Reverse Household Waste Flow Mapping

P5

Public Presentation

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IV. Methods

   A. Method Household-to-trashcan

   B. Method Household-to-retailer

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1. Introduction

Motive

- World population is expected to grow to 9 billion people in 2050
- Raw materials are finite
- Linear way of producing has to come to an end
- Companies and governmental organisations start to see value of circularity of raw materials.

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- Companies and governmental organisations start to see value of circularity of raw materials.

Difference between linear & circular:

Linear economy is take, make & waste, whereas circular economy uses the waste as input.

Circular economy is defined as:

“a regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing energy and material loops.”(Geissdoerfer et al., 2017)

Profits of circular economy

- Using less finite materials, because waste is also input
- Cost minimization
    - TNO estimates the added value of circularity to the Dutch metal and electronics sector on 7.3 billion euros
- Municipality of Amsterdam wants to profit from the possible benefits of circular economy

Amsterdam created a vision and action agenda:
Circular Amsterdam

Circular Amsterdam

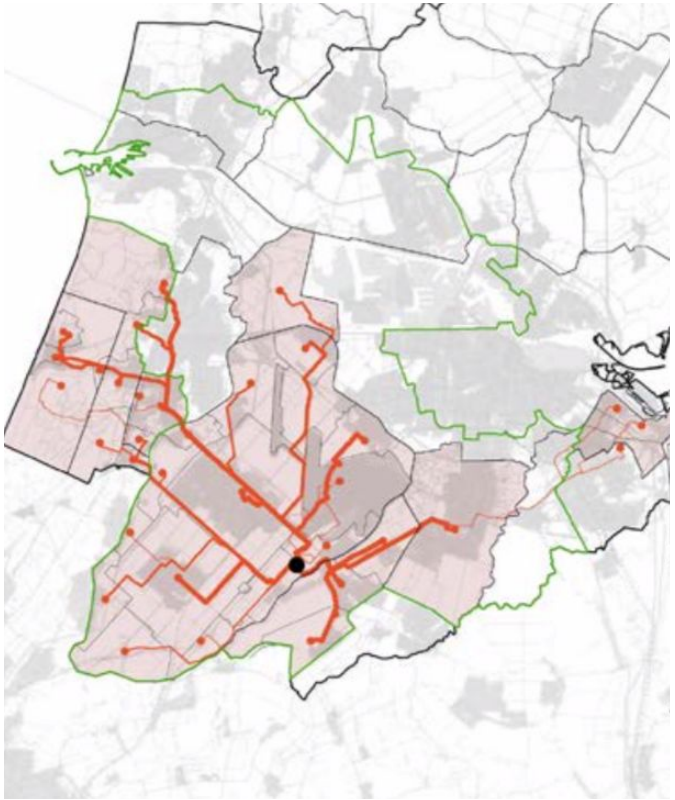
- Organic waste streams are mentioned as one of the three major action points
- Lack of understanding of these streams
- REPAiR researchs Amsterdam waste flows

REPAiR focuses on:

“The implications of possibilities of circular economy applications in the management of waste flows, aiming to fill a gap in the research on consumption behaviour and sustainable urban development.”

REPAiR previous research

- Visualized waste flows and mapped them for amsterdam from neighbourhood level to waste treatment plant



Waste flows

- REPAiR focusses on organic residual flows
- Mapping waste flows give a possibility to analyze waste generation (Kurdve et al. ,2015)
- Mapping waste flows results in better understanding of supply and demand

Waste flow mapping on household level is never done before, therefore potential behaviour data is missing.

This thesis

- Builds upon the previous research by REPAiR H2020 project
- Maps the flows in different direction than the REPAiR project (**reverse**)
- Touches household level, therefore fills the gap of consumption behaviour

2. Research questions

Main question:

How can household waste flows be mapped in reverse based on their environment?

Amsterdam does not collect organic waste

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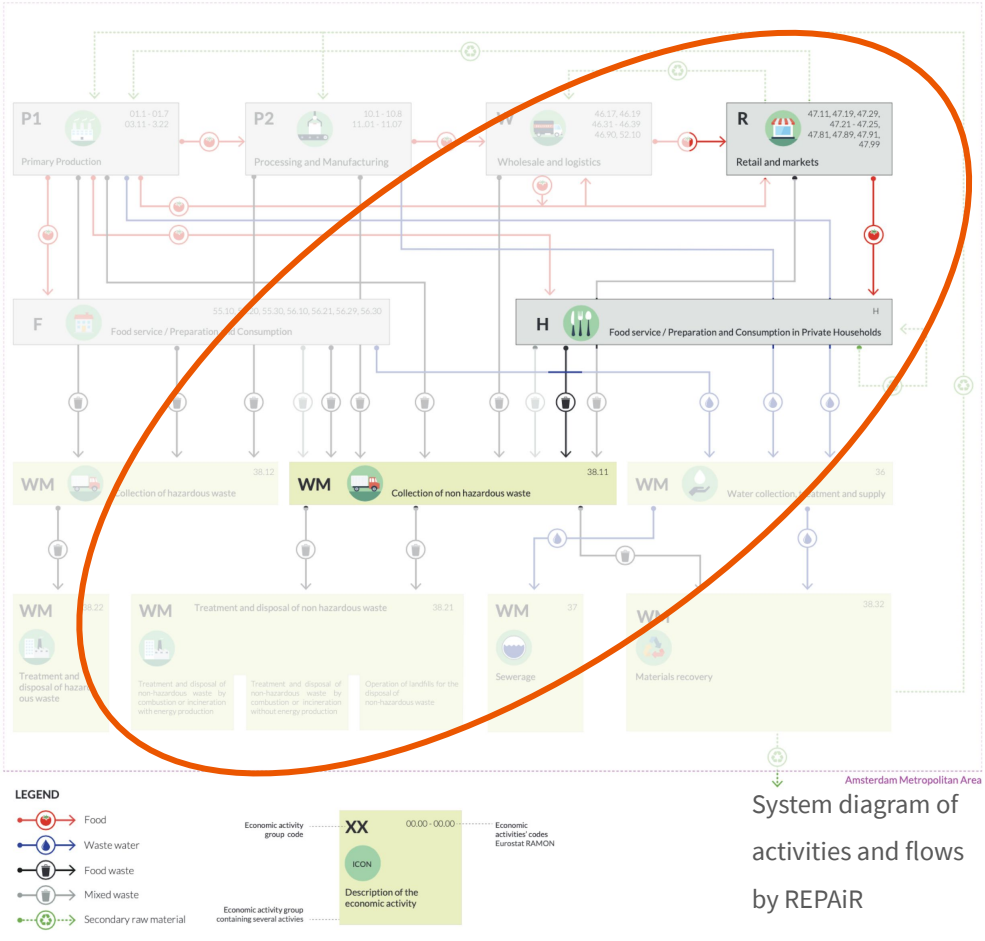


System diagram of activities and flows by REPAiR

Retail and Market

Consumption in Private Household

Non Hazardous Waste Collection

Treatment plant

Main question:

How can household waste flows be mapped in reverse based on their environment?

Connecting the next node is a human decision, influenced by the environment

Sub questions

Sub questions

Are related to:

- **Theory**

Sub questions

Are related to:

- **Theory**
  - Motive
  - Related work
  - Visualization methods

Sub questions

Are related to:

- **Theory**
- **Design**

Sub questions

Are related to:

- **Theory**
- **Design**
  - Datasets needed
  - Connection household -> trashcan
  - Connection household -> retailer

Sub questions

Are related to:

- **Theory**
- **Design**
- **Validation**

Sub questions

Are related to:

- **Theory**
- **Design**
- **Validation**
  - Validation with trashcan mass data
  - Optimization

Sub questions

Are related to:

- **Theory**
- **Design**
- **Validation**
- **Mass of the flow**

Sub questions

Are related to:

- **Theory**
- **Design**
- **Validation**
- **Mass of the flow**
  - Use results of design
  - Follow waste mass through flow

Sub questions

Are related to:

- **Theory**
- **Design**
- **Validation**
- **Mass of the flow**

3. Related work

Food waste

- Difficult to predict household food waste behaviour
- Households are one of the biggest contributors of food waste
- Main source: food retail
- Main disposal: food waste collection

Visualizing waste flows

- Material Flow Analysis (MFA)

Visualizing waste flows

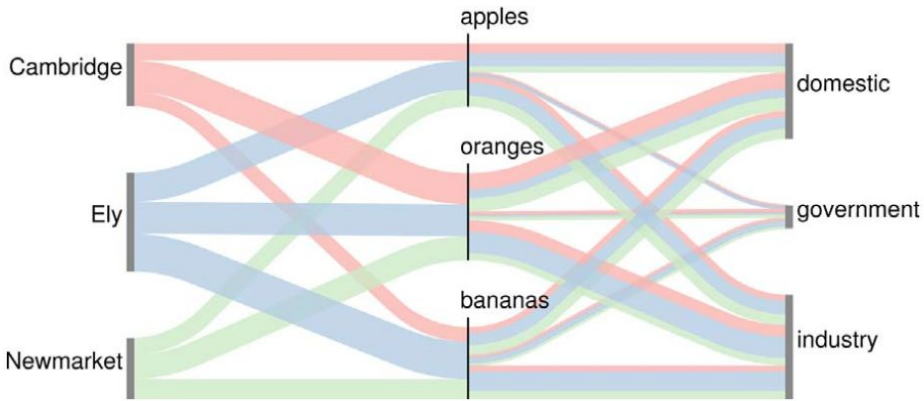
- Material Flow Analysis (MFA)
    - Allows to track specific material flows through a socio-economic system and provides a method to identify sources of generation (Brunner and Rechberger, 2004)

