affirmed our efforts to adapt for Conakry the mobile buyback program recommendation outlined in Chapter 3. She also provided additional information on the resale market for steel and on household practices, especially those of women. She referenced the potentials of biochar, another potential means to further divert organic waste from landfill. Based upon her considerations, we have included information on biochar in Chapter 6.

Activities/Goals: Ms. Cherif's work involves using social media to mobilize clean-up events and to raise awareness of the waste problem, putting pressure the government to address it. Ms. Cherif's ideas are fresh and innovative, for example, she advocates for construction firms and other businesses working in the city to be mandated to participate in the monthly 'Conakry Ville Prope' events by hauling waste or providing volunteers.

Opportunities for UNDP: Ms. Cherif is a natura la liaison with community groups and engaged youth. She has built an extensive following on social media and can be a good source of information on community leaders and the needs of particular communities. Through her reporting and other media participation, she propagates real stories of real people at the forefront of the fight against waste.

ENABEL

Description: Enabel is an economic development agency charged with implementing Belgian international development policy. It partners with 14 developing countries, mostly in Africa, to implement various sustainable development strategies including waste management.

Current involvement in waste management: Enabel's work in Conakry on the waste management system has focused on how waste moves from households to collection points. Their work has also directly involved planning for new waste sorting collection points. They have studied the overall system in detail and have also identified entrepreneurs who are developing or already producing consumer products from recyclable waste.

Activities/Goals: Presently, Enabel is working on new waste collection stations designed to separate waste. In considering how household waste might most effectively be gathered, Enabel has looked to a spatial organization which existed 15-20 years ago and which relied on mandatory payments. Under one proposal in development, each community would be assigned to a single SME who would manage a single collection point for that neighborhood, a scheme that has been named "a 1:1:1 solution". Within this proposal is also a consideration of how to draw "wastesheds" that might pair less affluent parts of the city with more affluent areas that have a higher capacity to pay the waste collection fee in order to ensure fair distribution of costs based upon elasticity. Another proposal might include fee reduction to households whose waste is separated prior to collection. Additionally, Enabel has been in conversation with a woman entrepreneur who is using post-consumer plastics for paving stones.

Opportunities for UNDP: UNDP can benefit greatly from Enabel's extensive knowledge on socioeconomics, waste components, costing, models, utilities, and recycling schemes. Enabel's existing work on household sorting and progressive fee structures make them a strong partner for developing a mobile buyback program and more equitable waste collection fee. Its work on plastics recycling can help in calculating the economic feasibility of new post-consumer markets for plastics.

CENTER FOR ENVIRONMENTAL STUDIES AND RESEARCH (CERE) AT GAMAL ABDEL NASSER UNIVERSITY OF CONAKRY (UGANC)

Description: UGANC's CERE is currently gathering extensive information relevant to waste management in Conakry including geospatial and socioeconomic data. Work on environmental impact of waste streams is also within the research portfolio. Because of its academic nature, CERE works independently of other organizations and maintains an objective position.

Current involvement in waste management: The institution's involvement in waste management includes data and information gathering, with several doctoral students working on waste management via GIS and other methods. While a full account of all projects was not available to our team, our single meeting with CERE in Conakry revealed an impressive range and capacity.

Activities/Goals: We were told specifically about two ongoing PhD projects on waste management in Conakry. One is addressing the perception of waste at the household level, while another is focused on spatial analysis of waste. CERE members expressed interest during our visit in best practices for landfill management and retirement that exist in the US including landfill biogas harvesting for use in electricity generation. Additional information on landfill management and retirement can be found in Chapter 6 of this report.

Opportunities for UNDP: CERE's extensive research portfolio make it a natural source of information for quantitative and qualitative information. We recommend strongly in favor of geospatial (GIS) based mapping in order to design equitable and optimal waste sheds, among other undertakings in the next phase of work on Conakry's waste management. UGANC's CERE has the capacity to use geospatial data to properly scale and assess the household waste management system. In Chapter 6 of this report, we explain further how geospatial data, in partnership with UGANC or others, can be considered.

ORGANISATION CATHOLIQUE POUR LA PROMOTION HUMAINE (OCPH)

Description: The Organisation Catholique pour la Promotion Humaine (OCPH) is a faith-based organization working to promote community and human development in Conakry. As an implementing partner of USAID, OCPH has worked to improve people's living conditions and has focused on humanitarian assistance and community development.

Current involvement in waste management: OCPH launched the "Projet de Gestion des Déchets Solides à Conakry" also known as Conakry Fentenyi in 2017. The project is expected to come to a close in November 2019. The program aims to ensure that citizens of Conakry live in a healthier and safer environment. Its objectives include improving the cleanliness of Conakry; educating residents on the importance of proper waste management for human health reasons; training them to properly handle, sort, and dispose of waste; and increasing recycling in the city.

Activities/Goals: OCPH is working directly with 72 SMEs in Conakry to build capacity, optimize business models, and ensure sustainability of operations of the small businesses involved in waste sorting and collection. It works with community members, including leaders of local communities and women's groups, to understand the issues which impact these groups most, and to identify opportunities that would help streamline the household waste management system. For example, OCPH worked to distribute recycling bins to households to encourage waste sorting at homes. The bins were purchased at a reduced cost by OCPH from Sodiaplast, then wholesaled to SMEs who sold them to individual households.

Its program target is strengthening and streamlining the recycling process in Conakry through education and capacity building. It is measuring success through a reduction in disease and increased perception of the cleanliness of the city.

Opportunities for UNDP: UNDP could benefit from OCPH's market expertise and networks of SMEs and community groups. OCPH's program and progress thus far provides a solid foundation for increased recycling in Conakry. They also have developed an intimate knowledge of household behaviors relative to waste and waste sorting, and know many of the waste haulers operating in Conakry. These two relationships make OCPH an invaluable source of knowledge for any bottom-up approach to capacity building and behavioral change agenda. OCPH could, for example, help SMEs to integrate mobile buyback programs that incentivize households to sort their household waste. UNDP could also learn from OCPH's past efforts to increase composting in Conakry. Dr. Fode Konate and his team have been instrumental in providing our team with information that has shaped our project, especially with the detailed information we needed for our economic models of the current system. They also provided detailed maps of collection points and other landmarks in Conakry (included in Appendix).

SODIAPLAST (SOCIETÉ DIA PLASTIQUE)

Description: Mr. Moussa Dia founded Sodiaplast to deal with the influx of plastic waste in West Africa. To ensure his supply of the quality post-consumer waste from which he manufactures his products, he provided upfront capital to waste collectors to start 3 collection points around Conakry: one at the airport, one near the center of Conakry and another at the Concassure dump. The company operates regionally, with factories in Guinea and Senegal and collection points in Sierra Leone, Liberia, Senegal and Guinea. Its goods are sold throughout West Africa. His operations are vertically integrated to ensure a reliable supply of clean, high quality plastic film. The only other element required in manufacture is iron ore, which gives the products their characteristic red-brown color.

Current involvement in waste management: The three collection points supply Sodiaplast with 15 tons of plastic film each day. The people employed in running these collection points are focused mostly on the pre-collection stage of waste management, or the path from home to the collection point.

Activities/Goals: Sodiaplast owns 2 box trucks and 3 smaller trucks that it uses to pick up plastic film from its three collection points and the 70-75 independent collection points it works with throughout the city. As soon as waste collectors can

deliver 500 kg of plastic film, it is financially feasible for Sodiaplast to send a truck for pick up. Sodiaplast serves the community by creating employment opportunities for both the waste collectors and the people who work in its recycling facility. The company sells high-quality products that are in high demand, such as washboards and storage bins. OCPH selected Sodiaplast to provide waste collection bins for SMEs which in turn were sold to households as way to encourage household waste sorting as part of OCPH's waste management pilot program. Mr. Moussa Dia also works with students and pupils from educational institutions to increase capacity of his operations while also raising awareness of waste management issues

Opportunities for UNDP: UNIDO has recognized the company as a model for West African sustainable development. Sodiaplast's model is designed to integrate different actors, supply chain needs and collaboration points for the full cycle of delivering plastics, transforming them into goods and providing training and education for the community. Since Sodiaplast has already established its relationship with local, regional and global stakeholders, it is a model for any strategy that hopes to transform waste into part of a value chain. The company's ability to maintain quality control and to manage supply chain would be a model of recycling best practices anywhere in the world.

AMERICAN INTERNATIONAL SCHOOL OF CONAKRY

Description: The American International School of Conakry is a private K-12 school for children of diplomats and wealthy Guineans, where yearly tuition is around $19,000 per child. There are 17 students in the high school.

Current involvement in waste management: There are no active composting projects on the school grounds but there is interest in implementing something in the near future and composting has been attempted in the past, from which two bins survive on campus. The school has a no-plastics on campus policy, with the intention of raising awareness among the young students.

Activities/Goals: Our contact at the school, Nicholas Kaufman, is interested in implementing robust science curriculum that can teach sustainable practices through science instruction such as cooking oil purification for biodiesel (in chemistry class), composting (in biology class), and anaerobic digestion.

Opportunities for UNDP: The school might offer the opportunity for a proof-of-concept or pilot project n composting and/or vermicomposting project to see how the worms behave in Conakry's climate, for example, or how composting could be performed in the most efficient manner.

NOTES ON INFORMATION REFERENCED IN THIS SECTION

On March 17-22, 2019 three members of our team embarked on a six-day trip to Conakry, to better understand the local context, meet with stakeholders, and test the feasibility of the solutions we researched in the first stage of our project. Each day of the trip was dedicated to meeting with our identified contacts, and one entire day was spent visiting official and unofficial collection points and the existing landfill. On this particular day, the group used a GPS device to map some of the waste accumulation points to have a better understanding of the scope and spread of the issue, in order to be able to craft solutions based on the make-up of the neighborhood. The trip provided photos, videos, and other context about the situation that we could not have gathered otherwise. We were able to understand the extent of the informal waste economy in the city, as well as the lack of proper equipment and detrimental working conditions. The information about each agency listed above is a compilation of both preliminary research and personal interviews conducted during the team's time in Conakry.

CONCLUSION

Each organization described above works on household waste management at different scales, from different perspectives, and with different stakeholders in mind, based on their classification as either local or international, and their place within the waste management system. Some organizations are private, others are nonprofit or governmental. As our team observed during our assessment of the waste management system, there are currently many players working in this field. It is possible that this could lead to some efforts being duplicated or overlapping, while some areas remain unaddressed creating gaps. Our goal was to identify those gaps and bring them to UNDP's attention. We also found positive examples of how careful landscape mapping can open opportunities for synergies. For instance, OCPH's utilization of Sodiaplast's products in pre-collection efforts is a good example of bridging two entities with a common goal: by purchasing products made with post-consumer waste, OCPH acted in accordance with the project's principles while also introducing the methods needed to sustain value creation from waste. Likewise, Enabel and UGANC/CERE could collaborate to ensure that optimized geospatial and socioeconomic data could be used to scale projects. Fatoumata Cherif, as an independent observer, could fill many existing information gaps relating to local initiatives or women and youth empowerment organizations relevant to waste management in particular. Sodiaplast's initiative to create its own waste collection points shows that pre-collection stages can indeed be managed and refined, but that they are an indispensable part of recasting waste as potential value. . By the time the unsorted waste gets to the landfill, it has become either too unwieldy or simply dangerous to sort, as the methods used by the waste pickers involve burning waste and rummaging through for salvageable materials to sell. Filling the gap at the household level would translate into cleaner waste that could be recycled or sold, as is the case with plastics and metals; or composted or turned into fuel as is the case with organic waste. In both cases, countless benefits could be derived, from obvious potential for profit-making to the health benefits of not having waste left in the streets where it exacerbates flooding, spreads disease and propagates unsightly living conditions.

5:
CASE STUDIES

In order to help identify innovations and proof-of-concepts relevant to waste management in Conakry, our team identified innovative large- and small-scale solutions to household waste management throughout Africa and other developing cities. From our conversations with UNDP and other stakeholders in Conakry, we narrowed our focus areas to the three solutions we outline in the economic model section of this report. However, there are many other approaches that UNDP can consider that are very specific precedents that could be extremely helpful references for the future of waste management programming. Our report primarily focuses on higher level findings as a function of the decision to invest strongly in economic models. We believe that UNDP will find many solutions in the case studies outlined below that add dimension and specificity to the higher level suggestions made elsewhere in the report. This chapter aims to serve as a menu of waste diversion tactics with recommendations tailored specifically to the context in Conakry. We have focused on five topic areas: Artisanal Solutions; Integrated Waste Management; Transportation, Collection and Sorting; Waste-to-Energy; and Education.

5.1:

ARTISANAL

Our team found a number of examples across West Africa, East Africa and South Africa of organizations and social enterprises using craftsmanship to address waste management through the upcycling of glass, plastic, and other materials on a small scale. These programs provide economic opportunity for women, youth, and other marginalized communities as their core objective.

From our research, it is clear that there is no shortage of products that can be created. Most programs provide women with training to lean how to make the products from the collected materials. However, the biggest challenge is finding a viable market to sell these goods to ensure sustainability of the program and maximum impact for the women and youth groups served.

We've included a few examples of programs below to illustrate the breadth of programs. If UNDP chooses to pursue small-scale, artisanal solutions to waste management, we recommend it works with local artisanal groups to understand their scale and the issues they face. Establishing a sustainable market can be accomplished by working with global associations like World Association of Women Entrepreneurs (Les Femmes Chefs d'Entreprises Mondiales) (managed through the Ministry of Social Affairs) or the Association of Women Entrepreneurs of Guinea. Femmes, Pouvoir & Developement (FEDEP), a nonprofit in Conakry founded by Fatoumata Cherif, aims to empower women to play a more integral role in sustainable development and decision making in Guinea through skills training, leadership and women's entrepreneurship. FEDEP has provided training of 500 girls including 300 in the fields of crochet art, embroidery, sewing, weaving pearls, and 200 in basic computing, and could be a strong partner in establishing artisanal household waste solutions. Boost Africa, a joint initiative between the African Development Bank and the European Investment Bank is another program focused on empowering young African entrepreneurs and can help in building market access for these programs107.

We've included additional recommendations for programs that seem especially relevant for Conakry, otherwise the remaining case studies provide a survey of the types of waste that can be upcycled and the variety of products created.

It is important to remember that many of the products and processes described below use post-consumer materials that may be considered low value among recyclers. Artisanal solutions are the best method to move low-value materials into high-value economic sectors such as fashion, construction or traditional craft-inspired products. UNDP would be well positioned to assist in convening some of these entrepreneurs in Guinea for a summit on what artisanal solutions might be leverage the country's traditional capacities. The solutions can provide added value for post-consumer materials, guarantee access to consumers able to pay higher prices for the goods created and sustain traditional handicrafts as part of Guinea's national heritage.

ARTISANAL:
RETHAKA FOUNDATION'S REPURPOSE SCHOOLBAGS

PROBLEM

In rural areas in South Africa, it is more difficult for children to go to school and perform well when they don't have access to basic necessities like electricity. Once the sun goes down, families only have access to candle light and it is difficult for children to complete their homework. In addition, schools are often located a long distance from children's homes. Children must walk long distances in the sun carrying everything they need for the day. This is extremely dangerous as some children may have to walk to school in the early hours of the day or late at night, putting them at risk of getting hit by a car due to lack of visibility.

In addition, plastic consumption and waste is a huge issue in South Africa. It's a major source of pollution and an even greater health risk. The already scarce access to fresh water has become contaminated with plastic and waste products. With a lack of recycling options, many times residents burn their plastic, releasing one of the most dangerous toxic chemicals for the human body to inhale. In addition, South African landfills are filling up and there isn't the proper infrastructure for sufficient plastic recycling to deal with the problem.

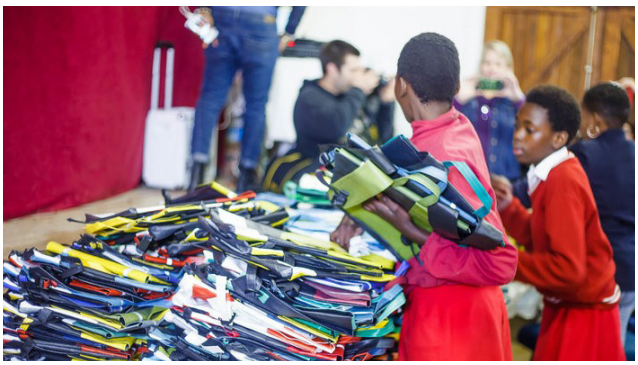
PROJECT DESCRIPTION

Repurpose Schoolbags is a brand founded in 2013 based on the goals of innovation and solution-oriented manufacturing through the Rethaka Foundation based in South Africa. The two founding entrepreneurs discovered they could upcycle the plastic littered in their local communities and build backpacks for local children. In addition, these backpacks have a built-in solar panel and battery that charges during the day and operates as a light in the evening when the sun goes down to replace candles. Many schoolchildren live in rural communities without electricity, making the bag's light important to the family as a whole. In addition, the bags are reflective to protect kids who walk on the side of the road so that drivers can see them and prevent accidents. Major donors such as Unilever and the Bill & Melinda Gates Foundation have teamed up with Repurpose to cover the costs of the bags for local schools in South Africa.

Repurpose also operates a grassroots campaign that engages students with the environment around them and gives them an opportunity to contribute to a meaningful product they can benefit from. Schools run campaigns to get students to bring in plastic to be upcycled. Plastic for the bags is picked from landfills by students and local community members. The plastics come to the Repurpose shop where they are processed into a textile and sewn with large industrial sewing machines.They are then distributed to the school for the students[108].

OPPORTUNITIES FOR CONAKRY

While most of Conakry has access to electricity, Repurpose can serve as an example for Conakry in two ways. UNDP can work with local schools to implement a similar type of grassroots program, where students are encouraged to bring elements from their household waste to schools which are then used to create products that address a specific issue within Conakry. Alternatively, Conakry's waste, collected through a proposed mobile buyback program and/or in partnership with schools, can serve as a supply chain partner for Repurpose's operations in South Africa.



