

**Optimization of solid waste collections in Blantyre, Malawi**

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**Abstract**

Your abstract should succinctly summarise the research gap, the methods you employed, your results, conclusions, and recommendations. Don’t use acronyms if possible and keep the language as general as possible. Keep the abstract to a maximum of 500 words. The abstract stays on its own page.

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# Introduction

The project seeks to minimize the costs of operation of the municipal solid waste management service in Blantyre Malawi, while limiting overflowing of the communal skips.

## Background topic 1 (Solid Waste Management)

## Background topic 2 (SWM in Africa)

Maybe now you dive into the global differences in collection

### Alskdjfasd

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## Justification and Research Questions

1. How can we model with limited data
2. How many trucks are needed to service all the skips? What would be the mileage and cost of servicing all skips without overflow?
3. What would be the optimal routing schedule?

# Data analysis

In order to formulate feasible and pertinent recommendations, parameters reflecting the situation need to be calculated. Specifically, the location of skips and the rate at which skips are filling, so as to know the frequency at which they need to be emptied (services). The more robust set, as seen in this section, is a timeseries of specific skips filling and emptying. However, the scope of it is quite narrow, with only 12 useful filling rates extracted, all in a small area of Blantyre. A second dataset gives the arrivals at Mzedi dump, the main waste **\*word\*** in Blantyre.

## Set of skip locations

A set of skip, taken to be all the community skips to be serviced in Blantyre, along with GPS coordinates is given. Each skip is 7m3. Some data points have the same name, when several skips are in the same area (e.g. three skips in the same market). It is unknown if more than one skip can be represented by one coordinate point. Furthermore, there is no information about the intended nature of the waste (organic or inorganic). The locations of the municipal dump (Mzedi dump), the truck storage facility and the compost facility are also given. The locations are mapped in Figure 1.