Visualizing waste flows

- Material Flow Analysis (MFA)
- Sankey Diagrams

Visualizing waste flows

- Material Flow Analysis (MFA)
- Sankey Diagrams
  - Represent visual flows related to a given functional unit or period of time
  - The link widths represent the size of the flow



Adding spatial dimension: Spatial Material Flow Analysis

- Roy et al. (2015) developed a model to measure flows of construction material at a spatial level

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- Font Vivanco et al. (2012) developed a model for building waste with transport intensity indexes

Adding spatial dimension: Spatial Material Flow Analysis

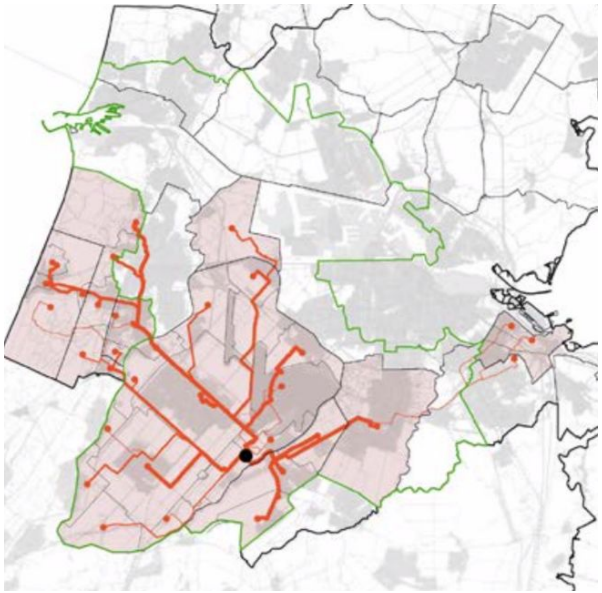
- Roy et al. (2015) developed a model to measure flows of construction material at a spatial level
    - Is able to estimate and spatially allocate construction material flows at a neighbourhood level
- Font Vivanco et al. (2012) developed a model for building waste with transport intensity indexes
    - Is able to estimate transport intensity indexes based on a network analysis

Adding spatial dimension: Spatial Sankey Diagram

- REPAiR used a Spatial Sankey Diagram to map the waste flows

Adding spatial dimension: Spatial Sankey Diagram

- REPAiR used a Spatial Sankey Diagram to map the waste flows
    - By connecting the neighbourhoods via a network to the waste treatment plant belonging to the neighbourhood



Summary: Related work

- Main source: food retail
- Main disposal: collection of residual waste

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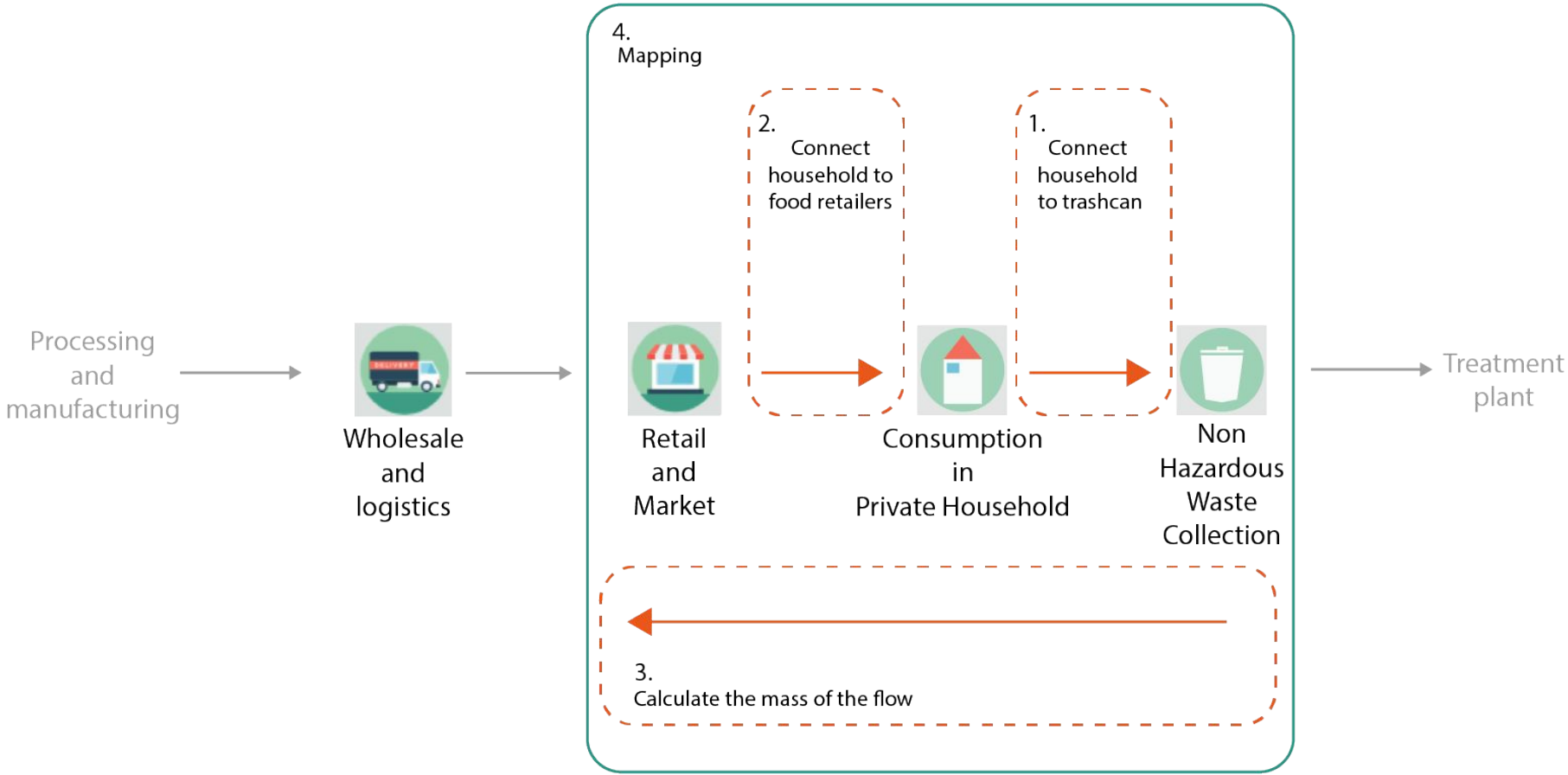
Summary: Related work

- Main source: food retail
- Main disposal: collection of residual waste (in Amsterdam)
- Multiple visualization and mapping methods, not with needed level of detail
- Household level of detail is mentioned as missing in waste flow research

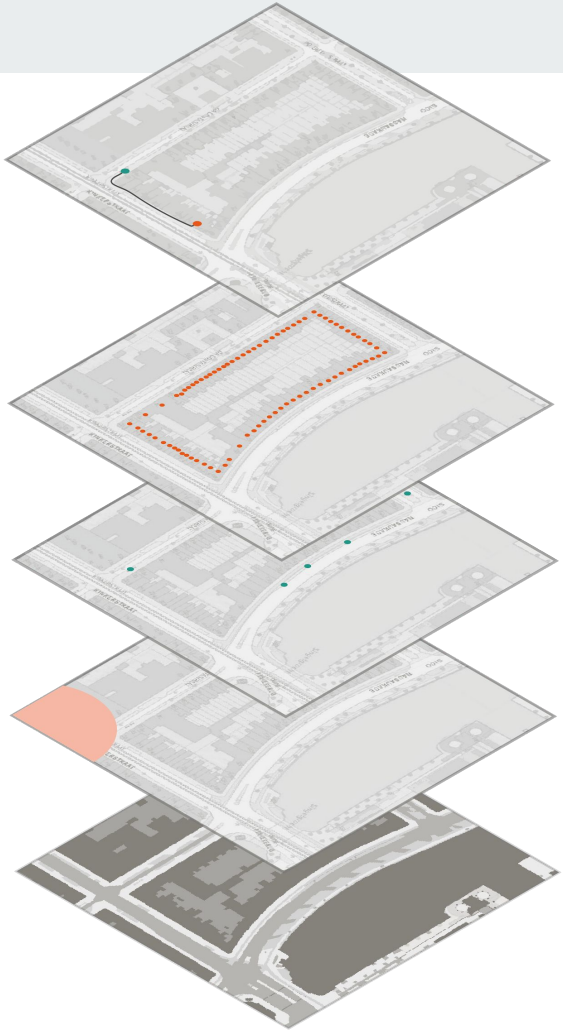
4. Methods


4.
Mapping
2.
Connect household to food retailers
1.
Connect household to trashcan
Processing and manufacturing
Wholesale and logistics
Retail and Market
Consumption in Private Household
Non Hazardous Waste Collection
Treatment plant
3.
Calculate the mass of the flow