Students choose Repurpose backpacks made from upcycled plastic

ARTISANAL:
SOKO IN NAIROBI, KENYA

PROBLEM

The founders of Soko sought to create economic opportunity for women artisans in Nairobi, Kenya by creating an online platform, similar to Etsy.com, for jewelry artisans to sell their products internationally. However, they realized this model wasn't sustainable, as there was limited demand for the products being produced and sold on the site. In order to address this market access issue for their artisanal goods, Soko created a new innovative approach that relies on technology to quickly respond to changing trends in fashion and jewelry.

PROJECT DESCRIPTION

Soko is an ethical fashion brand that uses technology to connect talent from emerging markets with international fashion consumers. Soko designs products and works with international designers, mostly in the US, who have demand for those products in museum shops, boutiques, and other specialty stores. Soko works with artisans to build their production capacity to respond to these desired product designs quickly, and Soko collects the completed items at its central office in Nairobi for finishing, quality control, packaging, and distribution. Soko keeps up-to-date on which skills are in rising demand based on market shifts, so the company can train artisans in new skills when necessary and thus keep all its suppliers employed for the long term.

Currently, it takes Soko one to two weeks to design a new product, two weeks to produce the product using its network of over 2,000 artisans, and two weeks for finish the product, ensure quality control, and ship it to stores. This allows the company to bring a new product to market in five to six weeks, allowing them to participate in the fast fashion market[109][110].

OPPORTUNITIES FOR CONAKRY

Soko is an example of how a company focused on artisanal goods created a sustainable market for those products. By digitizing their operations, Soko is able to quickly and frequently change their designs to respond to product demand. Should an artisanal solution be implemented in Conakry, working with the founders of Soko to design a similar platform and business model could ensure the success of the business. Alternatively, UNDP can explore whether artisans from Conakry could be added to Soko's growing network of artisans.

Handmade jewelry made my Soko artisans

ARTISANAL:
ECOPOST IN NAIROBI, KENYA

PROBLEM

Ecopost was created to address growing urban plastic waste and chronic unemployment of youth in East Africa. The company transforms plastic, which is environmentally harmful if discarded improperly, into an eco-friendly building material that can be used by governments, schools, organizations, homeowners and business owners. With the total volume of waste generated globally expected to increase rapidly, Ecopost's innovative, technology-based model can help alleviate waste management throughout Africa while also creating jobs and decreasing deforestation.

PROJECT DESCRIPTION

Ecopost recycles plastic and agricultural waste, such as rice and coffee husks, into a Wood Polymer Composite (WPC) material that can be used for fencing, road signage, outdoor furniture, lockers and other products. These products would often be constructed from wood, so the use of Ecopost material reduces deforestation. The company has customized training programs for workers, as well as educational tours and training for primary and secondary school students to educate students on eco-friendly topics. Ecopost relies on a points-based system tracked through a custom text message-based phone application. Waste collectors provide Ecopost agents with plastic waste, agents measure the weight and moisture content of the plastic and log the info into the app. The supplier then receives a text message confirming the points they received based on the quality and quantity of waste delivered. Clients can then redeem these points for phone minutes, shopping vouchers or mobile money. Ecopost specifically hires youth and women, and prioritizes waste collected from women- or youth-led waste collection groups, creating job opportunities for these groups. Additionally, having a market for the agricultural waste supplements farmers' revenues.[111]

Fence made with ECOPOST

OPPORTUNITIES FOR CONAKRY

Ecopost's model provides a number of opportunities for UNDP. First, UNDP can foster a partnership with Ecopost, or a company like it, with SMEs in Conakry to create a post-consumer market for plastic waste. This type of partnership would reinforce the business case for SMEs to create buy-back models where waste is sorted and collected at homes. Because Ecopost is focused on social issues, their model would work especially well for waste collection groups that are majority women or youth. Alternatively, UNDP could support the creation of a company like Ecopost, working with Sodiaplast, Topaz, or another companies that use recycled material as feedstock to expand their offerings to this type of product. This would also create a post-consumer market for plastic and organic waste, create local jobs, and the resulting building materials could be used in the booming construction and development in Conakry.

ARTISANAL:
OCEAN SOLE IN KENYA

PROBLEM

Flip flops, the plastic foam thong beach shoes now worn throughout the world, have a very short product life but are not designed for upcycling or for reuse. Because they are often used at beach resorts, they can make their way into sea animals and ocean plastic waste concentrations.

PROJECT DESCRIPTION

Ocean Sole, founded in 2005 by a marine conservationist, is an organization that recycles flip-flops into art, home decor, and accessories. Located in Nairobi, Kenya, the organization pays women to collect and wash discarded flip flops and trains them to upcycle them into products that are sold in hotel gift shops across the world. Products are also sold directly through their website. About 90% of their customers are from the US. It has created environmental and social value by facilitating the collection and recycling of flip-flops as well as through environmental awareness-raising among local communities and end customers. The company also works to provide a healthy work environment through fair wages and worker benefits. Ocean Soles currently employees 80 people and plans to expand to 120[112].

Figures made with recyled Flip Flops

OPPORTUNITIES FOR CONAKRY

Although beach thongs may or may not be a high percentage of Conakry's household waste, the approach taken by Ocean Sole to design and create desirable consumer products from a type of post-consumer waste for which no other market exists, can be instructive. Small scale artisanal work can best contribute to Conakry's waste problem when it is focused on using waste items for which no other market exists. In addition, Ocean Sole's success in accessing an international market, focused on sales in places where the problem is located - at beach resorts - is instructive.

ARTISANAL:
THE BEAD CHEST IN GHANA

PROBLEM

Loss of artisanal capacity is a loss of national heritage. By substituting much lower cost post-consumer glass granules for virgin material, this project solved two problems at once: the need for a higher value post-consumer market for recycled glass and the need to create and sustain an economically viable market for traditional glass beads.

Beads made with recycled glass

PROJECT DESCRIPTION

The Bead Chest supports the creation of African glass beads from recycled glass by members of the Krobo Tribe. Post-consumer glass is compressed into a dry grain, which is heated and cast into beads. The organization's mission is to provide quality beading supplies, while supporting women in developing communities. All beads are sold on an e-commerce site that sells the beads directly to jewelry designers, fashion designers, and other people interested in crafts. It is committed to providing the Krobo Tribe with access to international trade in order to improve their regional economies, earn a steady wage and provide a future for themselves and generations to come[113].

OPPORTUNITIES FOR CONAKRY

Because artisanal scale solutions can only deal with a small portion of household waste, it is particularly important that the products created are higher value and reach an audience willing to pay for that higher value. The Bead Chest offers a precedent of how social entrepreneurship can play a role in creating this economic relationship.

ARTISANAL:
E-COVER IN SENEGAL

PROBLEM

Tires appeared to be a significant proportion of the waste at the Concasseur landfill in Conakry. More worrisome was the practice of burning tires to recover the steel bands inside them, which are used directly by local women as part of the grill for cooking above charcoal or are sold to recyclers. The burning tires give off noxious fumes, a cloud of which hovers over the dump even on clear days.

PROJECT DESCRIPTION

E-Cover is a social enterprise that repurposes discarded tires into rubber shoe soles and rubber tiles used for playgrounds, courtyards, coverings for swimming pools, sports fields and roads. The company was started to address poor waste management by creating products that can be sold to businesses and government agencies throughout Senegal. E-Cover provides skills training for it workers, who collect discarded tires as material inputs and create products in the company's workshop[114].

OPPORTUNITIES FOR CONAKRY

As a successful business built around using post-consumer tires, E-Cover is particularly interesting because of the considerable benefits of taking tires out of the waste stream entirely. UNDP can encourage the development of an entirely new post-consumer material market by supporting tire buy-back programs. Given the many unpaved roads in Conakry, the potential for a paving product made from disused tires can address both infrastructural scale and artisanal or entrepreneurial scale economic development.

Sandal made from recycled tires

ARTISANAL:
ECO SHOES IN GHANA

PROBLEM

Eco Shoes was created to address a number of issues in Ghana including waste and pollution, a lack of access to proper shoes for school children which results in the spread of disease, and a lack of job opportunities for women, youth, and people with disabilities. Their approach uses post-consumer materials to address these problems.

PROJECT DESCRIPTION

Eco Shoes is a social enterprise that uses circular economy principles by upcycling waste, such as discarded fabric, rubber tires, and discarded footwear into shoes. They provide skills training for women, youth and people with disabilities to produce the shoes, providing steady economic opportunities for these groups. They also work with Ghana's most creative and sustainable footwear producers to define new strategies, create online channels, and market their crafts to local, national and international markets. Through the profits from their global sales, Eco Shoes provides durable shoes to Ghanaian school children at an affordable price, protecting them from disease and ensuring they can attend school regularly. Eco Shoes is an excellent example to local communities about how to get creative about reusing materials, extending materials' lifecycles, and reducing waste[115].

OPPORTUNITIES FOR CONAKRY

Eco Shoes might be encouraged to grow their operations regionally, if support for expansion into Guinea were available. UNDP could assist by connecting the company with local business opportunities.

Shoes made with a variety of recycled materials

ARTISANAL:
ALL WOMEN RECYCLING IN CAPE TOWN, SOUTH AFRICA

PROBLEM

With the advent of PET bottles throughout the world economy, a glut has been created in PET plastics that far outstrips the pay-off in material reuse, although PET is often cited as the most “recyclable” of plastics. By reusing PET bottles in their original form, this project removes an energy-intensive step in the reuse chain and creates high-value products from a low-value recyclable.

PROJECT DESCRIPTION

All Women Recycling upcycles plastic bottles to make gift cards and boxes called Kliketyklikbox which are sold worldwide. This initiative upcycles over 500,000 plastic bottles each year while providing in their manufacturing centers a safe place for women and disabled people to develop skills through training programs to create upcycled products. The company uses discarded 2-litre plastic bottles which are sourced from dumpsites, community centers and schools. The company aims to create a unique product while addressing local social and environmental issues. It plans to expand its employees to over 400 people, offer new products, and replicate their business model in India[116].

OPPORTUNITIES FOR CONAKRY

Although PET bottles seem currently not to form a large proportion of Conakry’s waste stream, this project offers an object lesson in creating high value product from the lowest value recyclable. The status of PET bottles as a proportion of Conakry’s waste may also change as producers move away from traditional glass bottles.

Kliketyklikbox, boxes made with PET bottles

5.2:
INTEGRATED WASTE MANAGEMENT

Waste is hauled into Conakry's landfill.

Throughout Africa, rapid urbanization has led to growing waste production, which many local governments have not been able to handle. Our team researched large-scale solutions to this growing waste management problem. The examples below provide guidance on integrated programs, cost recovery techniques for waste collection, and ways to improve the quantity and quality of household waste management services at a large scale[117].

INTEGRATED WASTE MANAGEMENT:
R20 PARTNERSHIP IN ORAN, ALGERIA

PROBLEM

Oran, Algeria is a coastal city in north-west Algeria, considered the second most important city of Algeria after the capital, Algiers, due to its commercial and cultural significance. Like many other African cities, Oran has experienced rapid population growth and its infrastructure and municipal services have not been able to keep up pace. The municipality faces deficient and inadequate waste management infrastructure, few collection points, and excessive dependence on landfills.

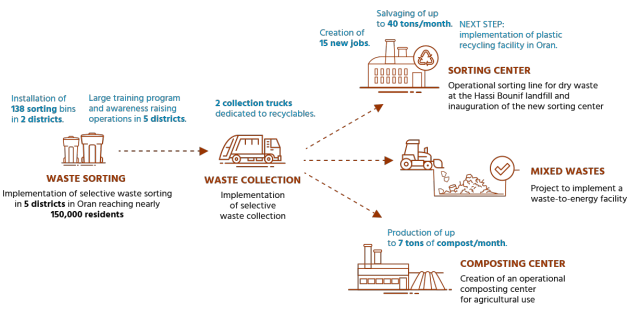
PROJECT DESCRIPTION

To mediate this problem, the Province of Oran partnered with R20, an organization that supports sub-national governments around the world to develop and finance low-carbon and climate resilient infrastructure projects. The intention was to develop a waste management system with the ultimate goal of reaching zero waste. It was executed in partnership with the Ministry of the Environment and Education Department of Oran. The project consisted of a waste audit, GIS mapping, stakeholder engagement, educational program and worker training development, and is exploring waste to energy plants as a next phase. R20 provided upfront funding for the project as well as the technical expertise to design and start the program (data collection, landfill and waste to energy plant site selection, transportation logistics, financial modeling, etc.). Collection and treatment of waste is managed by the municipality and by publicly-owned collection companies. Higher education programs were created in partnership with a local university to make Oran a leader in environmental issues and ensure workers are trained for the success of the program. A waste fee of $3-5 is collected from households, but findings since the program began indicated that fees should be increased to 1% of monthly incomes to ensure the program is financially sustainable, since the program now relies on state and national subsidies and continued R20 funding.

Oran's efforts to understand how the system can be financially sustainable through a proper waste collection fee is work our team started in Chapter 3.

OPPORTUNITIES FOR CONAKRY

A few things can be learned from this case study on wide scale municipal level waste management collection, transportation and disposal. First, a waste audit is a critical first step for undertaking any waste management solution to understand the scale of the problem and the most prominent materials in the waste. Enabel's waste audit has served as a proxy, but a larger and more comprehensive waste audit should be completed in Conakry. Additionally, if UNDP seeks to support solutions at the municipal level, encouraging the ministry to work with a partner with technical capabilities is important to design, finance, and implement a large-scale project. This includes mapping transportation routes and new collection points and designing new landfills or large-scale waste-to-energy sites.



Waste Management structure in Oran, Algeria.

INTEGRATED WASTE MANAGEMENT: WASTE FEE STRUCTURE IN MAPUTO, MOZAMBIQUE

PROBLEM

Maputo is the capital city of Mozambique and home to about 1.2 million people. It is estimated that the population produces about 1,000 ton of waste per day. It costs between 10 to 25 USD per ton to collect and remove this waste. The municipality has struggled in the past to collect the waste fee required to remove waste from the city. Waste fees were collected from each home by waste collectors, similar to the process in Conakry. In 2004, the city collected 250 tons of waste per day, providing less than 40% of the population with access to regular service, at a cost recovery of less than 40%.

PROJECT DESCRIPTION

Maputo sought to increase its cost recovery so that it could expand access to waste collection throughout the city. In 2005, the municipality integrated the waste fee into residents' electricity bills. This ensured reliable collection of the fee. In 2005, the fee started at 0.8 USD per household per month and was gradually increased to an average of 2 USD per household per month, which is less than 0.6% of average household income per month. In 2016, 850 tons of waste per day was collected, providing 100% of the population with access to regular service, and cost recovery was 90%. Additionally, the fee is now designed as a progressive fee that increases with electricity consumption, both for households and commercial waste producers. Progressive fees are more equitable and allow for higher fees to be collected from customers who are able to pay in order to cover for fees that may not be collected from the lowest-income residents. Maputo has ubiquitous access to reliable electricity, which has made this model successful[118].

OPPORTUNITIES FOR CONAKRY

Part of our work has focused on quantifying an appropriate waste fee for Conakry. A proper waste fee not only increases the amount of waste collected - keeping the streets of Conakry clean - but also supports SMEs, creates more jobs, and provides better wages for workers. From our conversations with UNDP, it is clear that Conakry does not have reliable access to electricity and residents often take electricity from their neighbors. Because of this, integrating the fee into phone bills, water bills, or another more reliable utility should be considered instead. This structure will require cooperation with local Ministries that oversee utilities, SMEs, and possibly private telecommunications companies. UNDP can act as a convener in these conversations. Additionally, structuring the waste fee as a progressive fee should be pursued in Conakry, even if it is not integrated into another billing mechanism.

Waste collection in Maputo.

INTEGRATED WASTE MANAGEMENT: CITY WASTE GROUP IN ACCRA, GHANA

PROBLEM

In Accra, Ghana, similar to Conakry, waste collection is largely conducted by informal workers. These workers do not use protective gear to collect and sort through garbage and often burn materials to extract the most valuable components, endangering their health. These materials are then sold to the highest bidders, with the remaining waste components left throughout the city.

PROJECT DESCRIPTION

In order to protect workers, avoid cherry-picking of high value materials, ensure reliable collection of all waste materials, and provide upward mobility for waste collectors, City Waste Group depends on a vertically integrated business model. It is a private company founded by Jürgen Meinel, former manager of GIZ and KfW in 2002. At a large plant in Accra, Ghana, they employ about 60 people full-time and recycle 4,000 kg of waste per day, half of which is plastic. Employees receive regular salaries, protective gear, insurance, pensions, paid holidays and paid maternity leave. Revenues are generated from recycling activities as well as exports of waste. City Waste Group also organizes about 500 waste collectors who informally pick waste and over half are women. The revenue received by these waste collectors depend on the amount of waste that they collect. For plastic, a person makes a minimum of 3.5-4 USD per day, twice the national minimum wage. If an employee collects more than 1,000 kg in one year, City Waste will pay the worker health insurance for the following year. People can start as waste pickers and then move on to manage their own collection points. From here, the model is designed so that they can only sell their plastic to City Waste. This is to avoid cherry-picking of waste and guarantee a sufficient supply of plastic for the company.[119]

OPPORTUNITIES FOR CONAKRY

The vertical integration of City Waste Group allows for employee benefits and upward mobility for many workers, helping move workers towards the formal economy. Additionally, it is an exemplary example of a company providing waste sorting work for women. UNDP can use this as a model when helping to build capacity for SMEs, encouraging them to formalize their operations and include recyclables by building out the value chain.

City Waste Group in Accra, Ghana

INTEGRATED WASTE MANAGEMENT: WASTE HIERARCHY IN SENEGAL

PROBLEM

A rapidly growing population is distributed unevenly in the country, with one third of its population living below the national poverty line. There is an electricity and energy shortage and waste management is neglected, leading to environmental and health risks. The rapid growth in Senegal has led to a significant rise in the production of household waste. Senegal produces about 2 million tons of waste per year, 80% of which is household waste. More waste is generated in the urban areas than in the rural areas due to an increase in living standards. In Dakar, collection vehicles carry waste about 14 tons of waste from collection points to the Mbeubuess disposal site.

Since the country's independence, different companies such as SOADIP and SIAS handled waste management in the capital city of Dakar but due to management issues that resulted in bankruptcy, these companies failed. Currently, the French engineering and infrastructure multinational Veolia leads the waste management initiative. In addition, all waste is transported to a disposal site but is not being treated by type. As a result, hazardous waste remains a major issue as a source of pollution that the country is struggling to deal with.