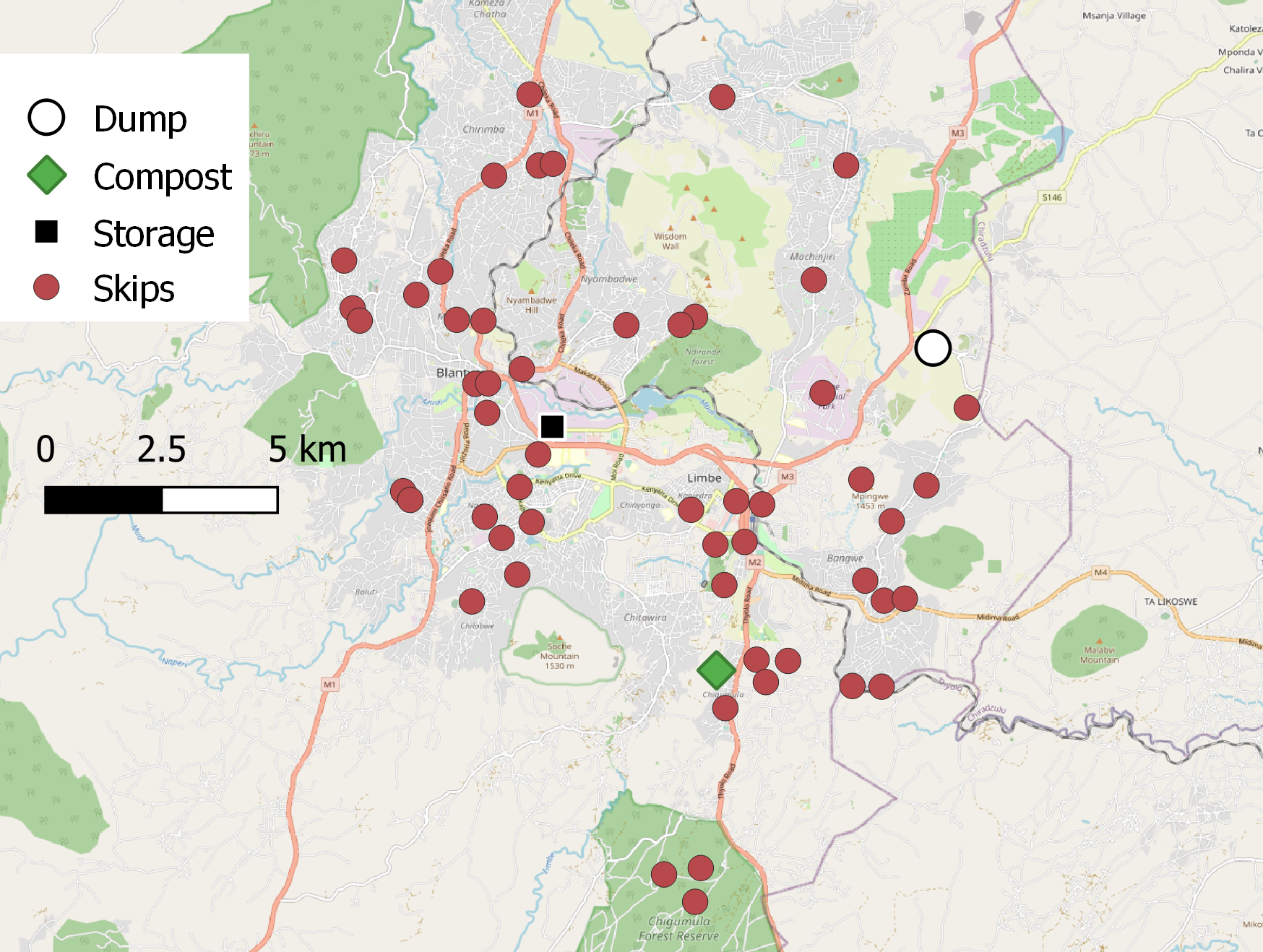


Figure Locations of skips, dump, compost facility and truck storage in Blantyre

## Skips filling data

Filling data for a number of skips is provided. The time series are named in the following fashion: “area+type of waste+number”. The names of the areas do not always match the ones from the set of skip locations, in addition to the ambiguity of several skips present in a certain area. The type of waste also complicates the analysis, as some are marked as organic, and other inorganic.

While efforts have been made to separate organic and inorganic waste at the skip level, those have, to my knowledge, not been successful. The composting facility does not seem to be in use.

Over a certain period of time (depending on the skip), a measurement on a scale from 1-5 was taken visually (generally) every day at those skips. A score between 0 and 4 indicate the estimated fullness of the skip, while a 5 means the skip was overflowing. Four of these are shown in **insert ref.**

**In other subsection:**

**insert ref** seems to be an ideal profile for data extraction. There are not too many spikes (taken as measurement errors), the ramps are discernible, and there is a good number of them to draw averages. **Insert ref** presents a bigger challenge, as it is difficult to make out the difference between measurement errors (outliers) and very fast filling of the skip. **Insert ref** is a timeseries from which filling rates cannot be extracted. Finally, **insert ref** only has one useful ramp, from which a filling rate can be computed.

## Dump arrivals logs

A separate time series is provided. It lists arrivals at the Mzedi dump, along with the origin of the skip carried by each truck. The origins match exactly the set of skip locations, but once again, not the filling data. The period of this series is 2020-12-05 to 2021-12-31. The sum of arrivals in each week during this period is shown in **.** A sizeable gap is noticeable for almost the whole of February 2021. This is reflected in the skips filling data, where many skips were overflowing and not emptied during this period. The reason for this gap is unknown, but assumed here to be the service simply not operating.



Figure Sum of deliveries (arrivals) at Mzedi dump over the entire period of measurements

# Results and Discussion

This is where you present your findings. As much as possible structure your results along the lines of your research questions. Start with the simplest results first and proceed to more complex ones. Tables and Figures should be clear enough that they need little explanation: do not simply re-write the numbers as text to fill space. Rather, highlight trends, outliers, or gaps.

## Discussion

Sometimes, the Discussion section is separate than the Results. Where to include it is personal, though it is often easier to include the discussion with the results. The discussion simply refers to the interpretation and contextualization of the results. You present your findings (results) and then explain what they mean; how do they relate to what other people have found; how they match or contradict the literature. The discussion requires references to other published works. Results sections that only present data are fine, but when there are multiple results, it is sometimes difficult for the reader to bounce back and forth between the results and the discussion.

## Tables and Figures

Tables and Figures are key to communicating your results so they need to be clear, organized, and well-presented. Both Tables and Figures should always be referenced in text before they appear.

## Tables

Table

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# Conclusions and Recommendations

No more than a page; two pages maximum.

# References

Raucq, J., Sörensen, K., & Cattrysse, D. (2019). Solving a real-life roll-on–roll-off waste collection problem with column generation. *Journal on Vehicle Routing Algorithms*, *2*(1–4), 41–54. https://doi.org/10.1007/s41604-019-00013-6