4 A. Method 1 Household-to-trashcan

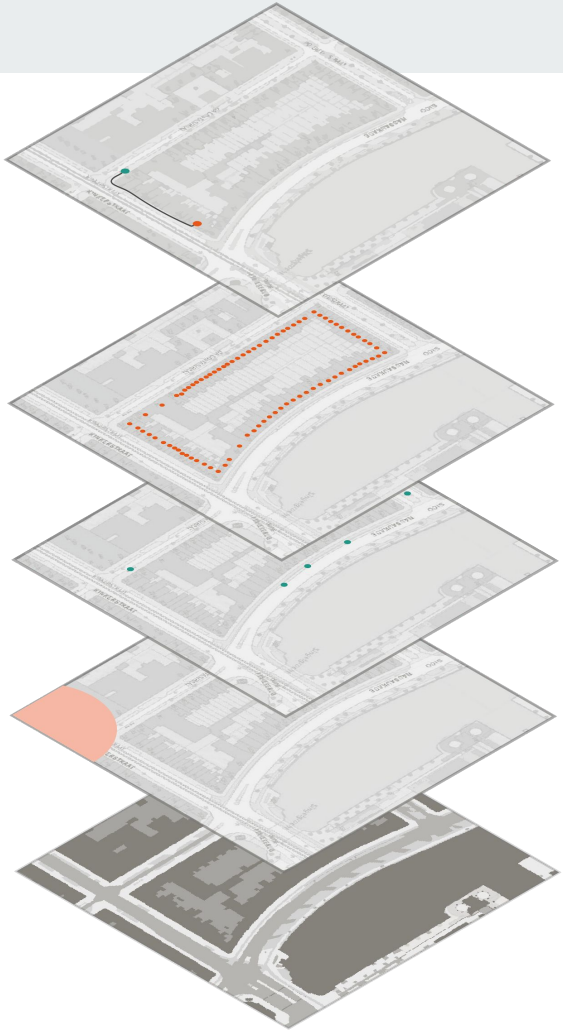
Hypothesis:

Residents of a household choose the closest residual waste trashcan to throw away their household waste, but are willing to walk further if the walk is in the direction of a city hotspot.



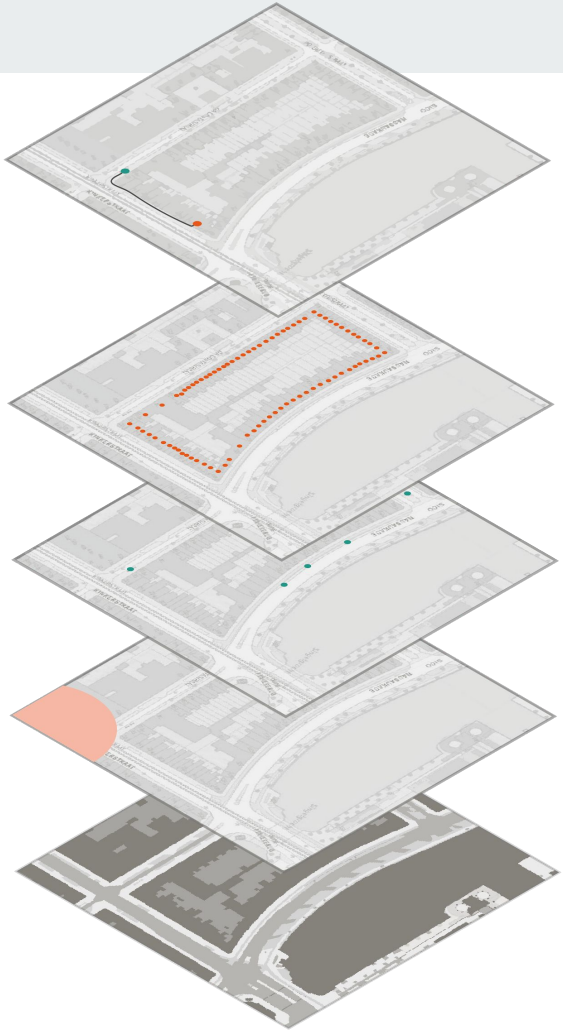
Goal:
Connect the household to the used trash can

Input:
Find all the households



Households

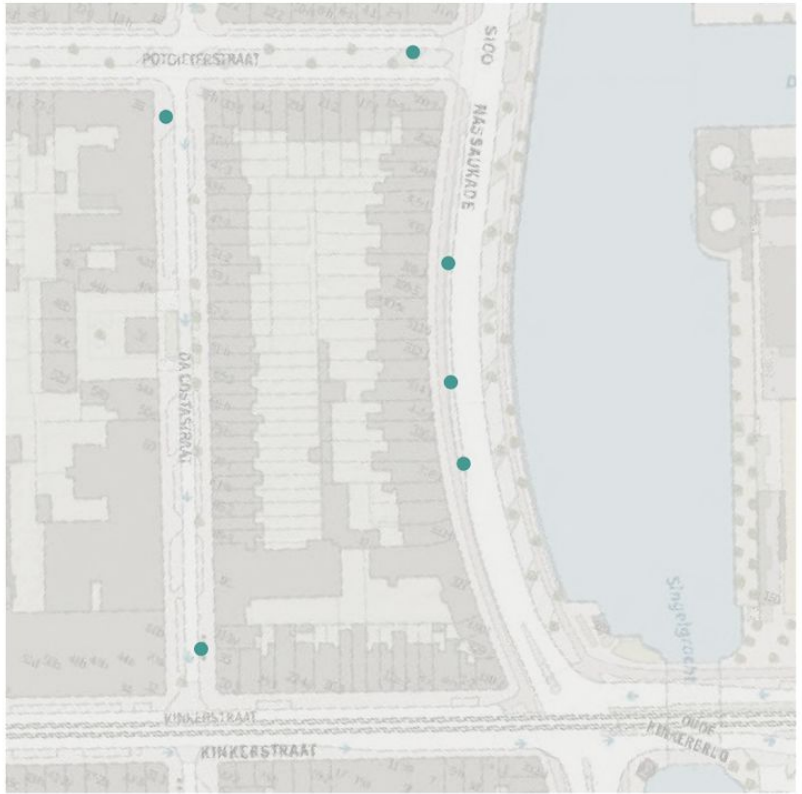
- Derived from BAG (verblijfsobjecten)
- Combined with BAG Polygons
- Represent every house in Amsterdam



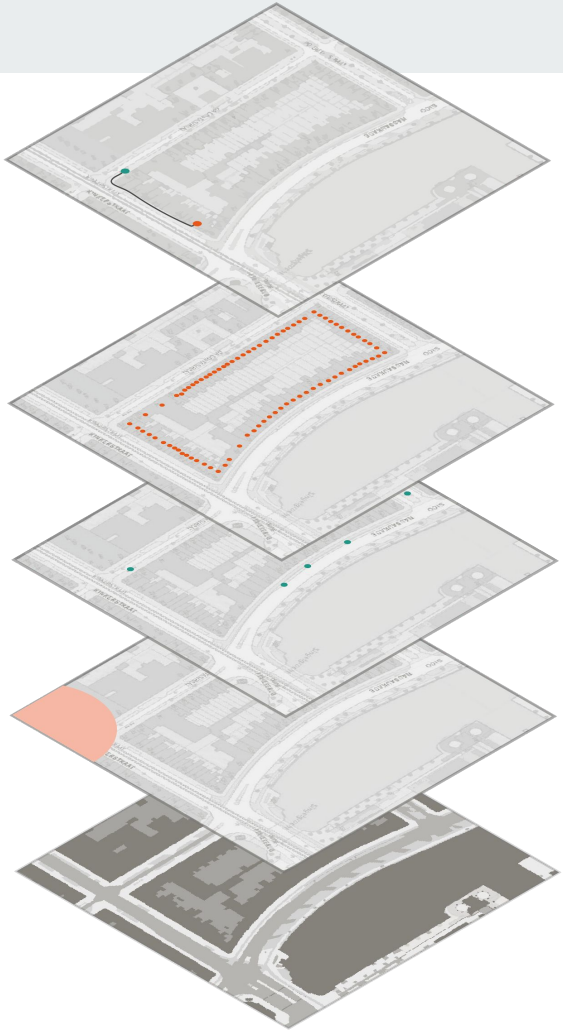
Input:
Position of all the trash cans

Trashcans

- Derived from municipality data
- All the locations of the trash cans with information about:
  - Number of times emptied
  - Mass of the waste while emptied
  - Types of waste available (rest, paper, glass, plastic)