PROJECT DESCRIPTION

Senegal, using tactics from European waste management legislation, plans to create a "waste hierarchy". This five-step waste hierarchy prioritizes waste prevention as the best option, followed by re-use, recycling and other forms of resource recovery, with disposal in a landfill as the last resort. According to a European study, it is estimated that the materials sent to landfill in Senegal could have an annual commercial value of around $5.9 billion.

These materials could be put to better use instead of putting the local population at risk. Materials can be separated for recycling and then the municipality can use market mechanisms to create a supply chain value. Currently, the European economy loses a significant amount of potential secondary raw materials such as metals, wood, glass, paper, plastics present in contaminated and uncontaminated waste streams. Like Europe, Senegal is looking to capture the material market.

Re-use is already a relatively strong cultural preference in most developing countries for local businesses and markets. Education and local policies that can prevent one-time only use of materials will need to focus on incentives to re-use materials and reduce virgin material supply chains. Future strategies for successful implementation would include running awareness-raising campaigns that encourage consumers to pressure businesses to use eco-designs to reduce resource use[120].

OPPORTUNITIES FOR CONAKRY

Conakry has issues with waste management similar to Senegal's. Integrating principles from the waste hierarchy system into household waste management education and waste diversion solutions will help incentivize people and local businesses to reduce, re-use and prevent use of virgin materials and emphasize the importance of material separation to create a value proposition for business supply chains.

Benches made by the students in Senegal out of old tires and trash

5.3:

TRANSPORTATION, COLLECTION AND SORTING

Bounds of imported plastic bags often used by residents of Conakry. Recycling plastic in the city could displace imported plastic goods

Our team observed a gap in Conakry's waste system pertaining to the collection of household waste at its source and quality control of waste materials for use in a secondary market. We found a number of innovative solutions to these problems, most often through social enterprises, in cities throughout Africa. We believe the business models and approaches to growing waste issues can be applied to the current SME system in Conakry to increase capacity of waste collection and add value to the waste stream.

TRANSPORTATION, COLLECTION, SORTING: WECYCLERS IN LAGOS, NIGERIA

PROBLEM

Lagos, Nigeria's capital city, face similar urban waste issues as Conakry. A growing urban population has led to a large increase in waste but waste management has been inadequate. In 2012, only 40% of the city's waste was collected and only 13% was recycled. This resulted in the spread of disease, psychological stress for residents, clogged gutters and drainage canals leading to flooding, and a burden for community residents. Additionally, recycling firms in Lagos lacked a steady supply of recyclable materials because of a lack of sorting waste at the household level. Poorly planned urban development patterns have put open space at a premium, making mobile collection systems particularly important.

PROJECT DESCRIPTION

In partnership with the Lagos Waste Management Authority (LWMA), Wecyclers collects recyclable waste items, such as plastic bottles and bags, cans, glass bottles, paper and cartons directly from consumers. It incentivises clients to collect and sort their used recyclable waste at home by exchanging waste for points. Families are encouraged to sort their waste, which is weighed and collected on specified days of the week by workers on bikes with carts. The families are given 'Wecyclers' points for every kilogram of material collected. The points are redeemable for goods such as cell phone minutes, basic food items, and household goods. Families receive collection reminders and reward updates directly on their mobile phones, making the benefits of recycling immediate. After collection, Wecyclers sell collected material to local recycling processors, bridging the gap between the recycling companies and communities that provide waste. Also, Wecyclers works as a franchise model[121].

OPPORTUNITIES FOR CONAKRY

Wecyclers in Nigeria is a social enterprise, a model we believe can be adapted and applied within the current SME system in Conakry. This system would would encourage households to sort their waste for SMEs to sell directly to recycling processors or exporters, increasing their revenues. This model would also reduce the amount of waste transported to landfill, reducing costs for SMEs and municipalities, and result in a more sustainable end-life for the waste. Our proposed model for Conakry is explained in further depth in Chapter 3 of this report.

Wecycler mobile recycling collectors

TRANSPORTATION, COLLECTION, SORTING: PACKA-CHING IN CAPE TOWN, SOUTH AFRICA

PROBLEM

Cape Town, South Africa experienced a large increase in informal settlements within the city. Because these areas are not served by the current waste management system, this new development lled to a large pollution issue. Packa-Ching, a social enterprise, seeks to address the waste management issue by incentivizing residents to sort their waste and dispose of it properly. It also seeks to create a steady supply chain of sorted materials for local recycling plants. Mobility is again a key component of the program's success.

PROJECT DESCRIPTION

A mobile kiosk where citizens can take recyclable materials such as plastic, paper, metal cans, and glass for recycling in exchange for cash cards. The goal of the mobile kiosk is to provide the opportunity for people in informal settlements to both manage their waste and get cash for it. Other goals include education and local community funding. A recycling truck with a trailer attached drives through a community and parks at designated sites on particular days to collect separated recyclable waste. A large community may be split up into several zones with multiple collection sites. Individuals bring their sorted waste materials to the truck where they are checked, weighed and exchanged for a monetary value that is paid into their eWallet account in real time. The material prices are set by the owner-operator of the unit and determined according to the current market value for each material type. Once a collection is finished, the materials are loaded into the truck and trailer and removed from the site, leaving no trace and restoring limited open space for other uses[122].

OPPORTUNITIES FOR CONAKRY

From our conversations with organizations working on waste management in Conakry, it is clear that there is a significant need for interventions in the sorting, collecting, and transporting phase of waste management. There is also a lack of supply chain quality control for recyclable materials. A model like Pack-a-Ching can solve for these issues and can be integrated into the current SME model or as a supplementary service. Complexities that arise from open space designation and from siting waste collection points in ways that can unintentionally disincentivize transportation from those points can be resolved by maintaining kiosk mobility.

Mobile recycling kiosk in Cape Town, South Africa.

TRANSPORTATION, COLLECTION, SORTING: TAKATAKA SOLUTIONS IN NAIROBI, KENYA

PROBLEM

Nairobi, Kenya, like Conakry has a waste management problem. More than 50% of Nairobi's waste does not get collected and less than 10% is recycled. This causes environmental and health problems for residents. TakaTaka Solutions aims to solve the problem by collecting over 50 tons of waste per day from households and businesses, recycling 95% percent of this waste themselves or with recycling partners, and employing over 50% women.

PROJECT DESCRIPTION

TakaTaka manages post-consumer waste by asking residents to separate waste into organic and inorganic portions for collection. The organic waste is used to create high-quality compost which is sold to local farmers. All inorganic waste is sorted into 40 different categories and either sold to recycling industries or used to create new products by TakaTaka. TakaTaka Solutions owns a fleet of new, brightly colored and branded trucks equipped with GPS with which they collect residential and commercial waste. Workers are outfitted with matching uniforms and provided with safety equipment and proper tools. This helps to raise the social status of TakaTaka's waste collectors. In order to recycle and compost the waste collected, locally hired women and youth living close to the two TakaTaka-owned sorting sites are trained to know the 45 different categories of waste that are recycled. Materials including PET bottles, aluminium tins and organic waste are separated and stored together. Customer pays a relatively low monthly fee ($1 for more residential customers) for the service collection[123].

OPPORTUNITIES FOR CONAKRY

The TakaTaka Solutions model can be adapted to Conakry's existing SME system. Understanding how TakaTaka Solutions keeps their service charges low while collecting and sorting so much waste can help identify how Conakry's SMEs can increase their revenues while diverting most of it from landfill. Its success in removing stigma from waste collection jobs is worthy of replication.

Takataka Solutions worker

5.4:

WASTE-TO-ENERGY

Community Cooker Waste to Energy Stove in Nairobi

Because Conakry's waste stream contains a high percentage of organic waste, our team explored successful cases of composting in urban areas throughout Africa and India at both large and small scales. Additionally, we explored small-scale waste-to-energy solutions, known as community cookers, which add value to organic and non-organic waste while providing additional services, such as access to clean water or heat for cooking.

WASTE-TO-ENERGY:
COMMUNITY COOKER FOUNDATION IN MATHARE AND NAIVASHA, KENYA

PROBLEM

More than eighty percent of Kenya's urban dwellers live in rural settlements. Households use charcoal made from wood as their primary source of energy which they burn for cooking and heating. Not only is this dangerous for their health, but their heavy dependence on wood for fuel has contributed to the rapid decline of Kenya's forests. In addition, major cities like Nairobi in Kenya generate almost 3,000 tons of municipal waste daily, sending less than half to the landfill and leaving the rest in streets, backyards and public spaces.

A boarding school called Naishava did not have a sustainable waste management system and the administration response was to burn waste in pits in the fields. By installing a Community Cooker, the school has been able to reduce their costs of operating by substituting energy source and use funding elsewhere. Another school near Nairobi called Mirema is a mixed day and boarding school. They also built a Community Cooker to meet the demand of providing enough meals per day to students and faculty while also reducing costs and waste.

PROJECT DESCRIPTION

The Community Cooker Foundation developed a product that will provide energy and offer a solution for solid waste management while also saving trees. The Community Cooker is a waste-to-energy technology that burns garbage in an environmentally safe way at 880-1,200 degrees centigrade to generate heat energy for many residential uses. The cooker has a 99% combustion efficiency and burns all waste except rubber, glass and metal. Waste is picked up from collection sites and brought to the facility in which the cooker is located. Workers at the facility sort waste, recycling valuable materials, and incinerating the rest.

The Community Cooker can operate 24 hours a day. In Methaire and Naivasha, a total of three Community Cookers have been completed and serve 2,100 residents in a 12 hour period. In addition, the Community cooker saves approximately 3,000 mature trees each year per cooker.

The Community Cooker produces large volumes of hot water and steam on a daily basis. Whether it is used commercially for washing clothes or bottling drinking water, this hot water production can create an economic opportunity for those living near the facility. It also protect residents from illnesses by providing access to clean water. In addition, a Community Cooker can provide up to 100 plates of cooked food per hour. Community Cookers provide jobs for up to ten people, including cooks, managers, waste handlers, handy workers, administrators and accountants that can support their families. The Foundation has received partner funding by the United Nations Framework Convention on Climate Change (UNFCCC), US Sustainable Energy Fund for Africa (SEFA), the United Nations Environment Program and the UNDP[124].

OPPORTUNITIES FOR CONAKRY

We believe there is a significant opportunity for Conakry to implement Community Cookers to address household waste management solutions in Conakry. Our full recommendations can be found in Chapter 3.

Community Cooker in a community

WASTE-TO-ENERGY: ACCRA COMPOST AND RECYCLING PLANT (ACARP)

PROBLEM

Ghana produces 12,710 tons of waste per day, much of which consists of recyclable plastic and organic waste. Space for landfills is limited and landfilling contributes to high greenhouse gas emissions.

PROJECT DESCRIPTION

ACARP is an integrated waste processing and recycling company, operated in partnership with Ghana's Ministry of Local Government & Rural Development, Ministry of Food & Agriculture, Ministry of Environment & Science and other organizations. ACARP receives, sorts and composts organic waste into compost used for agriculture in Ghana and West Africa. It also collects, sorts and recycles plastics, which are processed into new products. The plastic material that is not reused in country is sold to China and Malaysia. The plant receives approximately 600 metric tons per day of organic municipal solid waste, diverting all of that waste from landfill and creating a product that can be sold. The plant employees over 300 people across Accra for waste sorting and composting[125].

OPPORTUNITIES FOR CONAKRY

ACARP is one of few examples of a large-scale program under the jurisdiction of a governmental agency. It is also able to operate at local, national, regional and international scales, an enormous accomplishment. Based upon this precedent, UNDP can support collaboration among the national agency, Conakry's municipalities, SMEs and other organizations focused on waste management to create. The ACARP model can be used to create large-scale composting that could create enough product to be used to serve the bauxite industry's mine remediation efforts. Organic waste would have to be sorted from other types of waste and transported to a central location for composting, but the associated fees could be offset from the sale of the compost to the mining companies.

Students gather around a composting pile in Ghana

WASTE-TO-ENERGY:
PARTICIPATORY SOLID WASTE MANAGEMENT IN GALLE, SRI LANKA

PROBLEM

Arthacharya Foundation was founded in 2007 to implement a post-tsunami participatory waste management program in coastal cities in Sri Lanka.

PROJECT DESCRIPTION

The program has targeted 10,000 families in five towns and focuses on composting and artisanal recycling of plastic waste. Groups of some five families each deposit all of their organic waste in a steel barrel. Around 100 kg of compost is harvested per month, some of which is used by the families to grow vegetable gardens. The rest is sold to wealthy local households for around Rs20/kg. The main funding requirements were initial NGO facilitation and purchase of the barrels. 1,200 barrels have been provided to communities free of charge by the NGO, but since the project has been 'proven', the NGO is now providing bins via microcredit. Women were also trained to use plastic and polythene waste material to produce crafts that were used and sold to local communities. An important intervention made by the project was to develop a waste business group which would negotiate between the community level waste collectors and the larger waste dealers in towns. The NGO is funded by the Norwegian and Australian governments[126].

OPPORTUNITIES FOR CONAKRY

Arthacharya Foundation's program in Galle is an example of how to engage communities, and particularly women, in waste management. While the project currently works on a small scale, when applied to households at large, the scale of impact can grow significantly to reduce the amount of waste sent to landfill. Its comprehensive solution that addresses both inorganics and organics is of special note.

Household composting bin in Sri Lanka

5.5:
EDUCATION

Students in Bangladesh participate in Teach For America's "Waste: A Source of Resource (WAR)" program teaching students about the connection between improper waste management and poverty.

Through our research on waste management best practices, our team found several studies throughout the developing world highlighting the importance of education of residents for the successful implementation of any household waste management solution. Any solutions pursued in Conakry will require engagement with local communities to ensure residents understand the importance of proper waste management, and how to properly handle their waste, such as sorting it before collection.

EDUCATION:
WASTE: A SOURCE OF RESOURCE IN DHAKA, BANGLADESH

PROBLEM

Increased city population in Dhaka, Bangladesh coupled with a lack of government resources and action have led to deficient waste management, causing serious health and environmental problems. The residents of Dhaka generates about 3,500 metric tons of municipal solid waste per day[127]. The city of Dhaka relies on the Dhaka City Corporation (DCC), an independent company, as a contractor to handle city waste management systems. With limited manpower and logistical resources, DCC can collect only 42% of the total solid waste generated each day, while the rest lies on roadsides, near open drains, and in the low-lying areas of the city.

Blockages in the waterways from waste can cause contaminated puddles which have been shown to cause sores on children's feet, limiting their ability to walk and go to school. Many rural areas don't have the resources to protect themselves from these types of pollution-based health issues but tend to be the most at risk for them.

PROJECT DESCRIPTION

Teach for America Bangladesh launched the project Waste: A Source of Resource (WAR). With the support of Greenman Bangladesh and Bangladesh Environmental Lawyers Association, the program teaches children and their caretakers the interconnection between waste and poverty. Teach for America targets mothers and caretakers as they are the ones most closely intertwined with their own household waste management systems. Most importantly, they teach how waste reduction can alleviate poverty by encouraging the use of recycling materials for small enterprises.

In addition, Teach for America Bangladesh partnered with the UNDP and other NGOs to create environmental education in curricula of primary and secondary schools as the best course of action to manage future waste issues. The curriculum focused on reusing waste for local community needs, managing waste at home and in the environment as well as understanding consumerism and its role in society. This basic education will be intertwined into the education system and will be developed for school-age children and young adults[128].

OPPORTUNITIES FOR CONAKRY

The city of Conakry could use as a model these types of waste education initiatives and curricula with strong local leadership. Many of the issues Bangladesh faces regarding sorting waste, protecting local water sources and reducing public dumping of household waste are synonymous with Conakry. Conakry could partner with OCPH, local schools already engaged in environmental education like The American International School, and other local organizations to create educational programs to teach children about their local environments and how creativity and innovation can play a role in solving issues they face. By engaging with Sodiaplast, Topaz and other companies using post-consumer waste as feedstock, students can learn about businesses that are making positive decisions for the environment. This enables the younger generation understand the issues their communities face and they can creatively work to solve them.

EDUCATION:
NEPALESE WASTE EDUCATION PILOTS

PROBLEM

Rising urban populations in Nepal, coupled with a lack of municipal funding and efforts around waste management has led to pollution and human health concerns in several Nepalese cities. Within 58 municipalities, organic waste makes up 50-90% of the overall waste generated; much of it ends up in backyards and rivers. With increasing public awareness about the importance of maintaining a clean environment to encourage a healthier and better standard of living, solid waste management has become one of the top of the priorities.

Sorted plastic waste

PROJECT DESCRIPTION

Nepal is encouraging resident engagement by hiring locals to participate in structured waste management systems, such as trash collection. Since many of the municipalities have shown a strong interest in these types of programs, it was decided to run a pilot project among a few select municipalities to determine viability and success rates. Four municipalities were selected due to their strong waste management performance: Bhaktapur, Bharatpur, Biratnagar, Hetauda and Tribhuvannagar. NGOs like Urban Environment Management Society (UEMS) helped create household waste management programs by educating women who are in charge of organizing the home. In addition, UEMS administered activities intended to raise knowledge around waste-based issues through training, orientation, exhibitions, and education. Nepal is looking into developing education programs involving local teachers, community leaders, and women to educate school children and residents on the importance of minimizing waste and waste management solutions[129].

OPPORTUNITIES FOR CONAKRY

Conakry could benefit from incorporating education and training into its household waste management approach. From our conversations with Fatoumata Cherif, we know Conakry already organizes monthly volunteer-led waste clean up events. Working with activists such as Ms. Cherif, organizations like OCPH, local schools and Conakry's municipalities, UNDP can help build capacity and add an educational element to these events. While this voluntary system cannot address the entire waste issue in Conakry, it can be used as a first step in educating and engaging residents in waste management, to build support for larger systemic changes, like household waste sorting.

Volunteers can educate their neighbors on managing waste and reusing and repurposing materials. In addition, school programs could benefit from incorporating lessons about protecting the planet and the health of future generations. Building a strong message around waste management solutions could inspire young people to innovate new products or solutions and enable discussion around issues in their environment.

EDUCATION:
SHUDDHAM IN PUDUCHERRY, INDIA

PROBLEM

Poorly planned and uncontrolled urbanization has led to environmental and health impacts in the coastal city of Puducherry, India. Sanitation and pollution issues have affected the local water supply, breathability of the air, and overall quality of life for residents. Failure to address these issues appropriately will only contribute to further land degradation, reduced economic opportunity, increased health and safety problems and increases in greenhouse gas emissions from improper management.

PROJECT DESCRIPTION

An NGO-led program, Shuddham focused on building waste management awareness and education in the form of door-to-door campaigns for residents, posters, pamphlets, and documentaries about environmental and health impacts, source separation and waste minimization. Shuddam is the brainchild of a group of local volunteers that were interested in implementing source segregation, composting and recycling.

Shuddam's strategy was based on studies of successful community and civil based organizations for increasing participation in effective household waste management efforts, as increased participation results in successful material sorting. The researchers completed a pilot program over six months in the Raj Bhavan neighborhood with a population of 1,700. Shuddam had a team of 30, including a manager, a supervisor, 24 female sanitation workers known as 'beautifiers' and four residents. Residents were instructed how to sort their waste into different categories and Shuddam staff collected the sorted waste door-to-door. This approach allowed for more opportunity to communicate with residents about waste reduction and recovery.

According to their study, the average amount of household waste generated in Raj Bhavan was approximately 8,582 kg per month. The study tracked the process of residential waste and found that about 47% was recovered through sorting, recycling and composting practices.[130]

OPPORTUNITIES FOR CONAKRY

Using this case study as a guide, UNDP can work with such proven partners as UGANC, OCPH, Enabel, or other organizations to support small pilot residential programs to study waste practices and composition. This would be a vital first step to identify the most effective innovative solutions to waste reduction and management in Conakry. The Shuddam study was heavily focused on the experience of material segregation and benefited directly from a hands-on approach to education with residents. The team that engaged directly with households provided residents with a resource to ask questions about waste sorting so that they could feel involved in the process. There is also much to be learned from how information gained in this study was used. Puducherry researchers analyzed the waste stream and resource recovery rate to hone their understanding of the deeper trends in residential waste and in turn, to assist with designing waste reduction policies and programs. This type of research, which would benefit from UNDP support, is a vital first step in targeting future funding initiatives and in designing locally-appropriate waste reduction measures.

A series of images depicting Solid Waste Management in Puducherry, India.

6: ADDITIONAL RECOMMENDATIONS

6.1: SPATIAL DATA AND ANALYSIS

Using available GIS and urban data collected from the World Bank Data Hub, Open Street Maps, and QGIS, our team was able to develop a map illustrating the locations of existing waste collection points throughout Conakry, and their proximity to major roadways. This mapped information, overlaid with urban building typologies in Conakry's five municipalities, allowed us to visualize how building density relates to municipality size, and proximity to waste collection sites, which in turn allowed us to identify parts of the city that could potentially benefit most from waste collection solutions, such as Community Cookers or composting.

We recommend that UNDP partner with organizations such as the CERE Institute at UGANC who is currently conducting geospatial research that could be applied to the problem of waste collection and diversion. This would provide UNDP with the ability to implement waste management solutions more effectively so as to produce greater long term results. Below are a few recommendations for how UNDP might identify projects to initiate and support efforts to use spatial data to scale, locate, and comprehensively plan the waste management solutions our team has put forth in this report.

Development of Spatial Maps: Leveraging the following geospatial and visualization programs, our team was able to produce a series of maps that break down and isolate key factors contributing to the state of waste in Conakry.

QGIS: An open-source geographic information system that enables the compilation of geographic information, such as spatial locations in Conakry, into data sets. The workflow involves layering organized data sets into visual modeling to produce maps. We'll refer to these as base maps.

Photoshop: Isolating components from the spatial maps developed in QGIS, Photoshop was used to color correct, and zoom in to elements, such as the waste collection points.

The maps our team designed, outlined in detail below, are not consistent in scale, although they are each internally accurate, and are not ready to be used for analysis. Rather, they are meant to be illustrative of the types of map and spatial analysis that can result from spatial data. Outlined below are our recommendations for how UNDP, working with a geospatial partner, can apply this research technique to better understand the household waste management problem in Conakry and properly scale and implement the solutions our team has provided in the previous chapters of this report.

UNDERSTANDING THE “WASTESHED”:

In analogy to a “watershed” through which surface water collects based upon topographical and surface water features, the city of Conakry might conceptually be subdivided into “wastesheds.” These are areas defined by population, buildings and infrastructural features that can optimize waste collection. Factors such as available open space, proximity to roadways, density of construction and density of inhabitants can be considered together, with various potential solutions compared on maps that prioritize each of these factors differently. Prioritization of these factors will provide deeper insight into which “wastesheds” produce an adequate supply of organic and non-organic waste to operate a Community Cooker, to facilitate composting, and to ensure buyback programs are profitable. Additional overlays are also possible, such as data that will predict capacity to pay for collection or that locate women’s groups, community assets or local entrepreneurs whose participation can facilitate expansion of diversion methods in which waste collection is transformed into value creation.

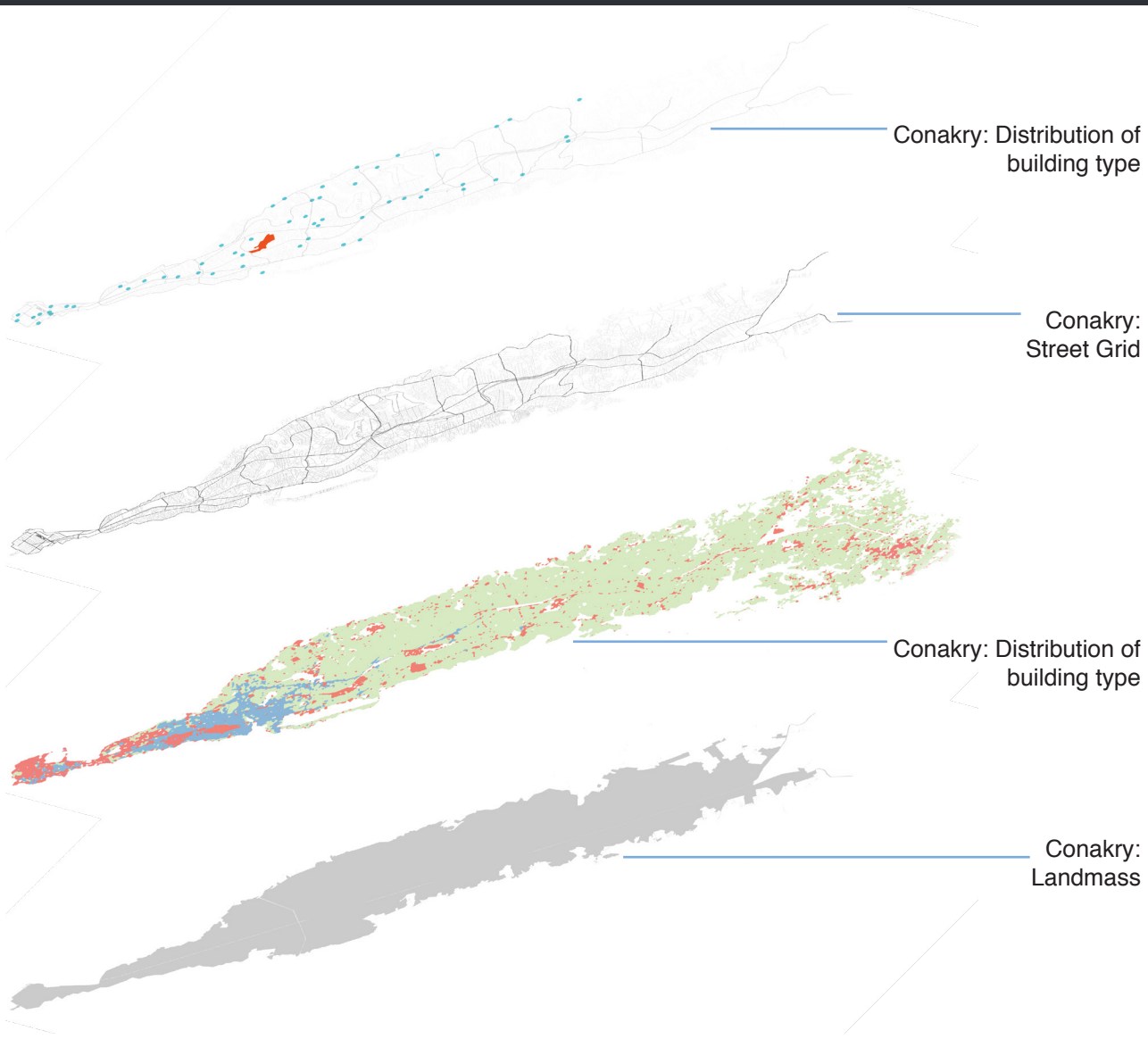


Figure 6.1.1: Exploded view of several layers of spatial data for Conakry. All maps developed by team member Geoffrey von Zastrow. For larger versions, see the Appendix.

HOUSEHOLD ECONOMIC DISTRIBUTION:

Supporting SMEs create a progressive waste fee system will increase the cost recovery for SMEs and ensure households are able to pay for this vital waste collection service, increasing access throughout the city. Understanding the economic distribution of municipalities and neighborhoods will help create a balance of low-, moderate-, and high-income households to create well-balanced collection territories. Adding commercial customers into this distribution could also help to balance the economic burden.

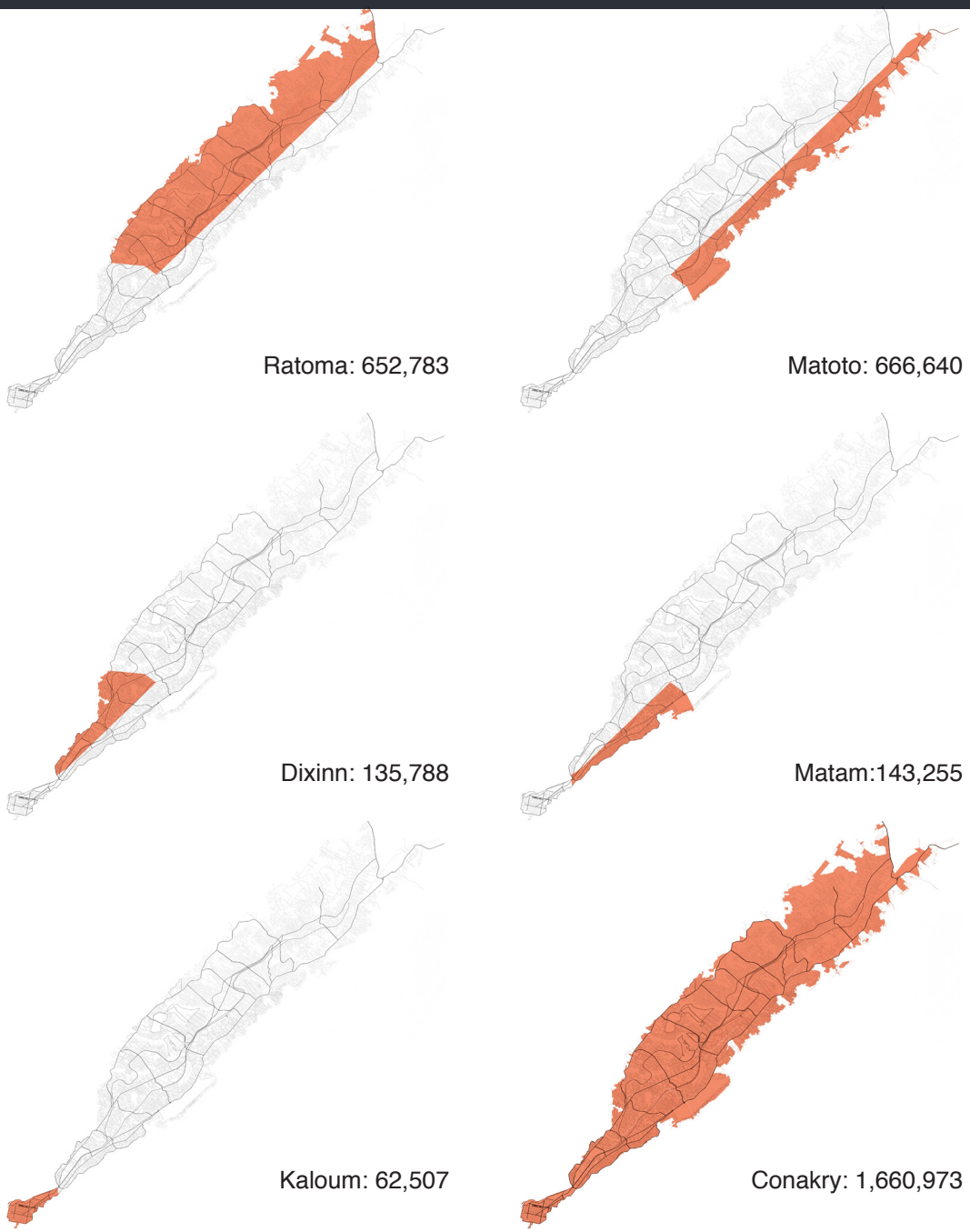


Figure 6.1.2: Isolation of Municipalities respective size and population, based on 2014 Census.

LAND CONSTRAINTS AND PLACEMENT OF WASTE SOLUTIONS:

Spatial data can be used to understand the potential scope of urban composting. We've included in Chapter 3 recommendations for two different scales of composting in Conakry - a decentralized model at the household or community level, or a centralized, large-scale model. Spatial data of open space in Conakry can help determine which scale is most viable. A similar analysis can be used to determine potential locations for Community Cookers, such as near marketplaces, in hospitals, in orphanages, or in government buildings. Understanding the location of these institutions around the city will help determine which location is most viable to support the construction of a Community Cooker, and yield the greatest impact on the community, through waste reduction and job creation.

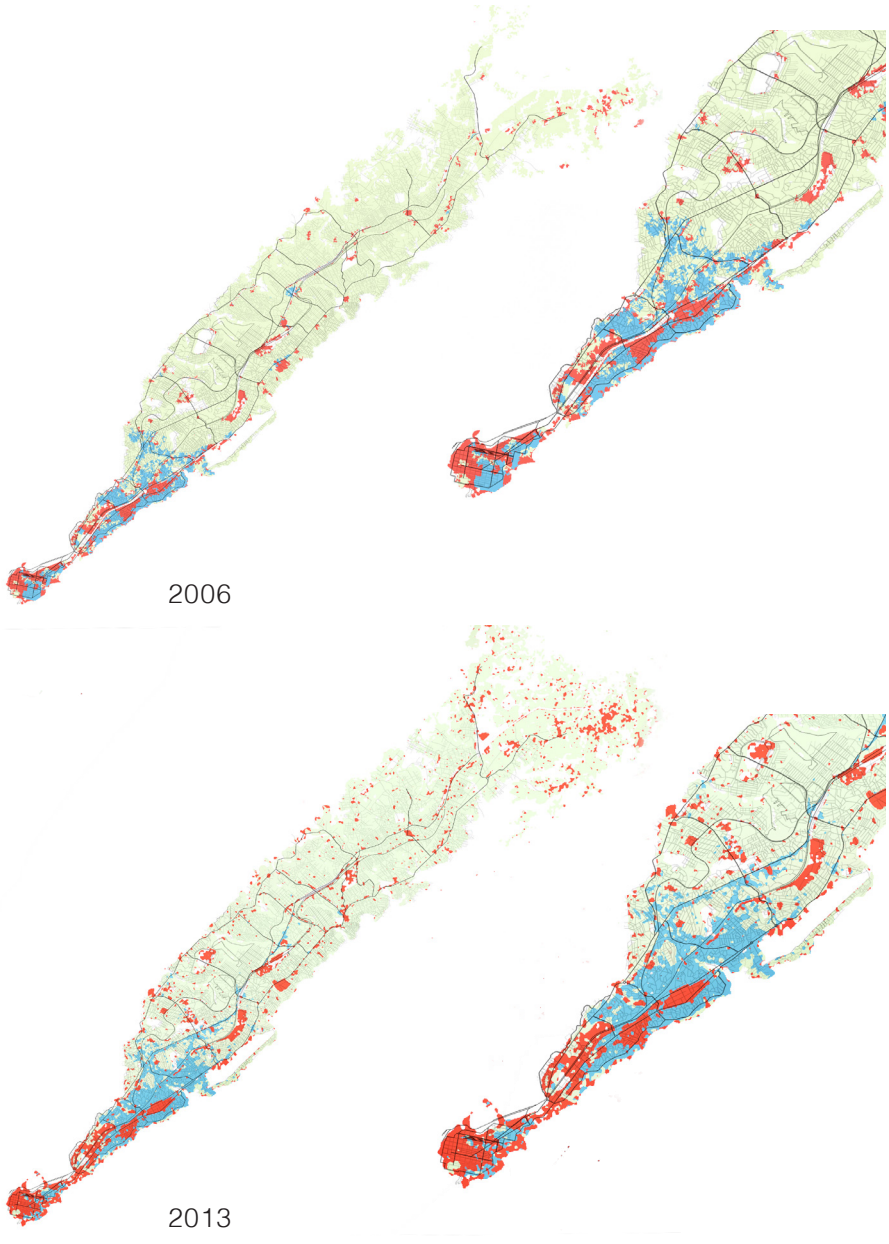


Figure 6.1.3: Distribution of building type in Conakry between 2006 and 2013.

REDUCING TRANSPORT COSTS:

Transporting waste (both from households to collection points, and from collection points to the landfill) is a complex and costly operation. Examining spatial data relating to the new and existing collection points in key locations throughout Conakry would enable waste collectors to decrease the distances they need to travel while maximizing the amount of waste collected. A similar analysis of Conakry's network of roads, to understand proximity between major arteries, side streets and pathways will inform what type of collection method (i.e., truck or cart) is appropriate for waste collection in a given area of the city. The relationships between these two spatial analyses will contribute substantially to reducing the overall cost and improving the efficiency of waste collection by the government and private organizations.