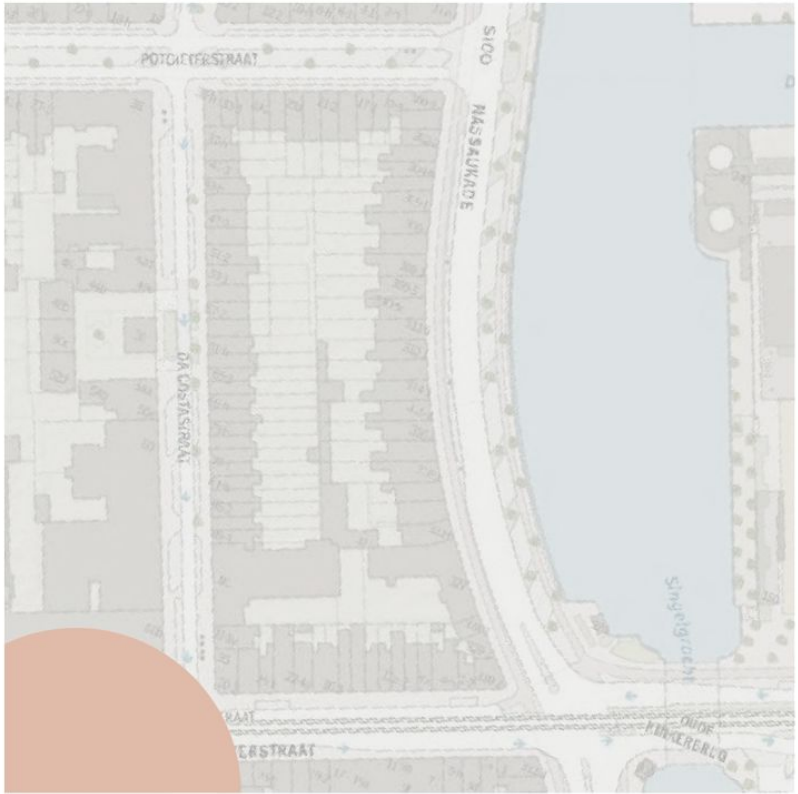


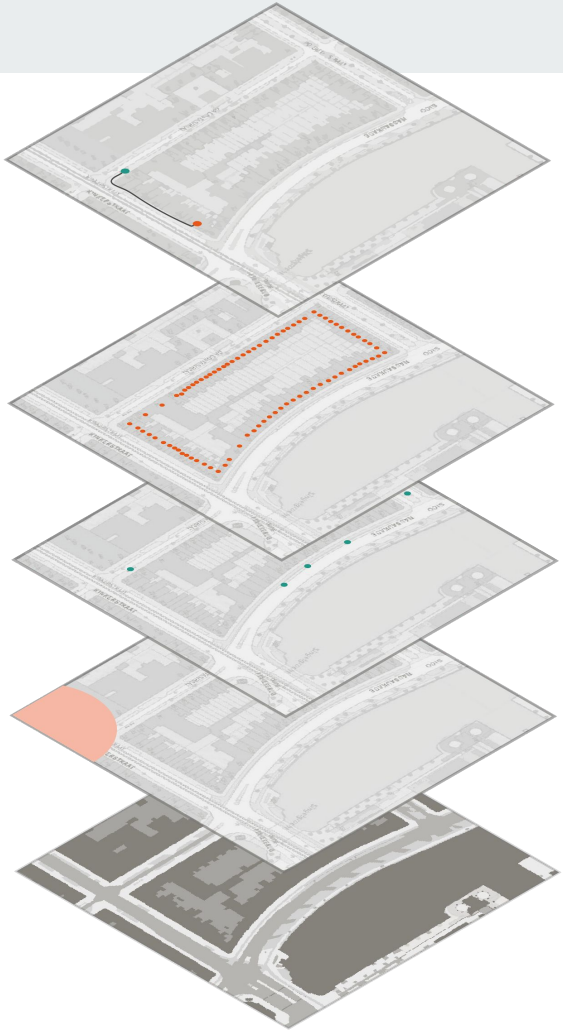
Input:
Hotspots



Hotspots

- Created by a density based clustering
- Derived from food waste actor data from AMS (hotels, restaurants, retailers)
- Matched to Googles ‘areas of interest’





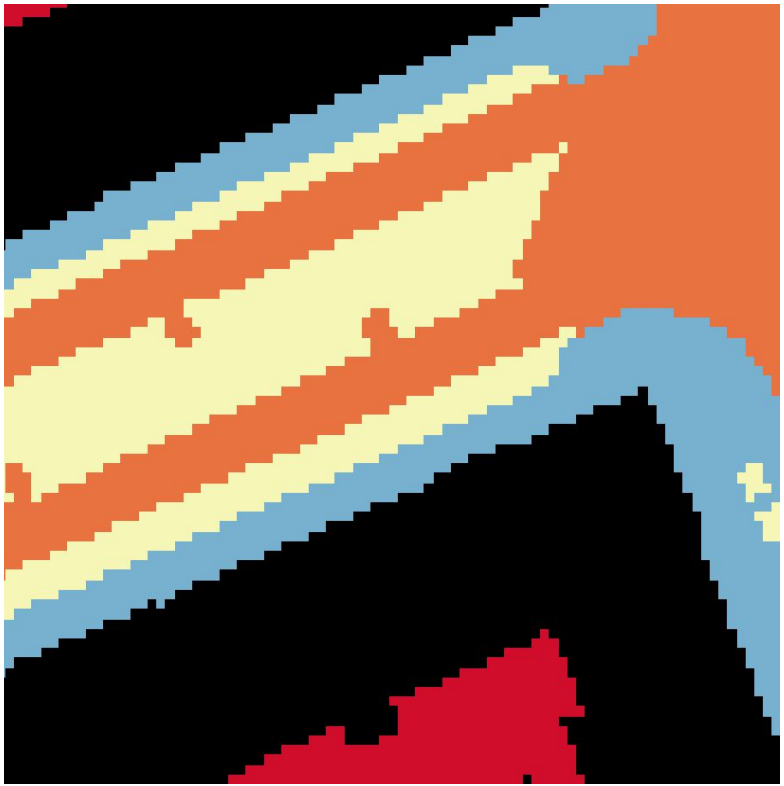
Input:
Least cost raster

Least cost raster

- Created by a rasterizing the BGT
- Derived by giving walkability values to every element
- Algorithm makes the least cost path based on the walkability values

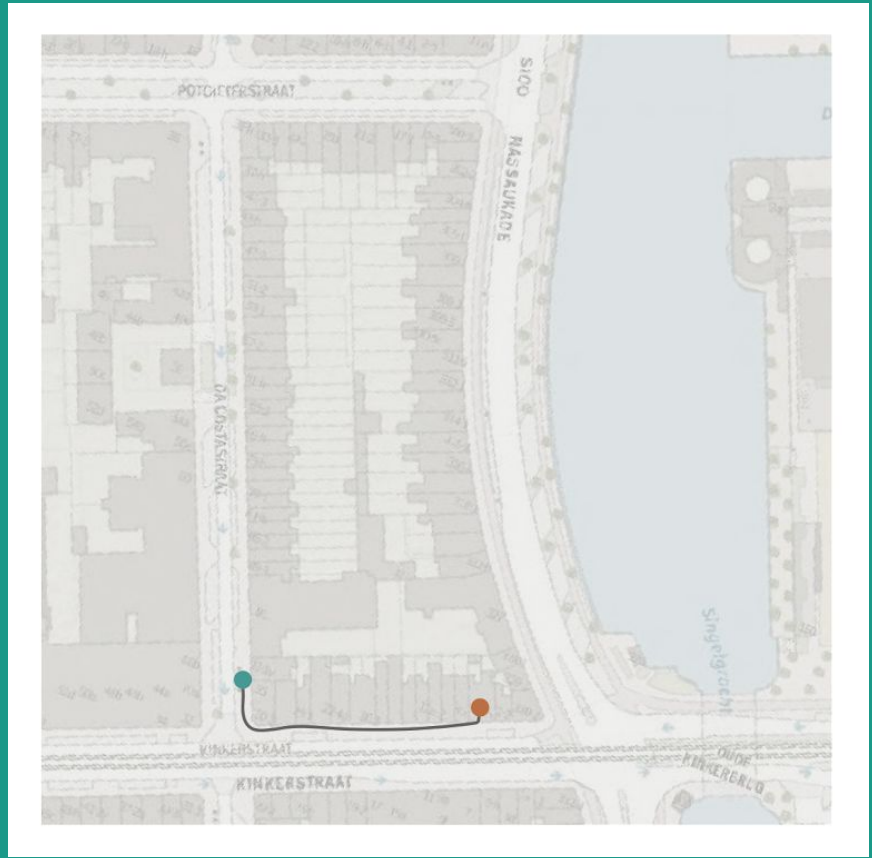
Least cost raster

- Pedestrian path gets value 1
- Parking places get value 2
- Streets get value 4
- Buildings get value 999
    - Determined by Alfonzo (2005) and Ammerlaan (2016)

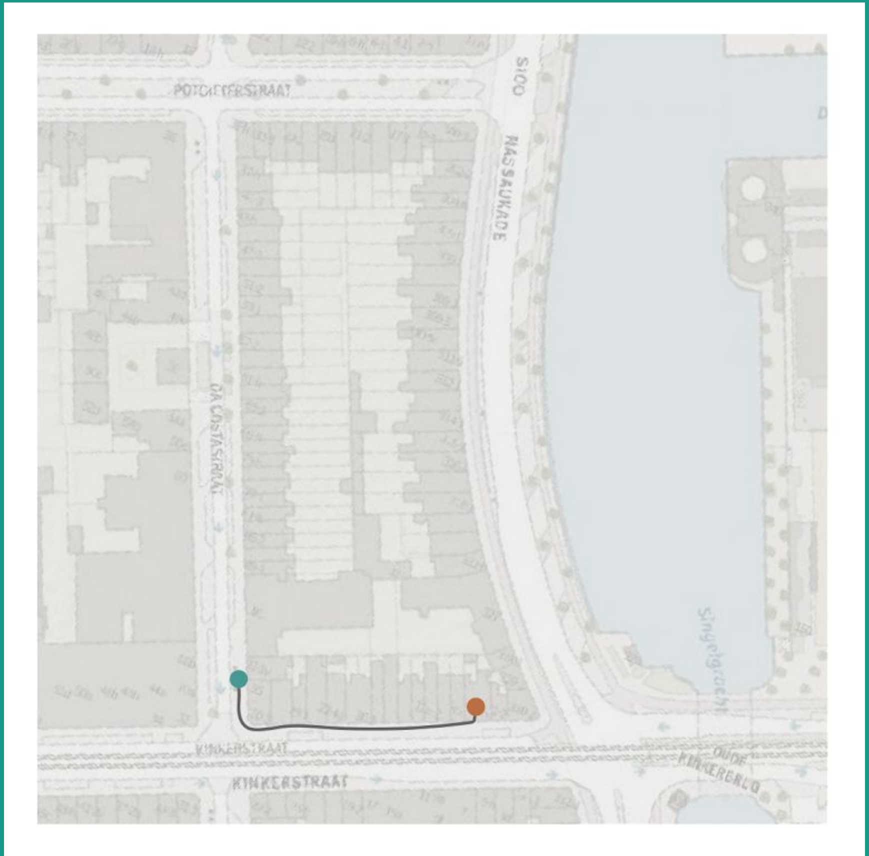


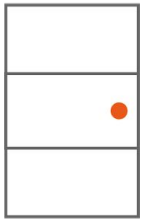
Goal:

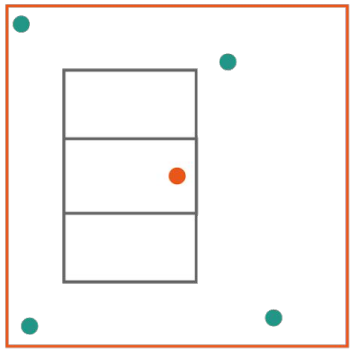
Connect household to used trashcan



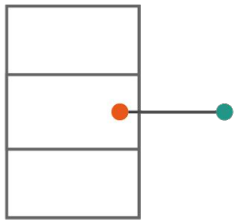
How?



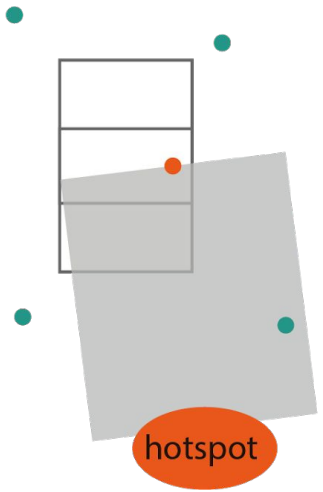


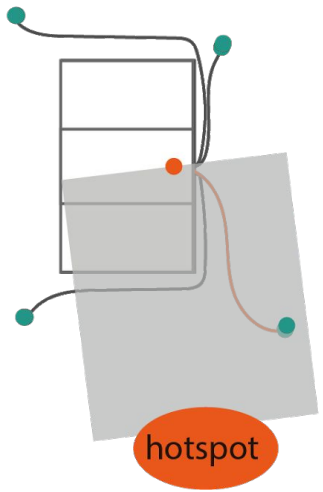


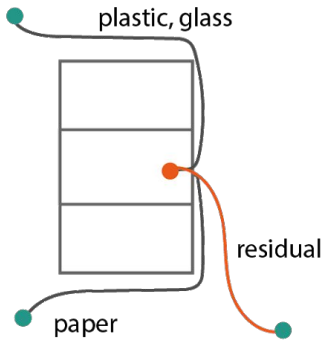
Option 1



Option 2

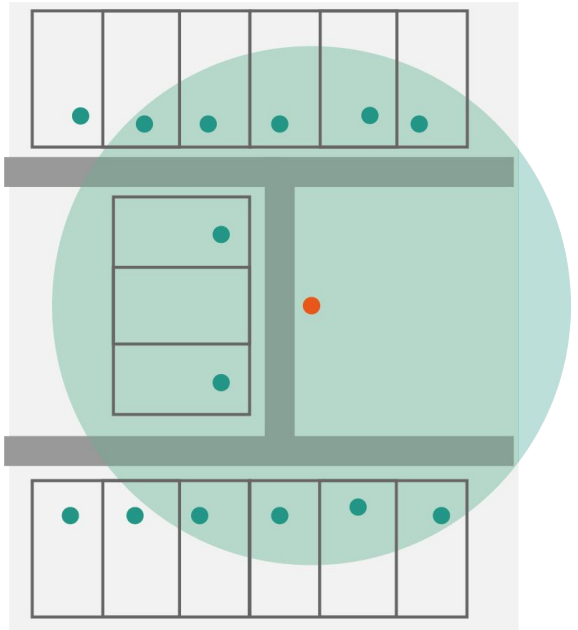



hotspot


plastic, glass
residual
paper

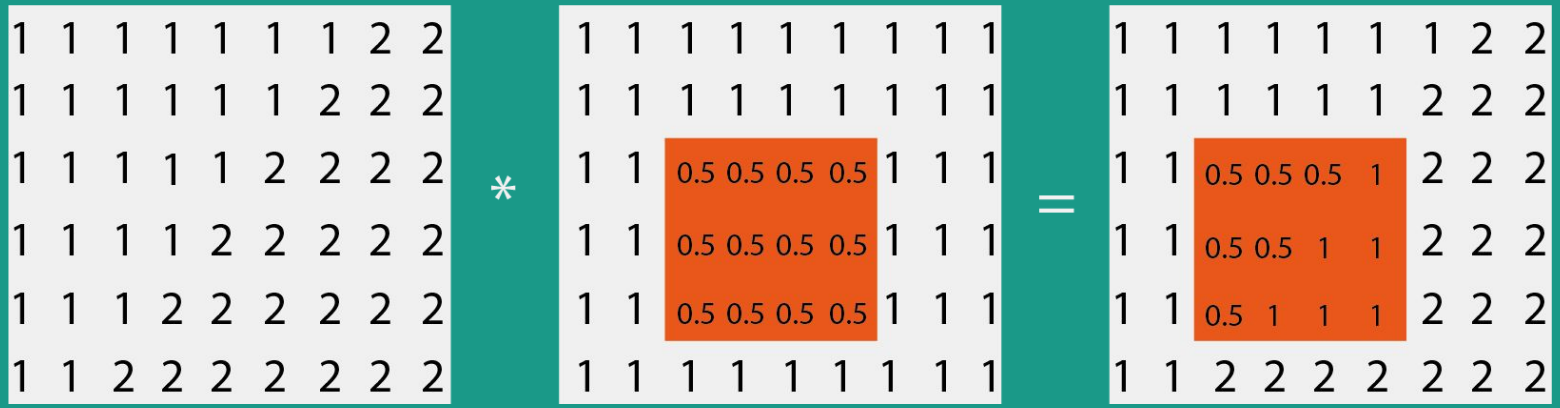
Validation

- Find all household who freely choose for a specific trashcan
- Correlate result of the method with the trash mass data
- Optimize with different preference adjustments



Wait, adjust for preference?

Wait, adjust for preference?