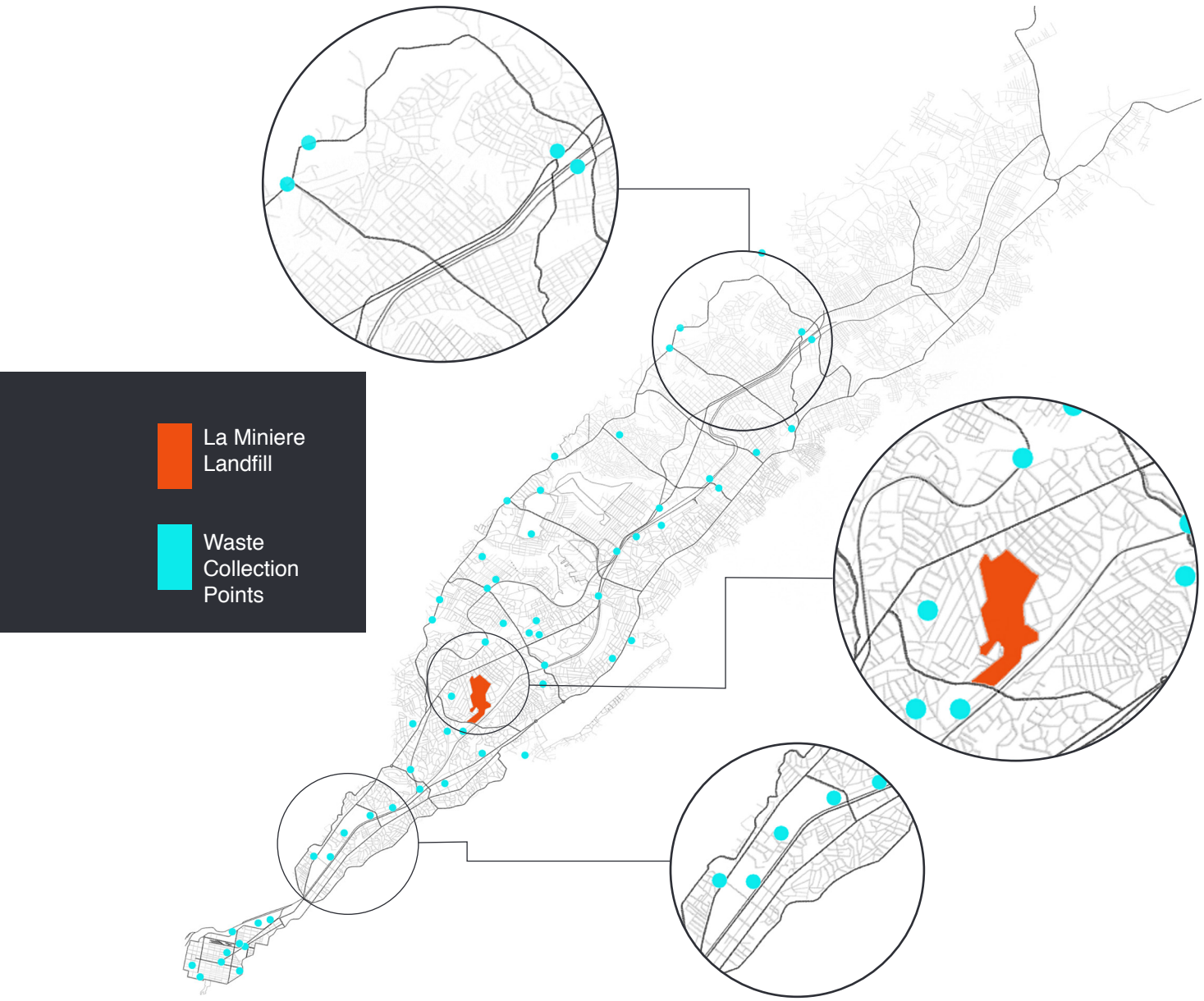


Figure 6.1.4: Distribution of waste collection points in Conakry and their relationship to the La Miniere lanfil.

USING SPATIALIZED DATA OVERLAY TO SCALE DIVERSION AND VALUE-ADD SOLUTIONS

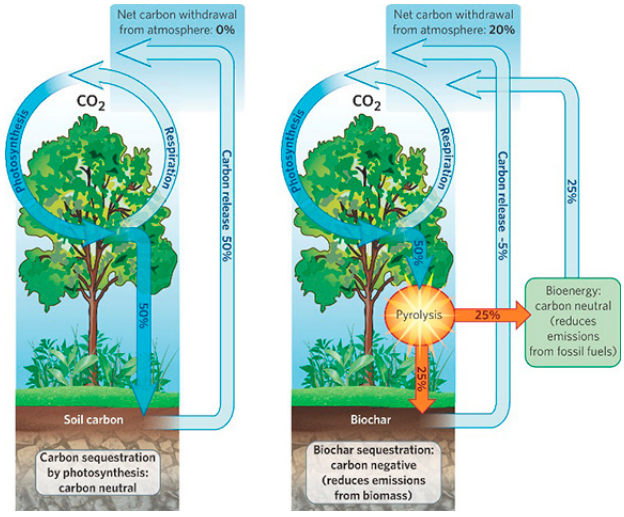
Although our recommendations conservatively estimated the share of waste diverted from landfill to levels we could confidently presume, the physical, social and economic constraints that may contribute to the successful scaling of alternative solutions for organics and inorganics can be understood most effectively in a GIS environment. For example, the Community Cooker solution outlined in Chapter 3 requires a combination of feedstock from separated waste, both organic and inorganic, a space large enough for the physical plant, and a community that will benefit directly from the Cooker's operation and maintenance, such as an orphanage or medical clinic needing hot water, or a women's group for whom the cooking and baking capacity represents economic opportunity. The overlay of open space, community asset, population, and economic activity data can optimize siting and guarantee success. The same holds true for composting, which could be scaled to industrial levels depending on market development (outlined in Chapter 3), and for mobile buyback programs collecting recyclable plastic and metals.

6.2:
ADDITIONAL AREAS FOR RESEARCH

BIOCHAR:

With a large portion of Conakry's population heavily relying on charcoal as a main source of cooking fuel, we recommend that UNDP conduct additional research into the possible application and production of Biochar as a sustainable alternative fuel source. Biochar has many applications that help support a sustainable environment. Biochar is produced through pyrolysis, which is the process of heating biomass with little to no oxygen in the same manner as charcoal[131]. When Biochar is produced using a biomass cookstove, the carbon emissions are substantially less than that of traditional charcoal and wood cooking methods[132]. Further, the byproduct of biomass cookstoves is Biochar. When used in depleted soil, Biochar increases soil nutrients, and boosts water retention, while sequestering the carbon that contributes to climate change (see Figure 6.2.1).

Figure 6.2.1: Climate Smart Benefits of Biochar



Biochar has numerous environmental benefits compared to burning charcoal or firewood for cooking.[137]

Biochar is another waste diversion solution that has the ability to divert more of Conakry's organic waste from landfill while producing a product that can be used for a number of applications relevant to Conakry. Biochar can be used for stormwater mediation and water retention or can be sold as a natural substitute for chemical fertilizer.

LANDFILL MANAGEMENT:

Landfills should be viewed as a final disposal site for waste that is unable to be utilized in other ways. However, proper landfilling methods are often lacking in developing countries, with landfills evolving from open dumping to sanitary landfills (See Table 6.2.2). The approaches we have outlined for UNDP, support the development of an Integrated Solid Waste Management "(ISWM)" approach to household waste management in Conakry. ISWM promotes limiting the waste that reaches a landfill, by emphasizing Reuse, Reduce, Recycle, and Recovery[133]. As landfills become overfilled, they are at risk of creating landslides, such as the one in Conakry in 2017 that killed eight people. To avoid these, and other human and environmental issues, proper landfill management is crucial[134].

Although our recommendations are not focussed on landfill management, we know from our conversations with Enabel that the landfill in Conakry is overfilled and a new landfill in under construction, 60 km further outside of the city. We advise UNDP ensure that ANASP, municipal governments, Enabel, and others involved in the planning and execution of the new landfill initiate an outline for a 5-10 year plan detailing the handling of waste that reaches Conakry's landfills and proper landfill site management. This outline for landfill management should also incorporate further research addressing greenhouse gas off-gassing in

the landfill, the structural integrity of the landfill and the potential impact on the surrounding community in the case of collapse, as well as health and wellbeing of informal waste pickers operating within the confines of the landfill.

Conakry's existing landfill should be phased out and eventually retired upon completion of the new landfill located 60 km outside of the city. Phasing out of the existing landfill should be carried out through a series of steps outlined below in Table 6.2.3.[135] The retirement of Conakry's existing landfill presents several opportunities. As the landfill is closed off, the use of compost or Biochar to cover closed off parts of the landfill will aid in the revitalization of the surface of the landfill into nutrient-rich topsoil. Following the complete closure of the landfill, we recommend UNDP in collaboration with local government develop plans to transform the landfill into a community park. Successful examples of landfill and revitalization can be found in the C40 Cities - Good Practice Guide: Sustainable Solid Waste Systems[136].

Table 6.2.3: Steps for Phasing Out a Landfill

Step 1:	Segmenting and phasing off portions of the landfill.
Step 2:	Containment of leaching and off-gassing.
Step 3:	Establishment of engineering strategies for drainage and filtration systems.
Step 4:	Moving beyond the landfill.

Four steps for proper landfill retirement for environmental safety[139] .

Table 6.2.2: World Bank Landfill Classifications

	Operation and Engineering Measures	Leachate Management	Landfill Gas Management
Semi-controlled Dump	Few controls; some directed placement of waste; informal waste picking; no engineering measures.	Unrestricted contaminant release	None
Controlled Dump	Registration and placement/ compaction of waste; surface water monitoring; no engineering measures	Unrestricted contaminant release	None
Engineered Landfill/ Controlled Landfill	Registration and placement/ compaction of waste; uses daily cover material; surface and groundwater monitoring; infrastructure and liner in place.	Containment and some level of leachate treatment; reduced leachate volume through waste cover.	Passive ventilation or flaring.
Sanitary Landfill	Registration and placement/ compaction of waste; uses daily cover; measures for final top cover and closure; proper siting, infrastructure; liner and leachate treatment in place and post-closure plan.	Containment and leachate treatment (often biological and physico-chemical treatment)	Flaring with or without energy recovery.

Four different classifications of landfills as defined by the World Bank[138]

CONCLUSION

Our team was tasked with helping UNDP understand issues facing household waste management in Conakry and providing initial recommendations for innovative waste management solutions that provide environmental, social and economic benefits. This chapter examines the conclusions our team reached through our research and analysis.

Consider Integration of the Waste Management System: First, we observed that the waste system in Conakry is a segregated system in which numerous public, private, and nonprofit actors participate in different parts. While this partitioning creates opportunities for some private sector companies, such as SMEs or companies like Sodiaplast, it is the source of many challenges. It creates uncertainty about oversight and authority, and makes it difficult for interventions in one part of the system to create meaningful impact on other parts. A fully integrated system, in which waste collection from households through deposit at landfill is overseen and managed by one entity and funded through one source, would increase the efficacy of innovative solutions. This model has been successful in other African cities facing growing populations and waste problems.

UNDP to Fill Gap in Waste Stakeholder Efforts: Although there are numerous stakeholders addressing household waste management problems in Conakry, there is a clear gap that UNDP can help to fill by targeting projects that work across both the private and public segments of the current system. One way to accomplish this is to advocate for an integrated system as outlined above. Alternatively, our system-wide economic model provides a tool to assess system capacity and our waste diversion solutions aim to divert waste from the system, providing economic benefits to the public and private segments of the system, respectively.

Focus on Diversion: Diverting waste from landfill is an essential strategy for addressing household waste management. It will reduce strain on the system, alleviate system capacity issues, and can add value to waste through secondary markets or new uses of waste. Additionally, diversion strategies are opportunities for economic development for entrepreneurs, women, and youth. Our team has identified three diversion solutions that are particularly promising: a mobile buyback program, composting, and Community Cookers. However, there are countless examples of other waste diversion solutions that have been applied successfully around the world. Some of these, including artisanal solutions that ensure the highest possible value creation for post-consumer materials, are included in Chapter 5. We recommend UNDP advocate for the implementation of the solutions we've recommended, but also explore additional strategies that can be tailored to the context of the city. Support for a regional summit on large and artisanal scale solutions, with participation from organizations such as the ones we have highlighted in this report, could offer an excellent opportunity for the exercise of UNDP's convener powers.

Utilize Spatial Data and Analysis: Spatial data and analysis can aid the process of tailoring solutions in Conakry. Using spatial data, UNDP can overlay different criteria and weigh them differently, making it easier to analyze social, physical, economic, and environmental constraints and benefits for each potential solution. Once the proper data is identified, it is much easier to perform this depth of analysis spatially than by other means. We recommend UNDP foster work with the Université Gamal Abdel Nasser de Conakry (UGANC) to locate spatial data and analyze it for household waste management solutions.

Consider Social Equity and Progressive Models: Social equity plays an important role in finding long-lasting solutions. An inability for households to pay for private waste collection services has increased waste accumulation in Conakry. Increasing access to these services will not only reduce the amount of waste left in streets, but also allow SMEs to grow their businesses. We recommend a progressive waste collection fee, in which the fee is designed based on households' ability to pay or the amount of waste they produce. A progressive fee can be designed for households exclusively or through the inclusion of commercial services to offset some residential costs.

Seek Unlikely Information Sources: Finally, we recommend UNDP diversify its information sources and partners when considering household waste management. Our conversations with Fatoumata Cherif, an activist and nonprofit leader, provided information across the entire waste management landscape. Our conversations with other organizations and agencies working on waste were fruitful, but often focused on only one part of the system. Ms. Cherif's on-the-ground activism combined with her high level participation in the topic equipped her to provide a wide reaching view of the current situation, without bias or the constraint of an organization's specific directives. UNDP should continuously seek to engage with other activists and on-the-ground sources such as Ms. Cherif.

We would like to thank UNDP again for providing an opportunity to work on this critical sustainability issue. We appreciate your guidance, encouragement, and hospitality over these past four months.