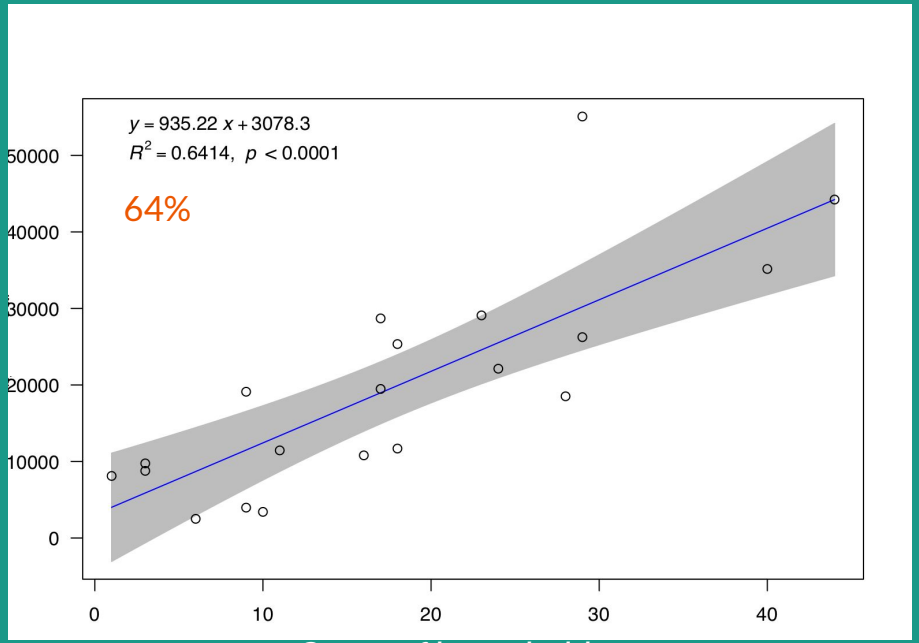
0.5 adjustment


adjustment
0.1
0.5
1


importance of hotspot

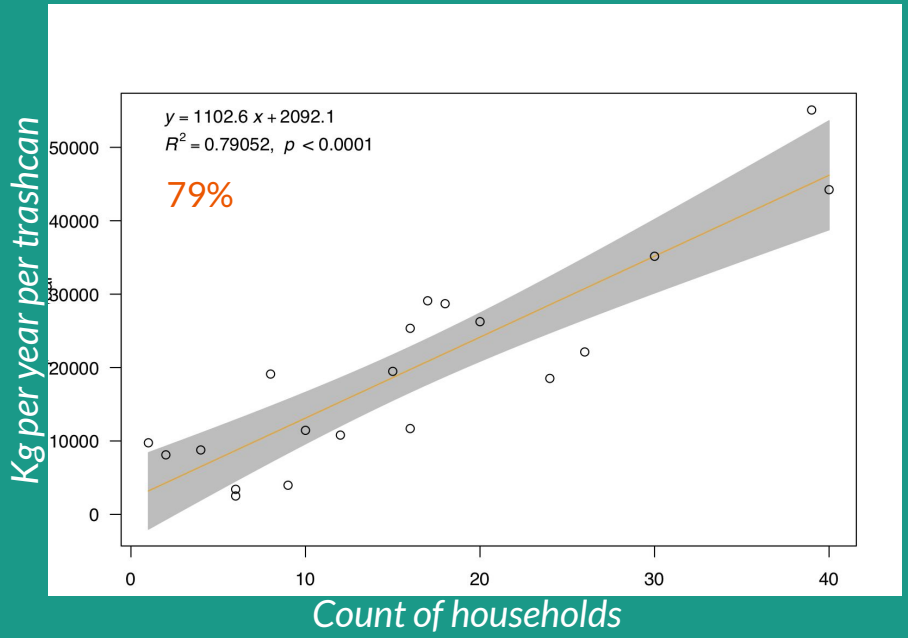

willing to walk further

1.0 Adjustment (no direction preference)

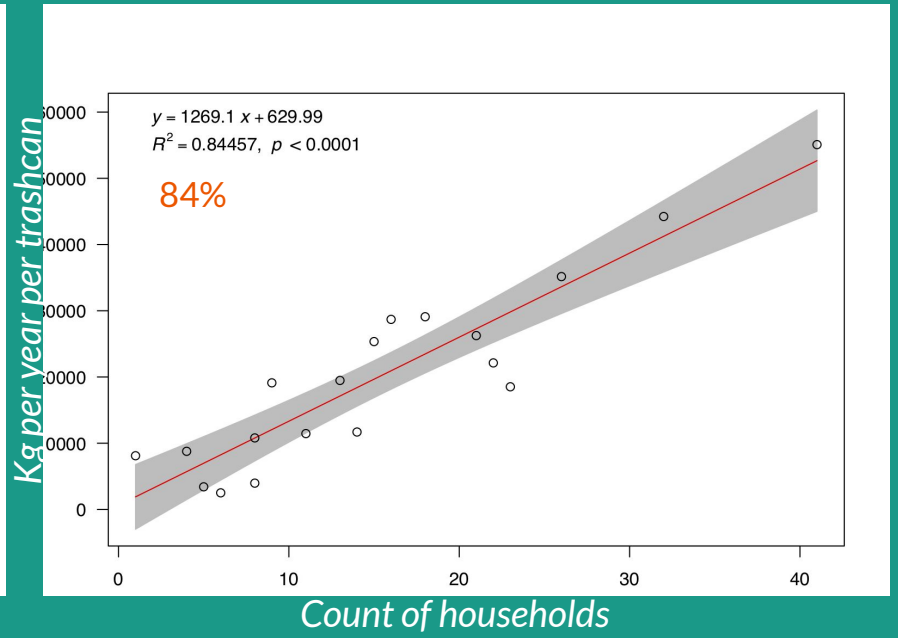


1.0 adjustment

0.4 & 0.1 Adjustment



0.4 adjustment



0.1 adjustment

The direction preference is improving the prediction capabilities of this method, with 0.1 adjustment as optimum

Results


ORANJE NASSAULAAN
EMMAPLEIN
PRINS HENDRIKLAAN
SOPHIALAAN

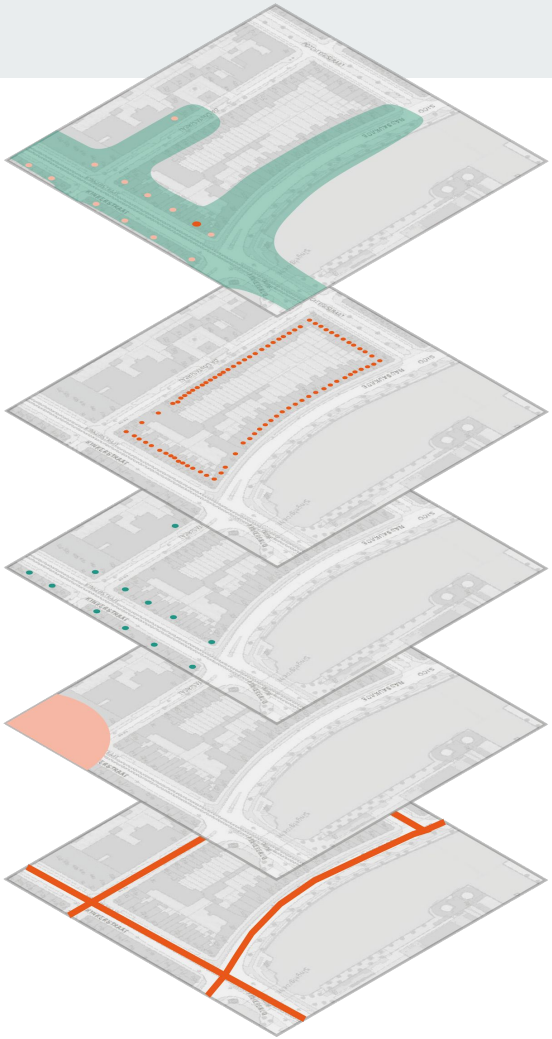
Results

Results (paper waste)

4B. Method 2 Household-to-retailer

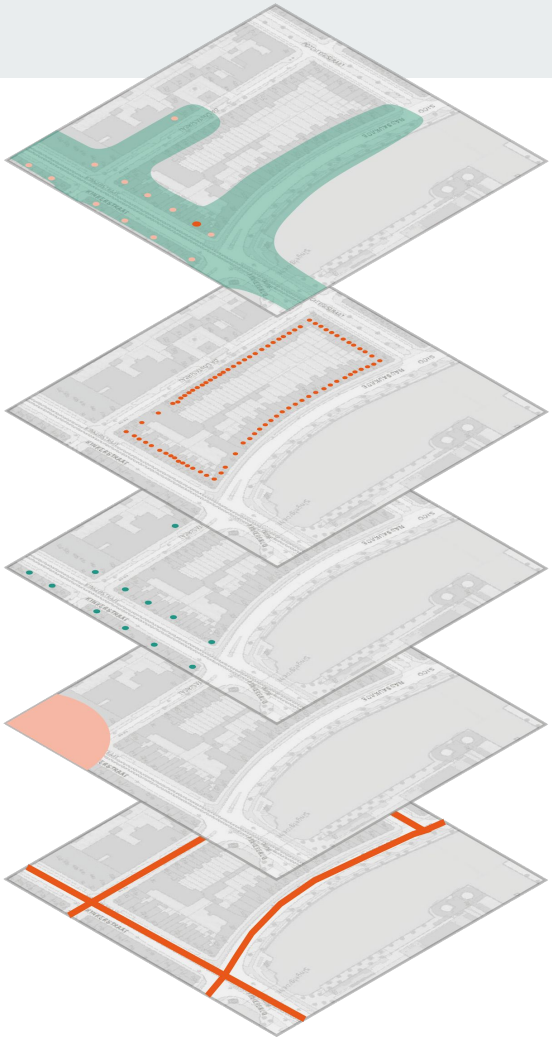
Hypothesis:

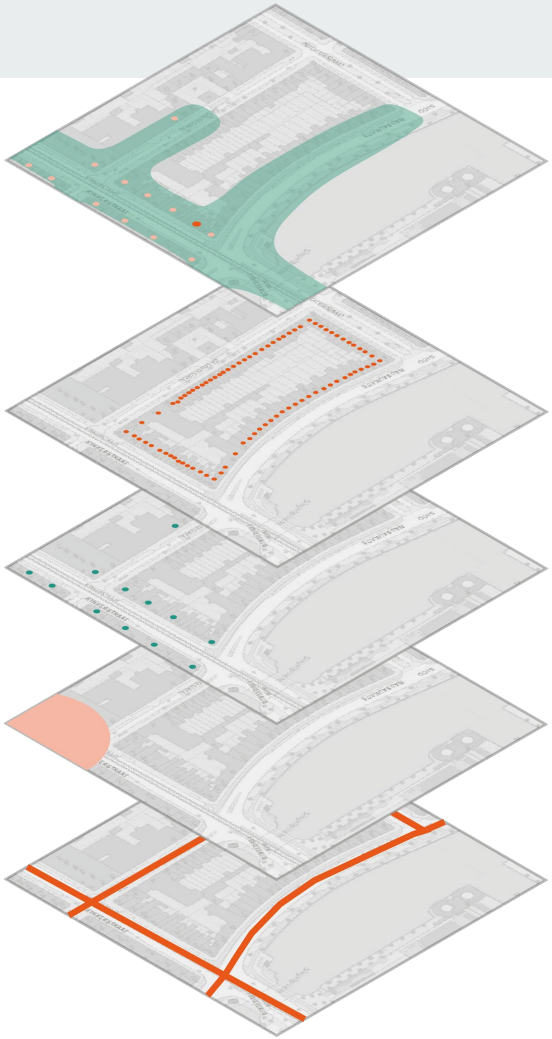
Food stores sell products that afterwards turn into waste and therefore contribute to household waste. Bigger and closer food stores have a bigger contribution.