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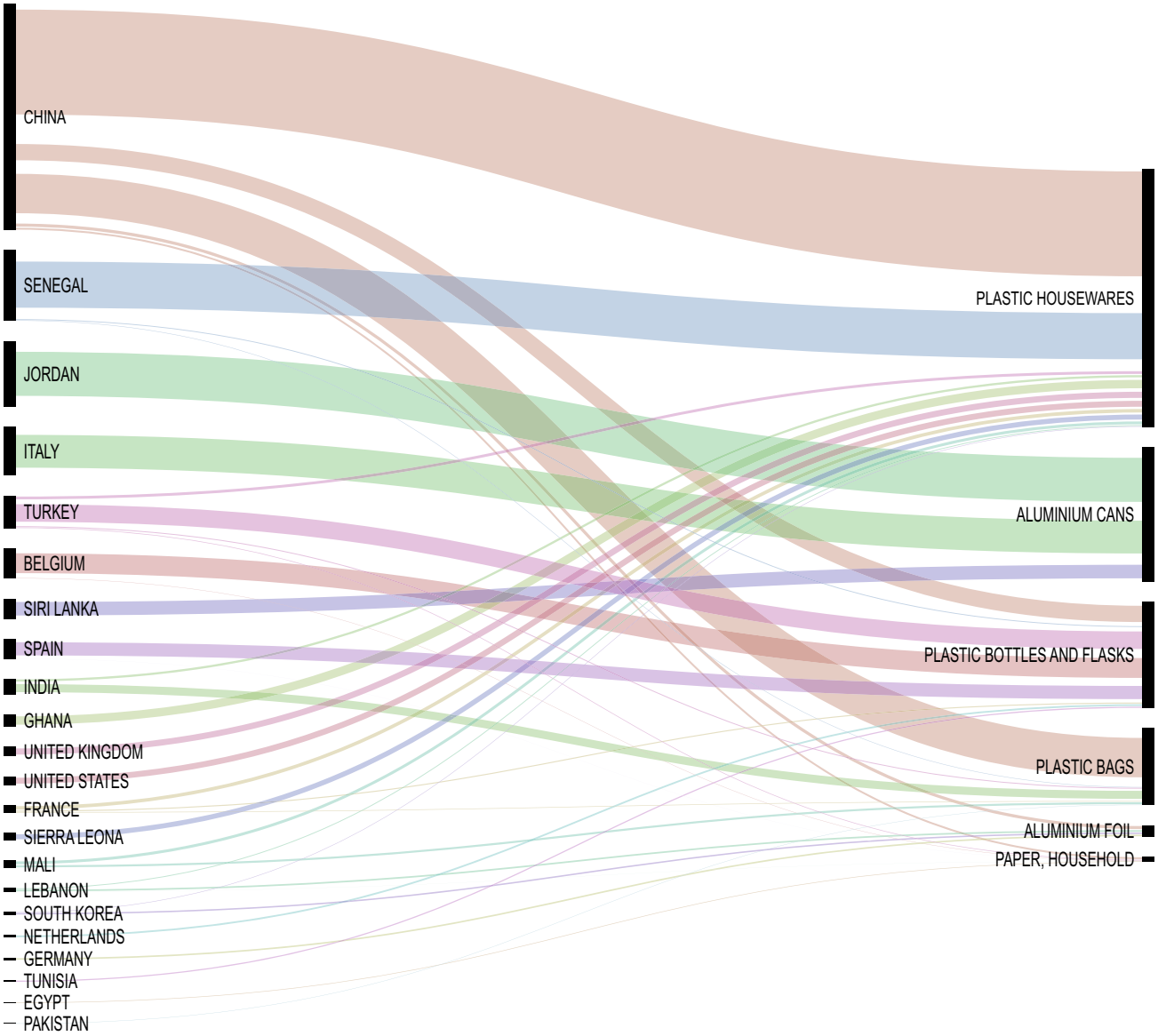
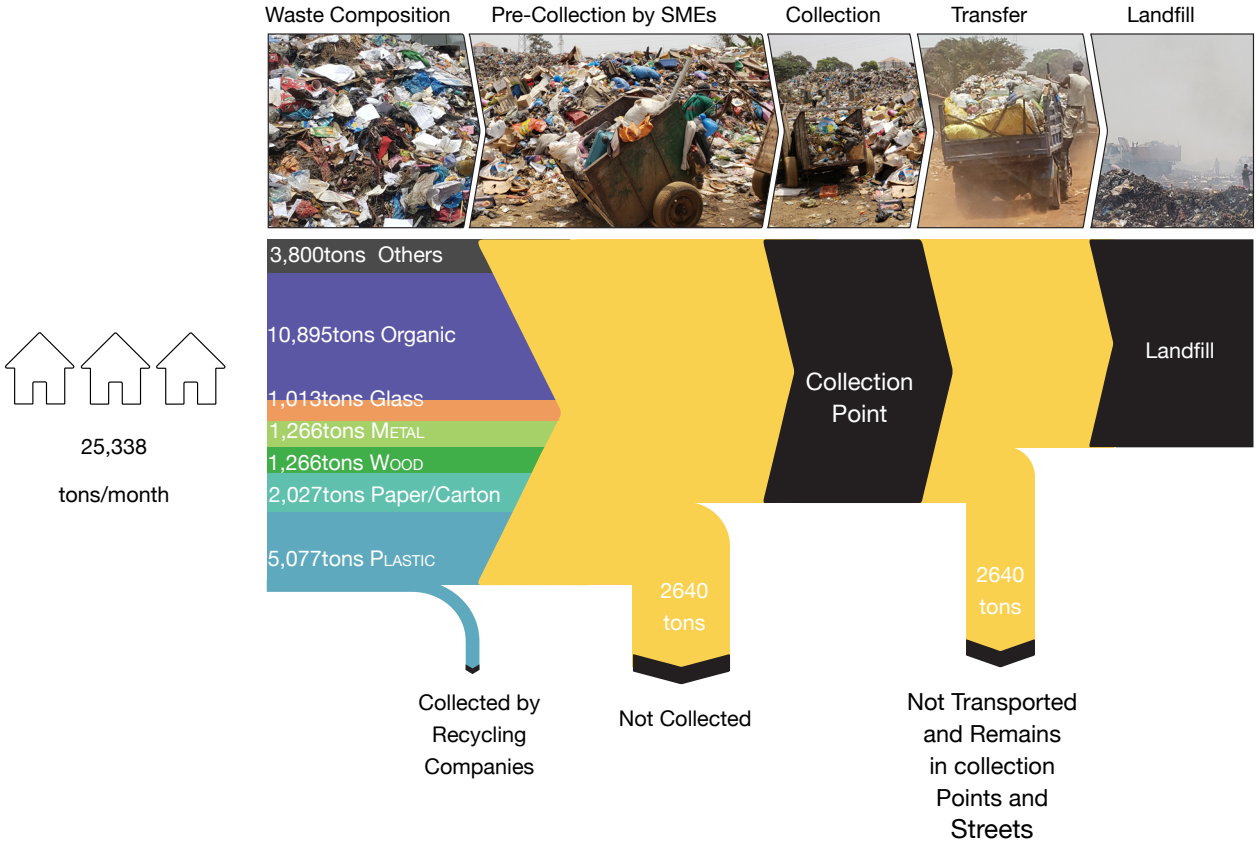
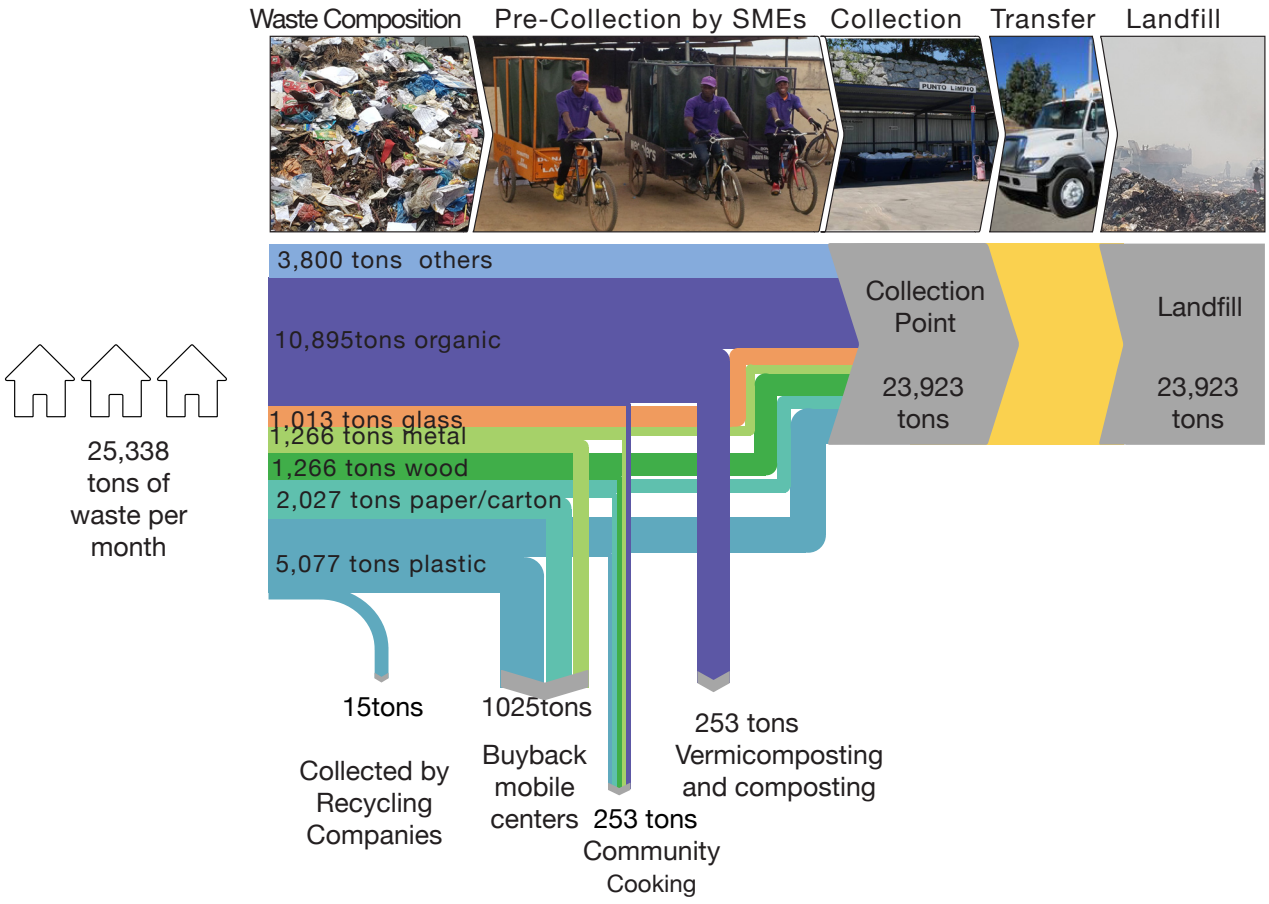
APPENDIX

APPENDIX 1: SANKEY DIAGRAMS



Introduction Figure 1.1: Origins of Plastic and Aluminum Imported into Guinea


Waste Composition
Pre-Collection by SMEs
Collection
Transfer
Landfill
25,338
tons/month
3,800tons Others
10,895tons Organic
1,013tons Glass
1,266tons Metal
1,266tons Wood
2,027tons Paper/Carton
5,077tons Plastic
Collection Point
Landfill
2640 tons
2640 tons
Collected by Recycling Companies
Not Collected
Not Transported and Remains in collection Points and Streets


Waste Composition
Pre-Collection by SMEs
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3,800 tons others
10,895tons organic
1,013 tons glass
1,266 tons metal
1,266 tons wood
2,027 tons paper/carton
5,077 tons plastic
Collection Point
23,923 tons
Landfill
23,923 tons
25,338 tons of waste per month
15tons
Collected by Recycling Companies
1025tons
Buyback mobile centers
253 tons
Community Cooking
253 tons
Vermicomposting and composting

APPENDIX 2:ISSUES AND SOLUTIONS TREE

The issues/solutions tree and potential outcome areas With its mandate and programmatic focus, UNDP can consider its household waste management design around five major strands of causes attributable to Conakry's current waste problem. While they are all intrinsically interconnected, some causes require more scalable action whereas others may be addressed with less resource investment. The table below describes the strands of causes based on assessment conducted through desk research, literature review and field interviews including those with topic experts and those with Conakry's dwellers.

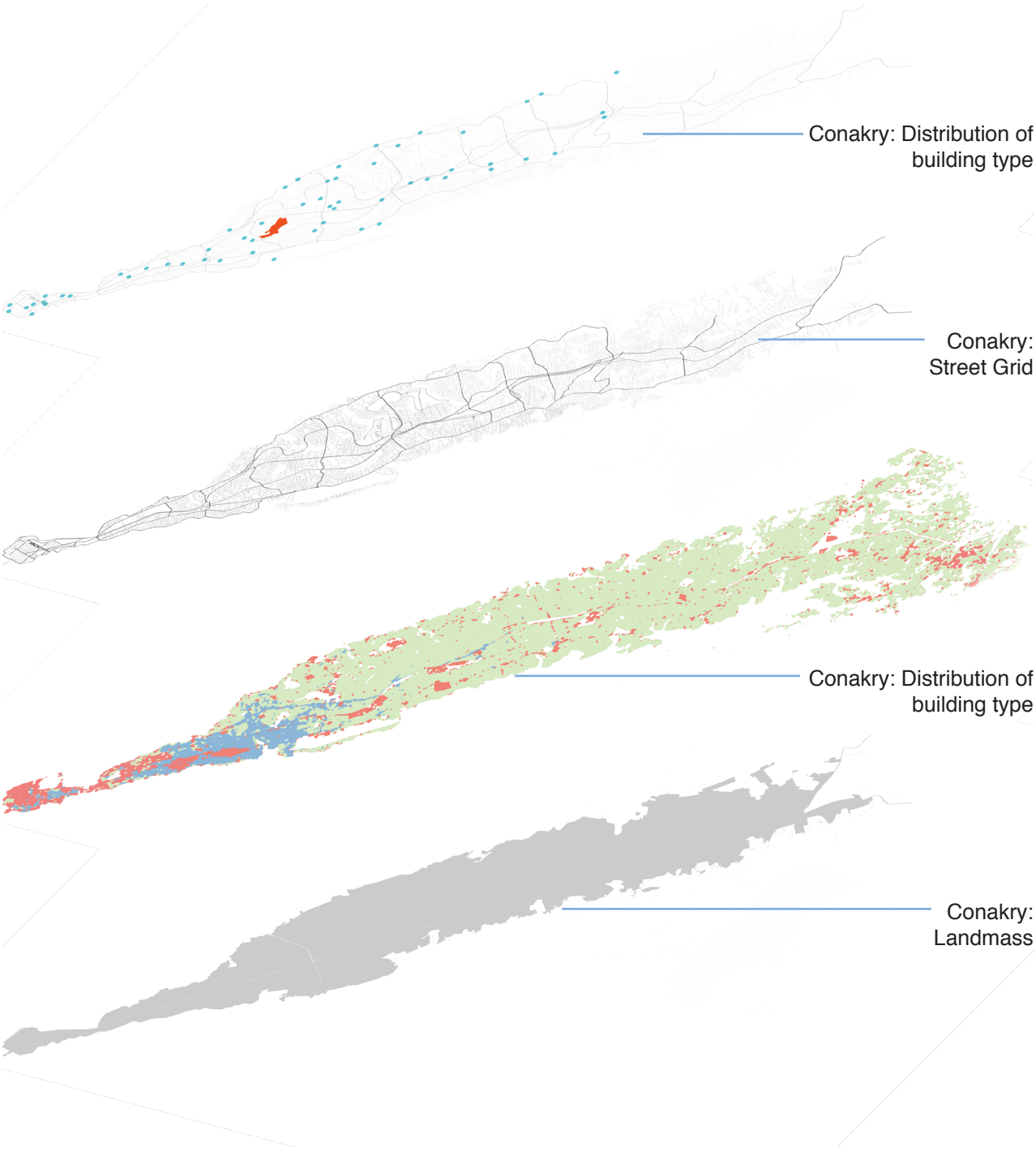
Immediate Causes	Underlying Causes	Root Causes
Excessive waste generation	Surging source of waste and demand of plastics (population, imports)	Population growth, urbanization, globalization and other development pathways
Disposal on the streets as a behavioral norm	Lack of effective education programs; weak policy and law enforcement	Unclear incentive structure; lack of prioritization in legislative/political agenda
High cost of the services	Low public investment in the current structure; low household income level	Lack of coherent investment plan for resource allocation
Lack of accountability	Mandated governing body joining the game later than others on the ground	Bureaucratic governance system susceptible to delay and corruption
Obsolete solutions to post-consumer waste	Lack of capacity to adapt/experiment with new solutions	Unclear understanding of the current landscape dynamics and work modalities

Based on this issue tree, it is recommended that UNDP considers seven priority outcomes as it conceptualizes and builds its new household waste management program. These outcome areas are not exhaustive and only intended to provide a foundation for UNDP as it further designs its program.

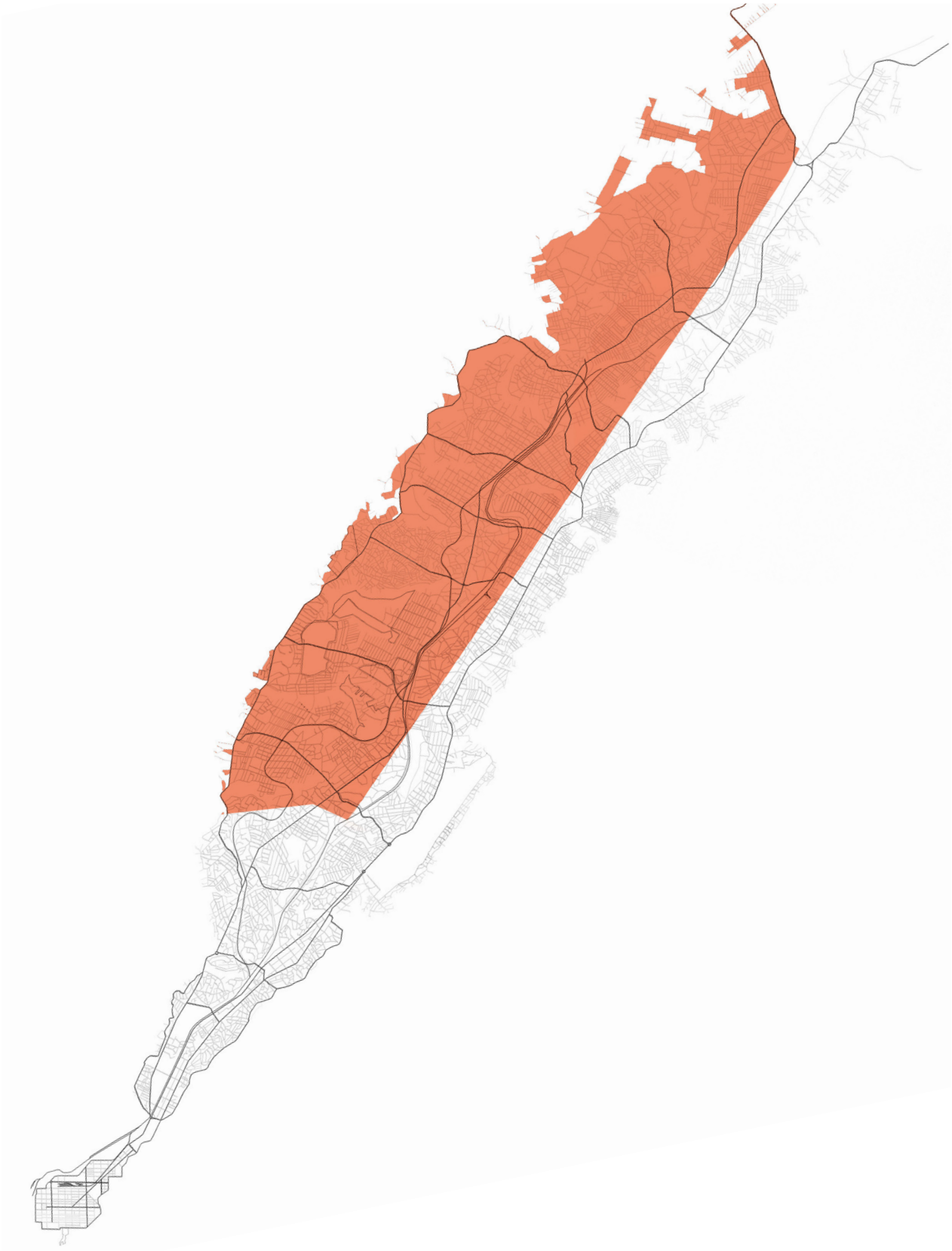
Immediate Causes	Underlying Causes	Root Causes	Outcome Areas	
Excessive waste generation	Surging source of waste and demand of plastics (population, imports)	Population growth, urbanization, globalization and other development pathways	**Public Awareness** Since Guinea is a pre-dividend country, according to WBG, it is most crucial and urgent to ensure that the current and next generations are well-aware of the means to reduce waste generation, the appropriate protocol of waste disposal, and the consequences of poor waste management.	**Data and Partnerships** Data and Partnerships are cross-cutting outcome areas for Conakry's household waste management, and perhaps the most crucial areas. The growing body of data, both in its content and in its form, offers UNDP and its partners more cost-efficient ways to understand the ground situation and map out effective pilot programmes. It is also strongly recommended that, given UNDP Guinea's constrained capacity, that UNDP partners with more civil society, academic institutions and private sector entities to better collect, analyse and make use of existing data. From government-led household surveys to new forms of data such as GIS, there are already many actors collecting useful data for UNDP's work. Nonetheless, the key is that UNDP diversifies the use of data to best inform the programme design. Finally, as partnerships do not only focus on data-related partnership, it is crucial that UNDP maps out the existing actors properly, maintain and constantly update the database and convene regularly to sustain a strong relationship. As the role of private sector is increasingly crucial in development, establishing more PPP should be prioritized. For example, as private sector has already experimented with more innovative solutions on the ground, their lessons learned and capacity built to date should not be undermined nor excluded in UNDP's programme.
Disposal on the streets as a behavioural norm	Lack of effective education programs; weak policy and law enforcement	Unclear incentive structure; lack of prioritization in legislative/political agenda	**Capacity Building and Policy Advocacy** To address these causes, UNDP must strengthen its staff capacity (skills, resources, technology and time) as well as its implementing partners'. Having a designated staff or task force for household waste management over the next few years is strongly recommended. Ideally the task force should further evaluate the financing model and make cost-effective recommendations to the government. UNDP can also bolster its investment around policy advocacy, especially to address the lack of accountability issue, to use its convening power and clarify who's doing what, where and since when.	
High cost of the services	Low public investment in the current structure; low household income level	Lack of coherent investment plan for resource allocation		
Lack of accountability	Mandated governing body joining the game later than others on the ground	Bureaucratic governance system susceptible to delay and corruption		
Obsolete solutions to post-consumer waste	Lack of capacity to adapt/ experiment with new solutions	Unclear understanding of the current landscape dynamics and work modalities	**Innovation and Inclusion** Of all causes, UNDP is best positioned to harness this strand of causes as a platform for further innovation and inclusion. Targeting the population of young people and women, UNDP can actively curate highly replicable models from other countries, facilitate localization and broker knowledge exchange. Examples such as community cookers can offer a good entry point to later leverage. UNDP can also play a role in pooling in SMEs from neighbouring countries, especially those who are seeking to expand their business continent-wide.	