Goal:
Connect the households to their food retailer

Input:
Find all the households

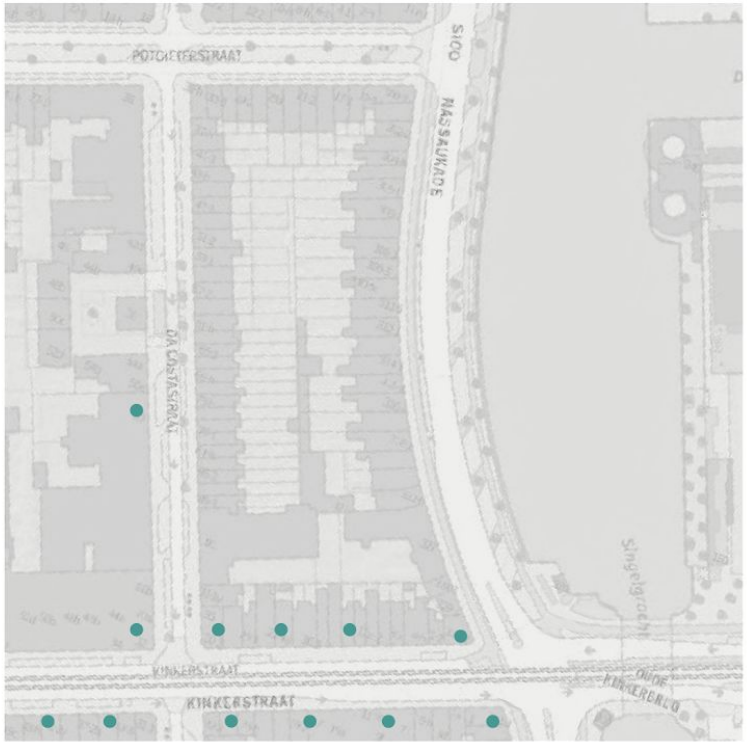




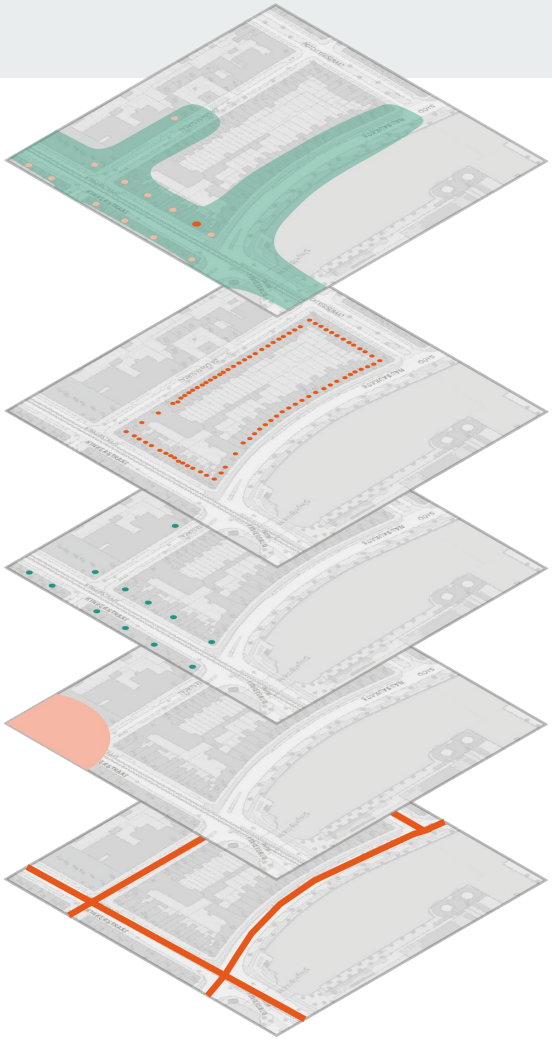
Input:
Actors in food waste chain

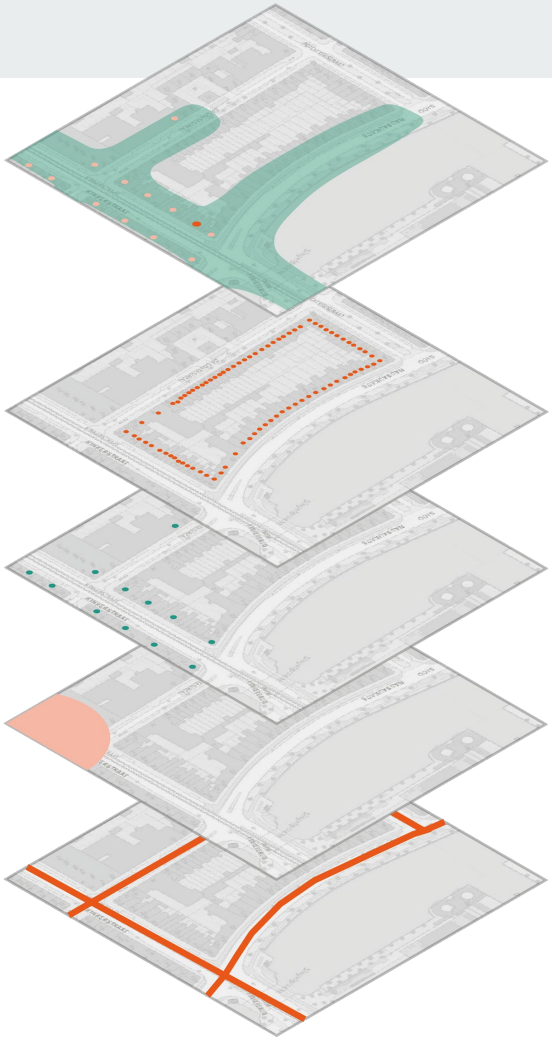
Actors in food chain

- Data from REPAiR Project
- Contains information about:
  - Name of retailer
  - Kind of retailer



Input:
Hotspot

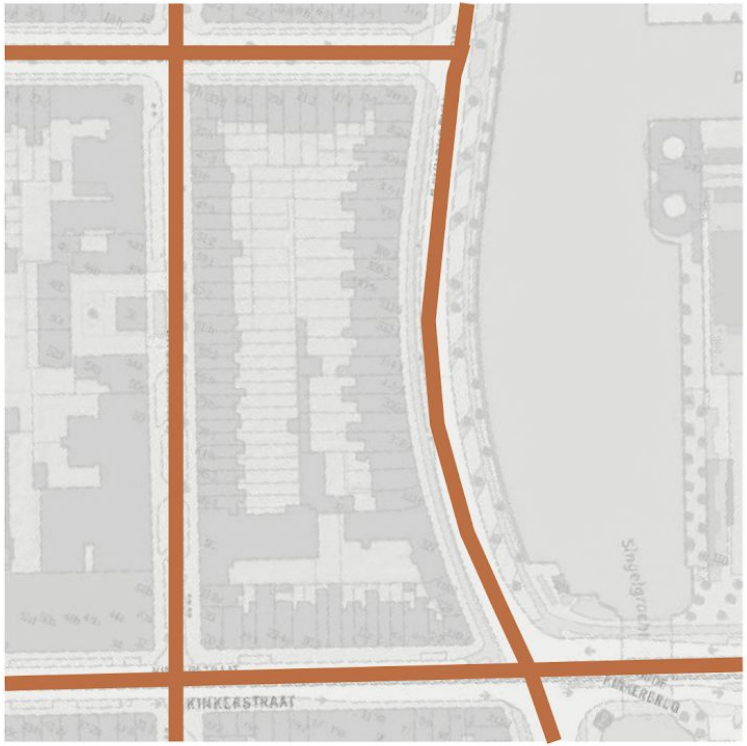




Input:
Street network

Street network

- Derived from Open Street Map
- Network that is considered bikeable



Goal:

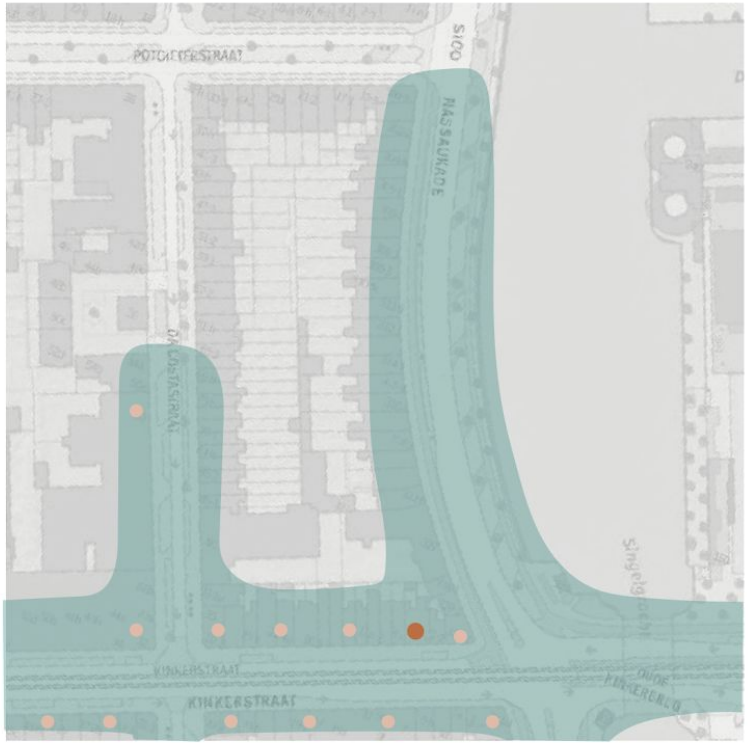
Find retailers in isochrone area and give importance values

Isochrone map:

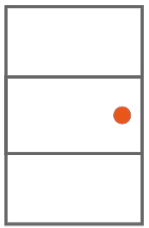
A line drawn on a map connecting points at which something occurs or arrives at the same time