APPENDIX 3: EXAMPLES OF SPATIALIZED DATA

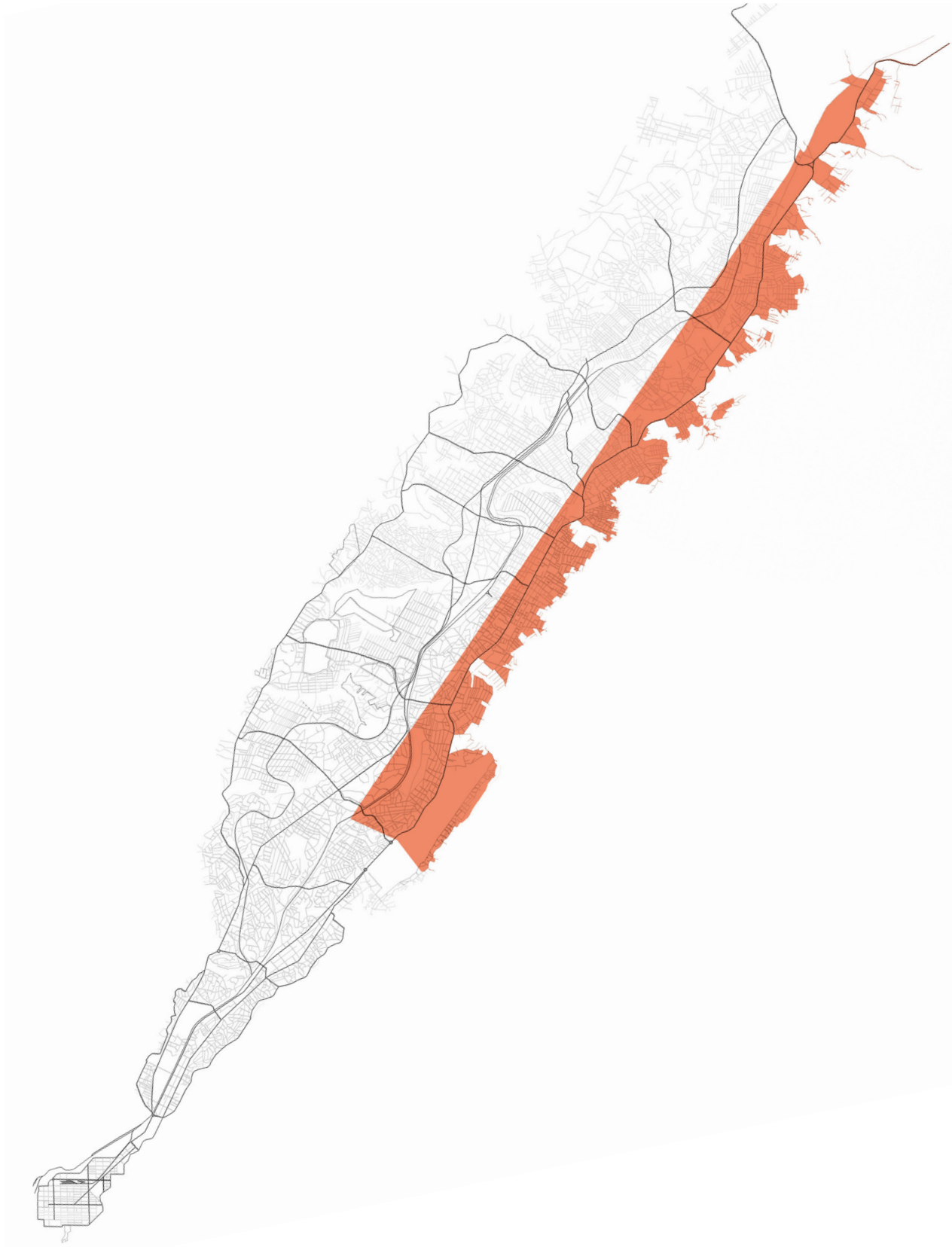
Figure 6.1.1:Conakry Road Grid



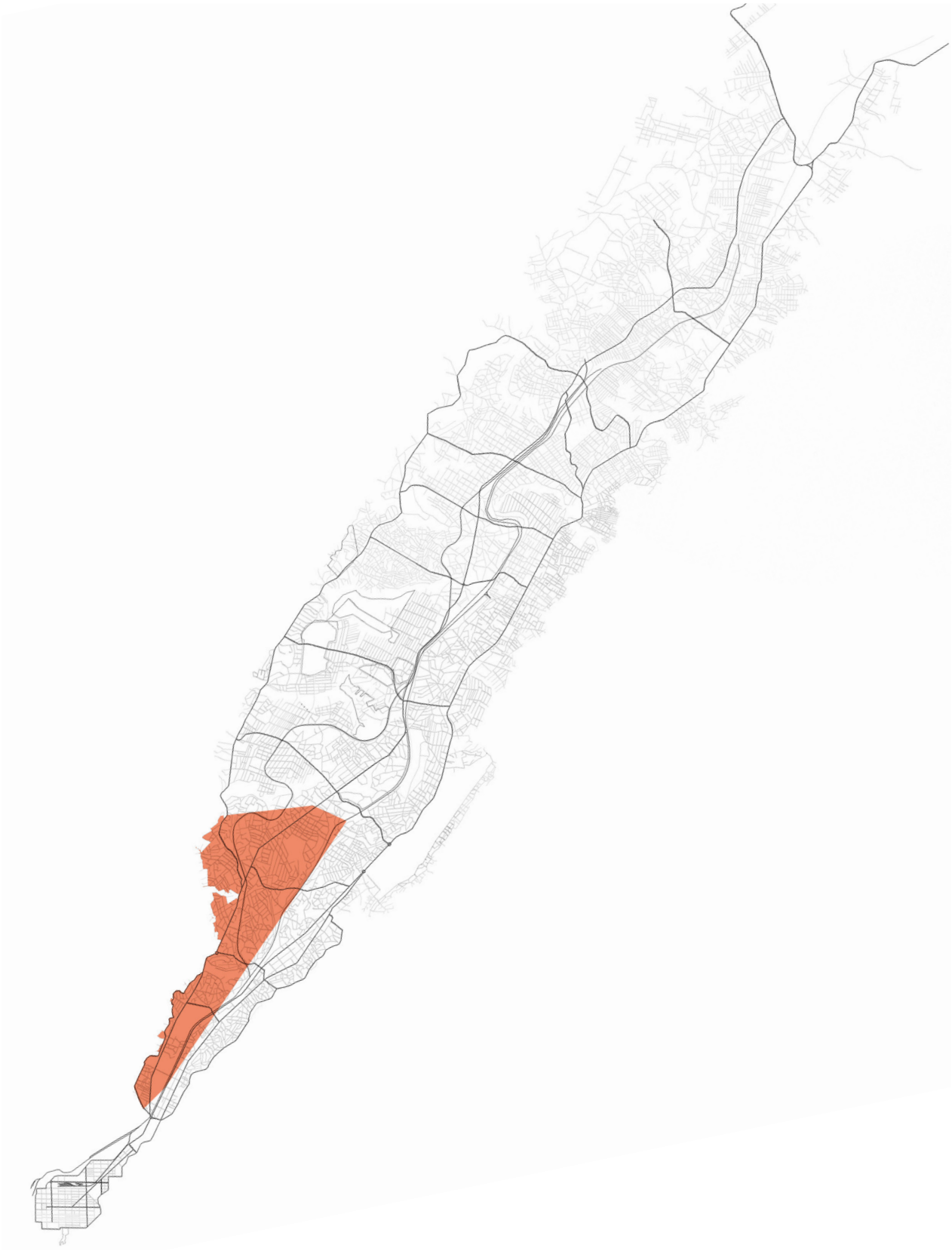
Exploded view of several layers of spatial data for Conakry



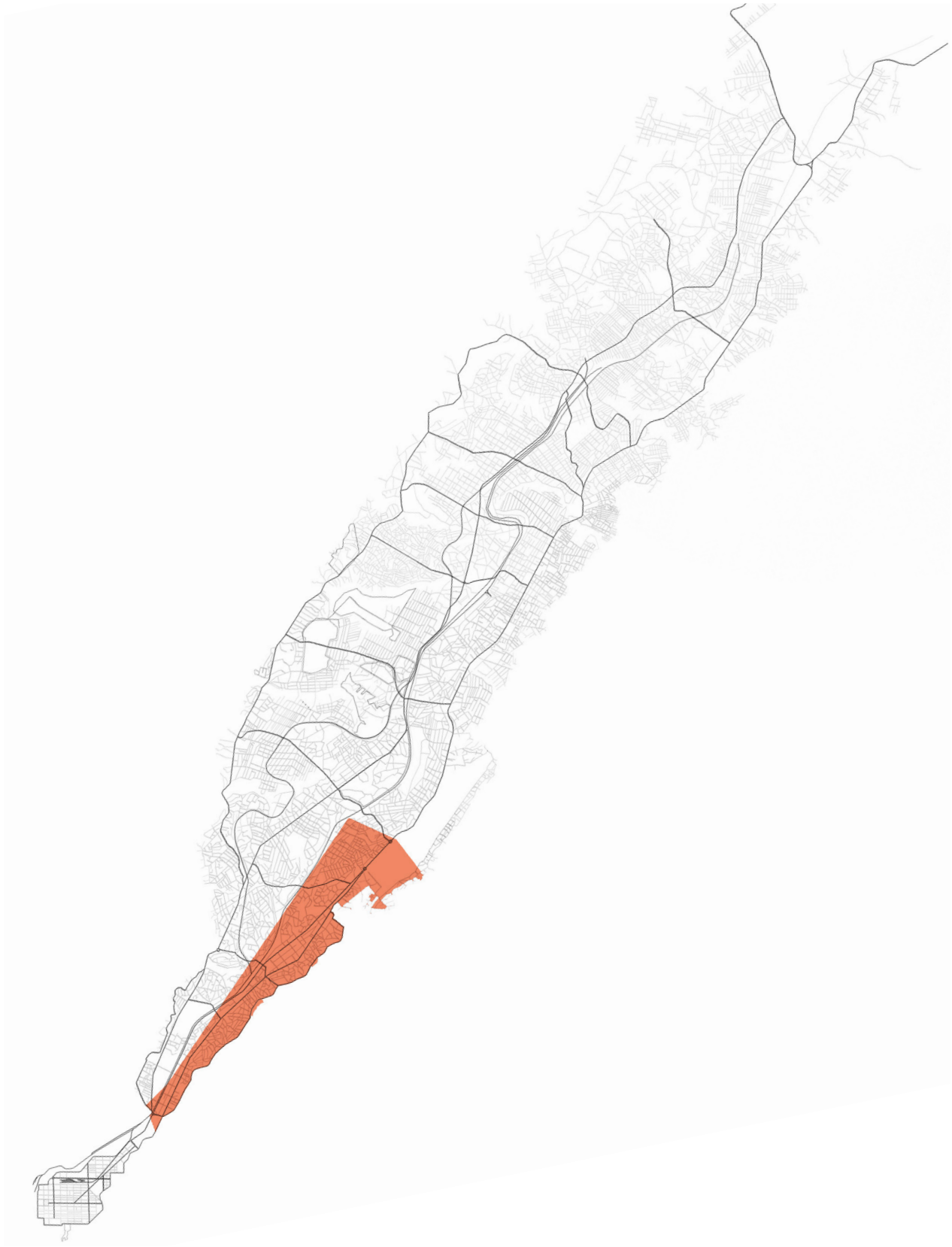
Ratoma respective size and population of 652,783 (based on 2014 Census data)



Matoto respective size and population of 666,640 (based on 2014 Census data)

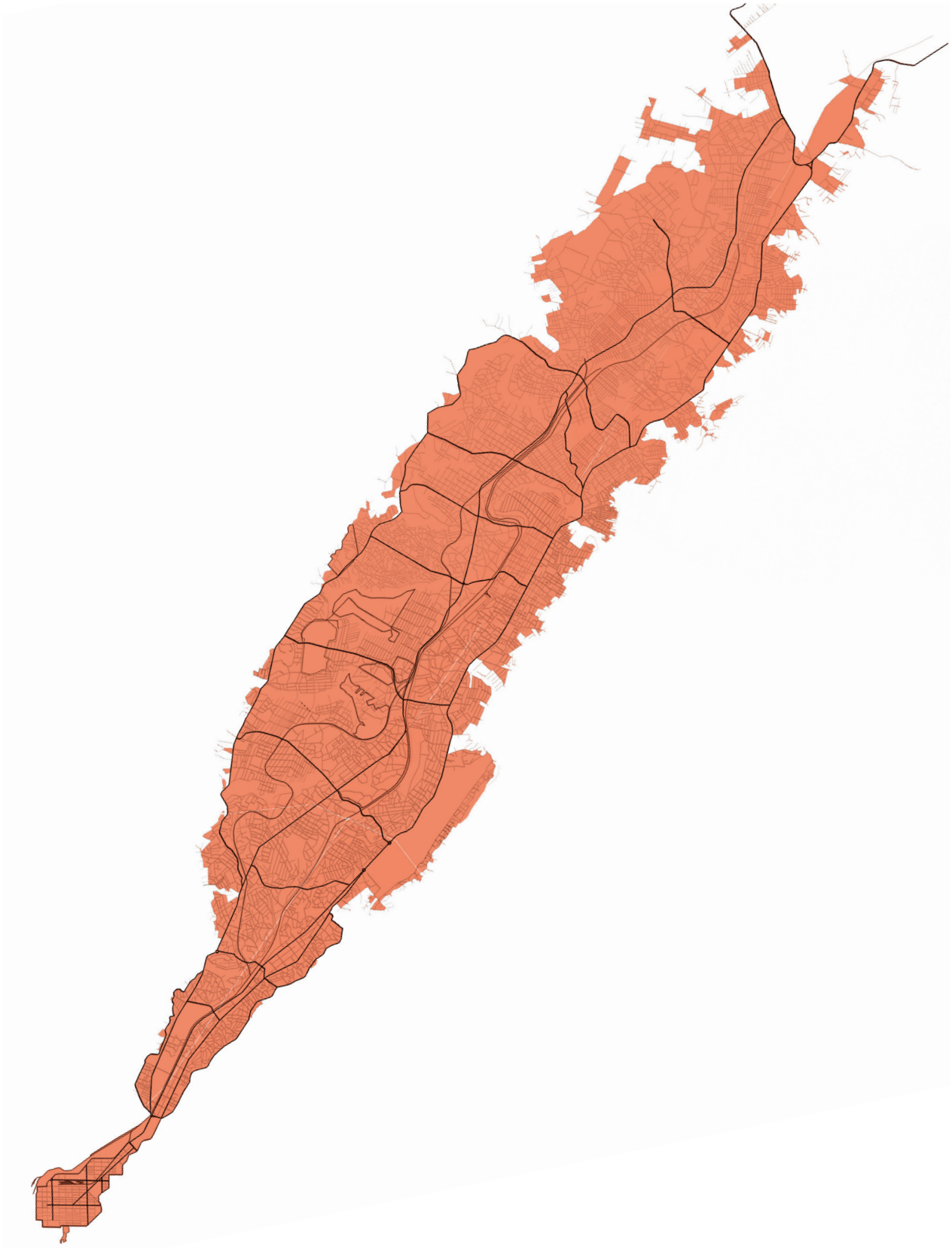


Dixinn respective size and population of 135,788 (based on 2014 Census data)

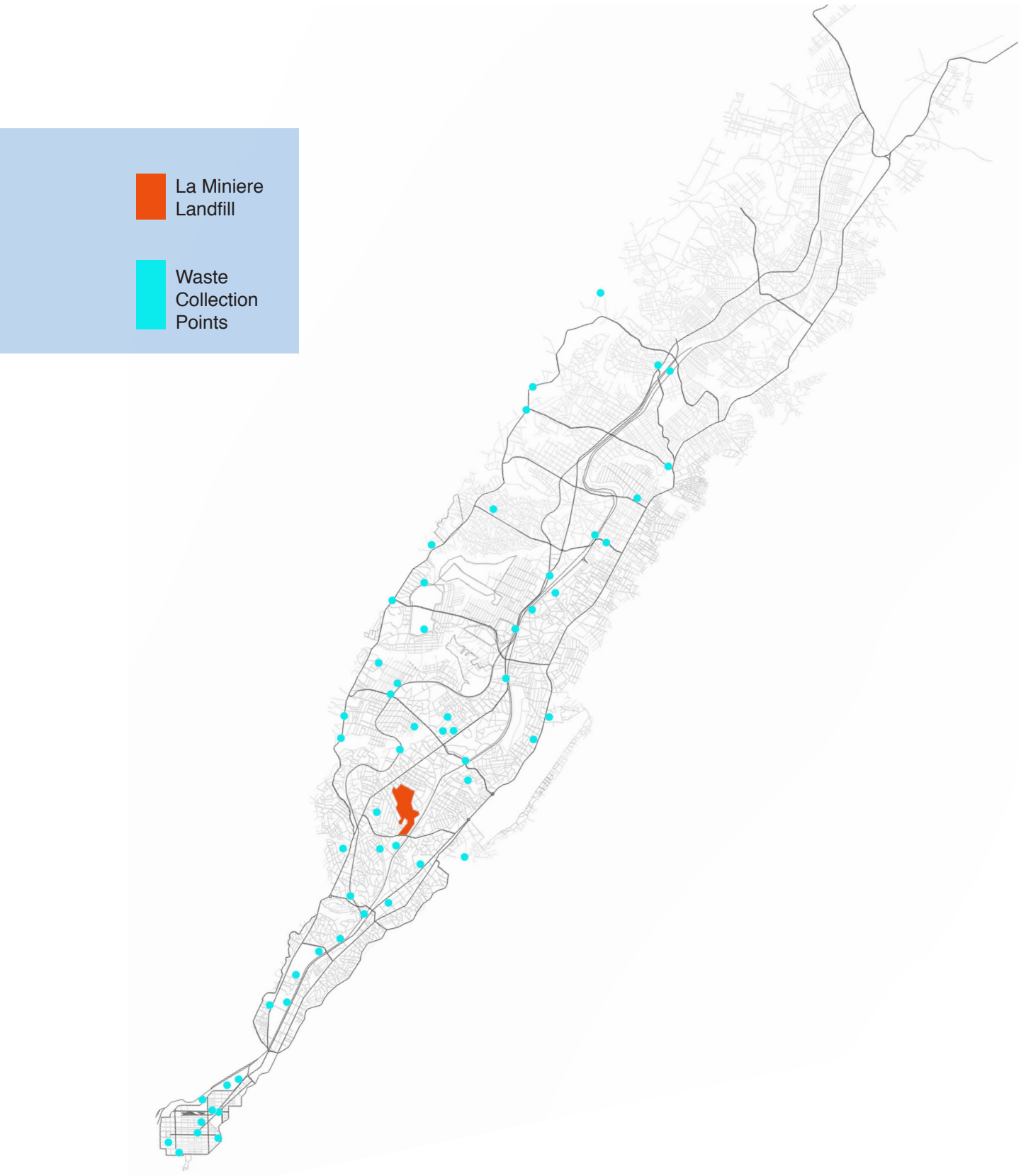


Matam respective size and population of 143,255 (based on 2014 Census data)

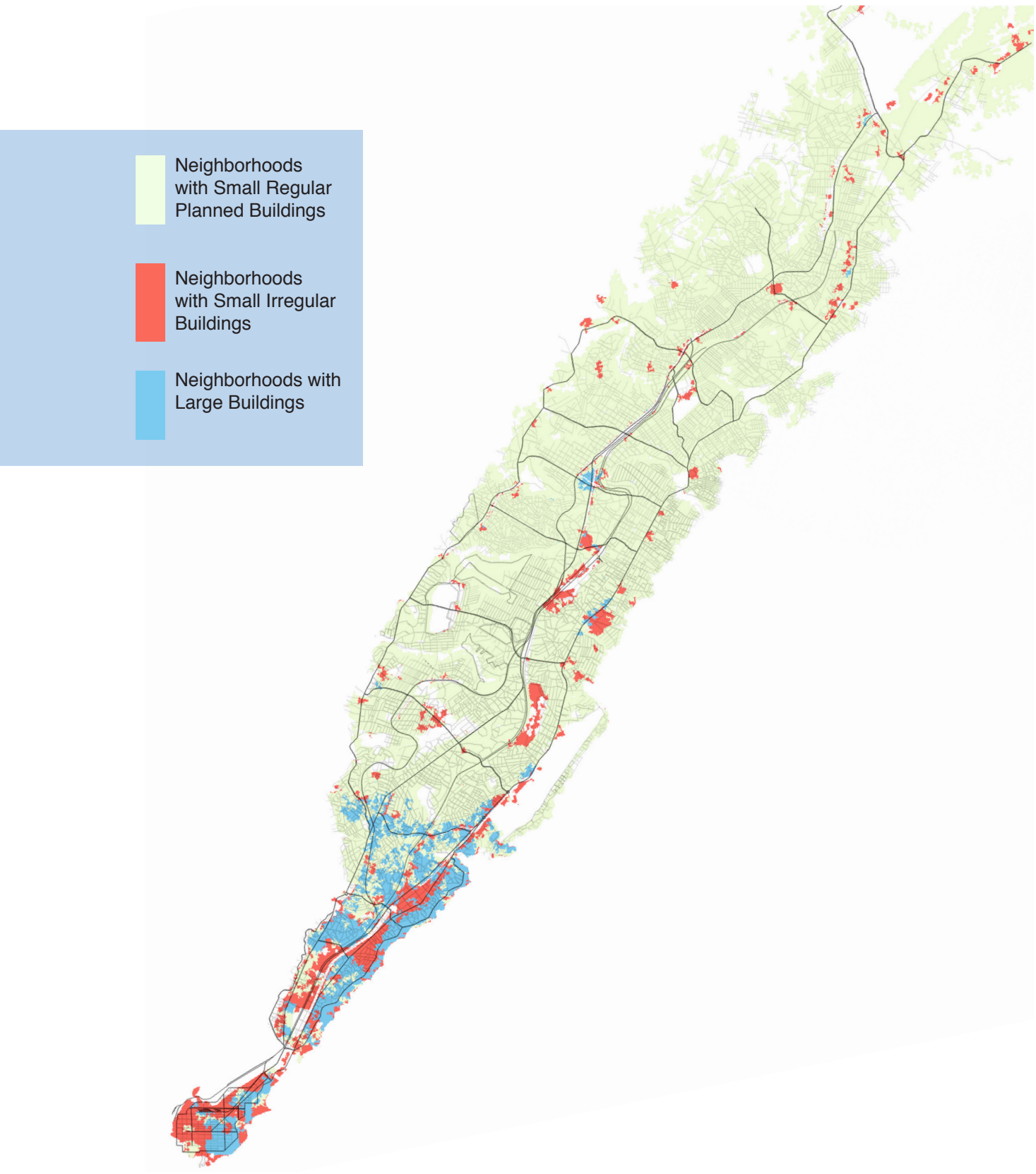
Kaloum respective size & population 62,507 (Population Based on 2014 Census)



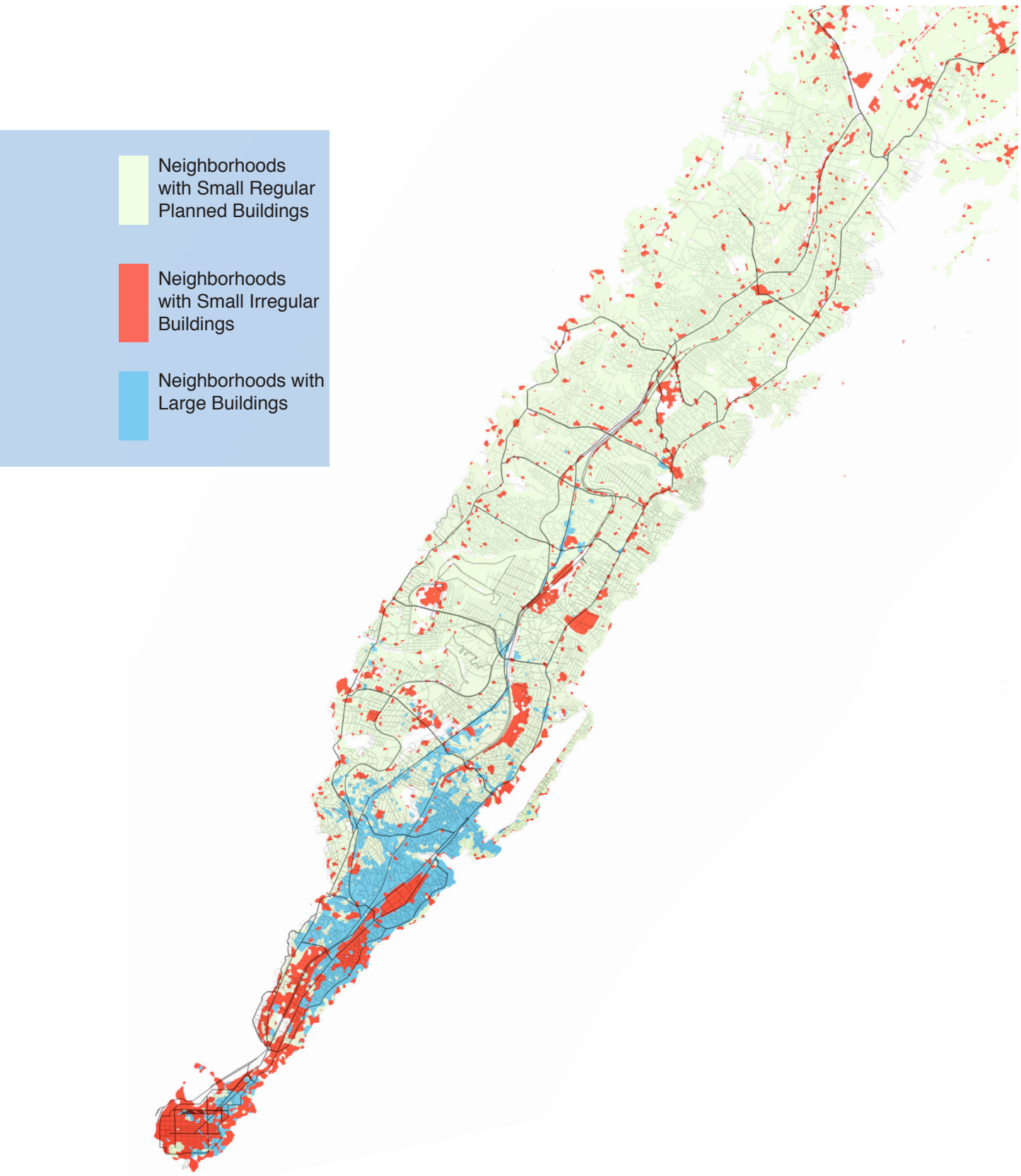
Conakry respective size and population of 1,660,973 (based on 2014 Census data)



Distribution of waste collection points in Conakry and in relation to the La Miniere landfill



Distribution of building types in Conakry in 2006.



Distribution of building type in Conakry between 2013.

APPENDIX 5: FATOUMATA CHERIF INTERVIEW

WOMEN:

1. Where do women in Conakry who are largely working in the home meet or gather? What activities do they share?

Les femmes de Conakry sont pour la plupart des femmes des marchés comme commerçantes. Ce sont des femmes entrepreneures. Même celles qui sont ménagères cherchent à développer des activités génératrices de revenus comme la vente de condiments, la vente de jus, la vente de repas pour le petit déjeuner et de déjeuner comme le riz et l'attiéké… Ces femmes sont souvent dans des associations et se réunissent à tour de rôle chez l'une des membres.

The women of Conakry are for the most part women market traders. They are women entrepreneurs. Even those who are housewives are trying to develop income-generating activities such as selling condiments, selling juice, selling meals for breakfast and having lunch such as rice and attiéké ... These women are often in associations and meet in turn at one of the members.

2. Are there now ways that women working in the home currently earn additional money for example, selling cooked food, taking in laundry, providing child care for others, any kind of piece work or in-home fabrication of items for sale by others?

Les femmes ménagères (dénomination donnée aux femmes sans emplois) exercent des activités génératrices de revenus comme la saponification, la couture, la coiffure, de la layette, certaines font du service catering pour les mariages en cuisinant des plats à domicile. Certaines femmes possèdent des boutiques de ventes d'articles divers qu'elles gèrent seules ou avec leurs époux.

Women housewives (denomination given to unemployed women) carry out income-generating activities such as saponification (making soap from oil or fat), sewing, hairdressing, layette (knitting baby clothes?), some do the catering service for weddings by cooking dishes at home. Some women have shops selling various items that they manage alone or with their husbands.

3. What skills do these women typically possess?

Ces femmes sont le plus souvent des femmes qui n'ont pas terminé leur cursus scolaire. Elles ont dû abandonner l'école pour se marier. D'autres par contre ont fini leur cursus scolaire mais ne sont pas employés. Mais elles sont très organisées car elles mettent en place des associations pour épargner. Elles sont aussi très écoutées dans leur milieu à cause de leur force de mobilisation.

These women are most often women who have not completed their schooling. They had to leave school to get married. Others have finished their studies but are not employed. But they are very organized because they set up associations to save. They are also very popular in their community because of their mobilizing force.

4. What is your experience with skills teaching? We'd be interested very much in how you are helping to teach waste separation but also how you are teaching awareness.

J'ai une approche de sensibilisation directe en allant vers les ménages ou les femmes aux marchés ou encore dans les écoles. Il s'agit de faire comprendre aux consommateurs que la plupart des déchets jetés sont utiles et peuvent être recyclés et vendus. Mais la plupart des ménages ne disposent pas d'assez d'espaces dans leurs concessions, pour disposer de plusieurs poubelles. Le manque de poubelles reste un défi dans la sensibilisation sur le tri des déchets. Mais avec notre organisation, nous arrivons à toucher quelques cibles surtout les jeunes que nous arrivons à sensibiliser au cours de nos opérations de nettoyage des plages et des artères publiques.

I have a direct sensitization approach going to households or women at the markets or in schools. This is to make consumers understand that most discarded waste is useful and can be recycled and sold. But most households do not have enough space in their concessions, to have several garbage cans. The lack of garbage cans remains a challenge in raising awareness about waste sorting. But with our organization, we manage to reach a few targets, especially the young people we manage to raise during our clean-up operations on beaches and public roads.

CELLPHONE ACCESS AND HABITS:

1. What is your experience with people's access to mobile data (for instagram, for example)? How many people use smart phones rather than mobile phones?

En Guinée, la plupart des villes ont une couverture internet. Qu'elles soient instruites ou non, les populations sont de plus en plus connectées car l'utilisation des réseaux sociaux comme facebook et whatsapp nécessite très peu de connaissances. Twitter est utilisé par des jeunes blogueurs et les institutions. Instagram est surtout utilisé pour des photos. Youtube pour regarder des clips vidéo et des novelas.

Ces dernières années, avec le boom du smartphone, le taux d'utilisation des téléphones intelligents a progressé. Si il y'a quelques années, il fallait au moins 300 euros pour s'en procurer, de nos jours avec environs 30 euros on peut disposer d'un smartphone avec Internet. Mais à cause du manque de courant, beaucoup de personnes utilisent également des téléphones analogiques car ils gardent la charge plus longtemps.

In Guinea, most cities have internet coverage. Whether educated or not, people are increasingly connected because the use of social networks like facebook and whatsapp requires very little knowledge. Twitter is used by young bloggers and institutions. Instagram is mostly used for photos. Youtube to watch video clips and novelas.

In recent years, with the boom of the smartphone, the rate of use of smart phones has increased. If a few years ago, it took at least 300 euros to get it, nowadays with around 30 euros one can have a smartphone with Internet. But because of the lack of power, many people also use analog phones because they keep the charge longer.

2. Do women have access to their own phones?

Oui, les femmes ont leurs propres téléphones. Sauf dans de très rares cas, certaines femmes sont obligées de passer par leurs maris pour appeler ou pour recevoir des appels. Car certains maris très possessifs et jaloux voient le téléphone comme un outil qui va pousser d'autres hommes à séduire leurs femmes ou encore à la famille de la femme, d'avoir une main mise sur elle et leur relation.

Yes, women have their own phones. Except in very rare cases, some women are forced to go through their husbands to call or receive calls. Because some very possessive and jealous husbands see the phone as a tool that will push other men to seduce their wives or the family of the woman, to have a hand on her and their relationship.

2. Do you have a sense of how much families or households spend on telephone cards each month? Even an estimated range would be helpful.

Depuis l'avènement des transferts mobiles, beaucoup plus de personnes utilisent moins de cartes de recharges. Les personnes qui ne sont pas très actives et qui utilisent facebook et whatsapp et qui sont à faible revenu utilisent en moyenne 30 000 GNF (3 euros) pour les appels et Internet. Ce montant varie en fonction de la profession et du revenu.

Since the advent of mobile transfers, many more people are using fewer refill cards. People who are not very active and who use facebook and whatsapp and who are low income use on average 30,000 GNF (3 euros) for calls and Internet. This amount varies by occupation and income.

POST-CONSUMER/SALVAGED RESOURCE BUY-BACK CENTERS

Could you please tell us a bit more about how plastics and metals collected are sold?

Les plastiques et métaux collectés sont vendus de manière informelle dans des marches ou dans des décharges publiques. Il n'y a pas de prix fixe. Le marché évolue en fonction du client. Pour les sachets plastiques par exemples, le prix dépend de la propreté du plastique, de sa couleur mais aussi du type. Pour les métaux, cela dépend du type : cuivre, fer, file de fer, aluminium…

Plastics and metals collected are sold informally on markets or in landfills. There is no fixed price. The market evolves according to the customer. For plastic bags for example, the price depends on the cleanliness of the plastic, its color but also the type. For metals, it depends on the type: copper, iron, iron line, aluminum ...

1. Are the buyers small local businesses?

Les acheteurs sont d'une part entreprises locales mais aussi des entreprises étrangères.

The buyers are on the one hand local companies but also foreign companies.

2. How many communes or quartier have a buyer or buy-back location?

La commune de Kaloum dispose de points informels de ventes d'objets recycles au marché niger. Dans la commune de Ratoma la décharge de concasseur et de Kakimbo et d'autres lieux, Dans la commune de Matam, à la Casse de Madina…

The municipality of Kaloum has informal points of sales of recycled objects to the Niger market. In the commune of Ratoma the crusher dump and Kakimbo and other places, In the commune of Matam, in the Casse de Madina ...

3. How does, for example, steel from the small buyer get to Indian or Chinese buyers?

Il y'a des acheteurs qui sont des intermédiaires entre les collecteurs de métal et les entreprises indiennes et chinois. Je ne peux pas dire avec exactitudes qui sont ces personnes intermédiaires car elles ne sont pas formalisées en centre d'achat ou de vente.

There are buyers who are intermediaries between metal collectors and Indian and Chinese companies. I can not say exactly who these intermediaries are because they are not formalized in a buying or selling center.

INCLUSIVE HOUSEHOLD WASTE MANAGEMENT SOLUTIONS IN CONAKRY, GUINEA

MASTER OF SCIENCE IN SUSTAINABILITY MANAGEMENT CAPSTONE PROJECT MAY 2019

Edited by Crysta Jentile, Rafaela Behrens and Geoffrey von Zastrow.