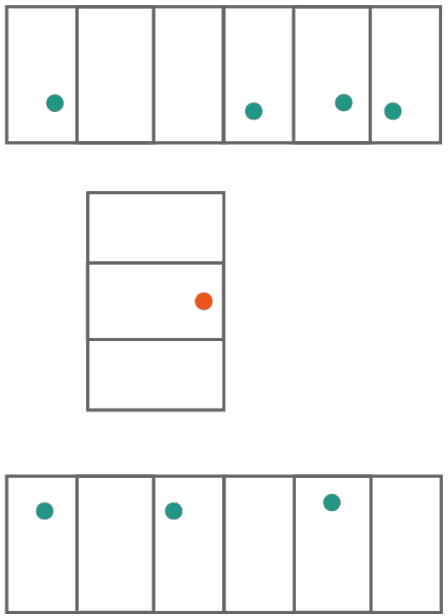
Goal: **Connect retailers**

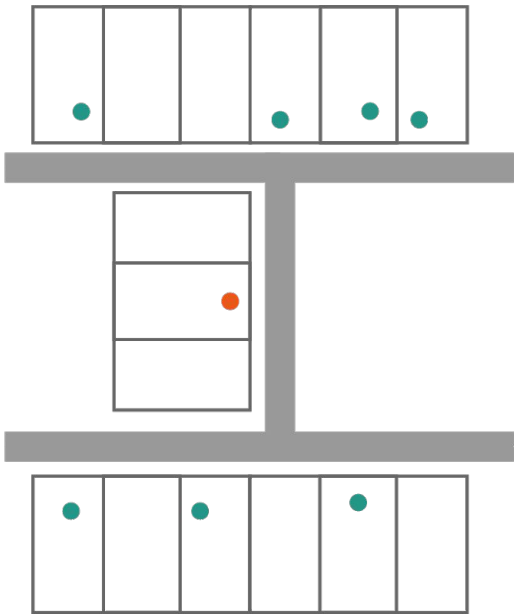
- Isochrone for 10 minutes in three steps
- Average bike speed in Amsterdam of 14.4km/h

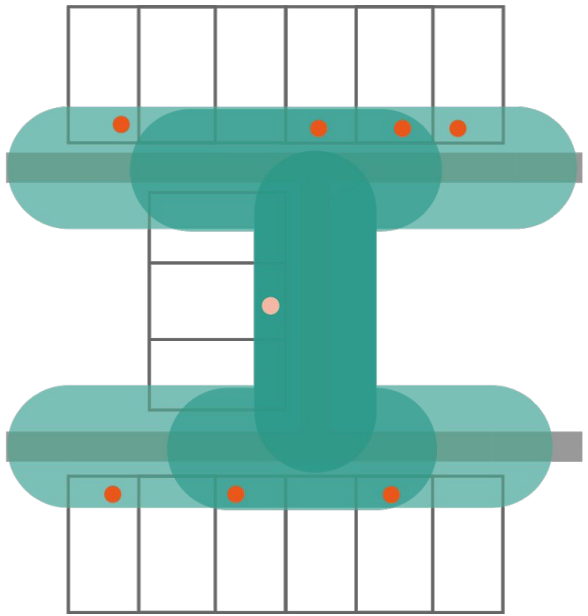


How?





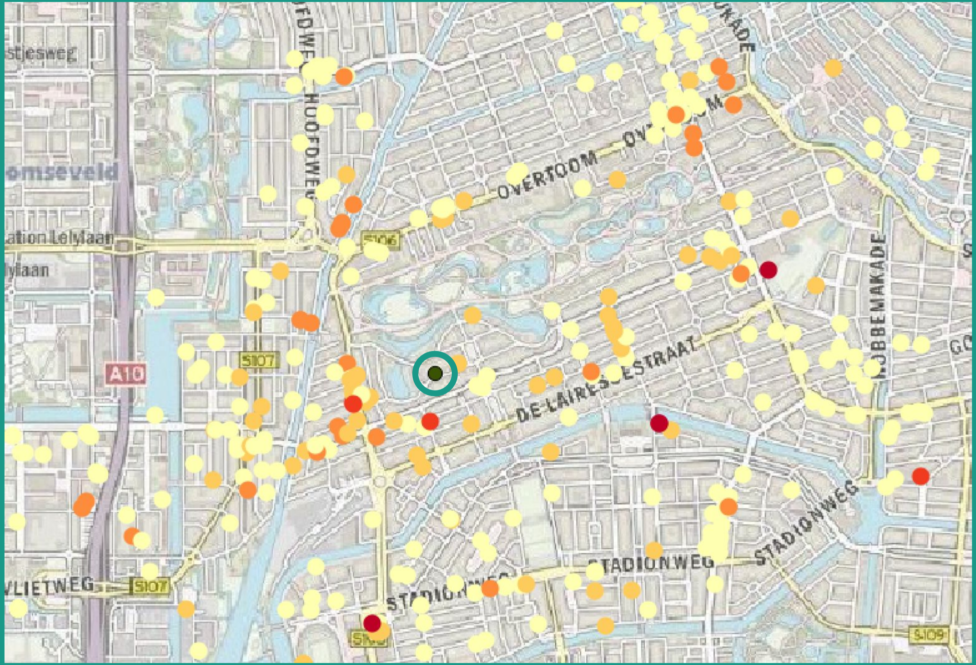




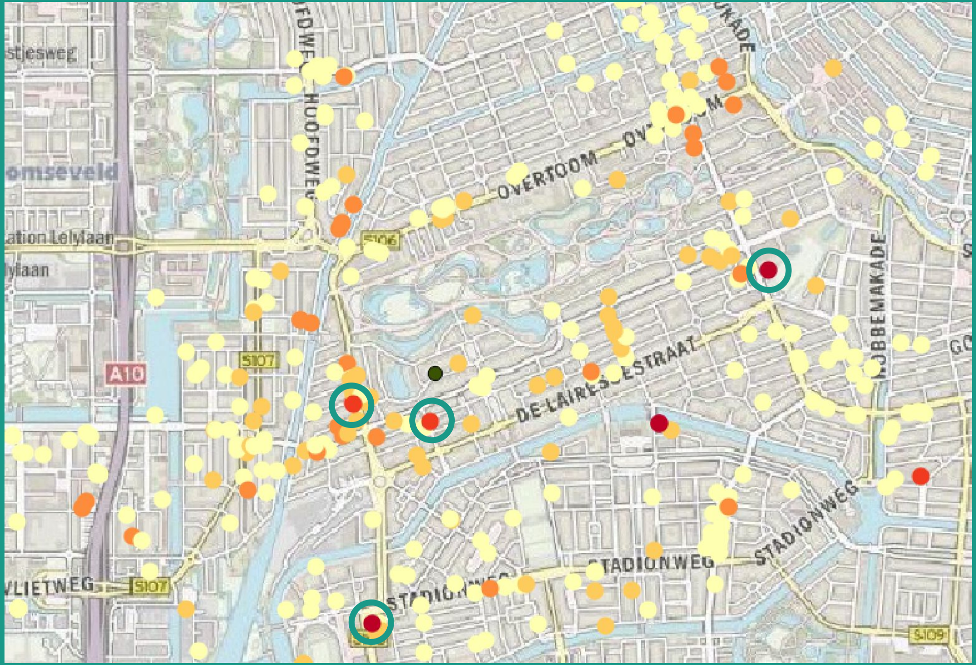
Importance value:

Value determined based on store floor size and distance to considered household

Results


OVERTOOM
DE LAIRESSESTRAAT
STADIONWEG
HOBBEMAKADE
A10
S106
S107
S109

Results

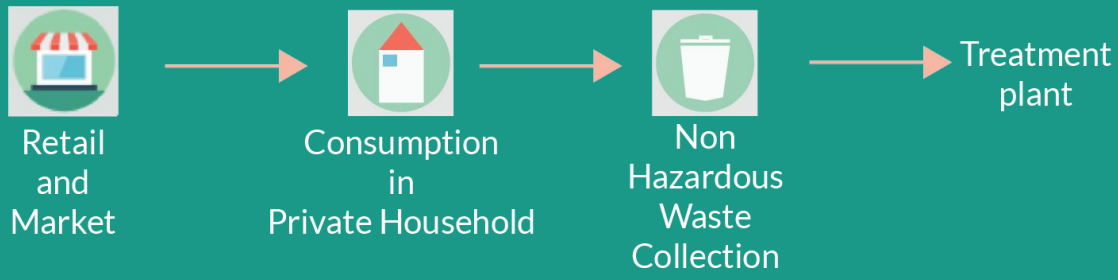


OVERTOOM
DE LAIRESSESTRAAT
STADIONWEG
HOBBEMAKADE
Station Lelylaan
A10
S106
S107
S109

5. Additional method

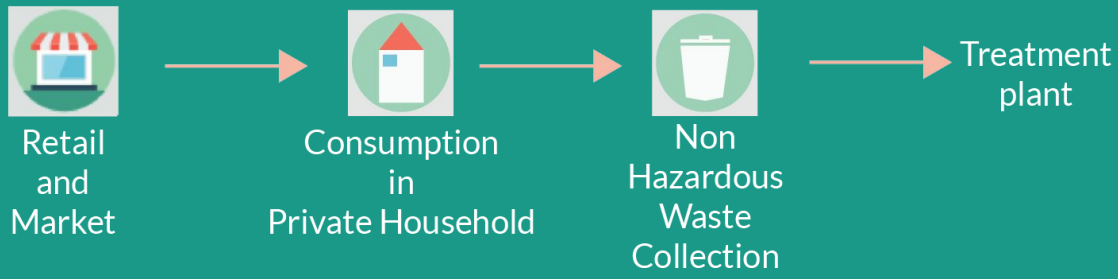
Mass of the flow

- Indicate the size of the flow of the created connections
    - Based on floor size, number of connections
- Based on trashcan mass data


Retail and Market
Consumption in Private Household
Non Hazardous Waste Collection
Treatment plant


Retail and Market
Consumption in Private Household
Non Hazardous Waste Collection
Treatment plant

10.000 kg



300 kg

10.000 kg


Retail and Market
Consumption in Private Household
Non Hazardous Waste Collection
Treatment plant
x kg
300 kg
10.000 kg

6. Conclusion

Conclusion: Method household-to-trashcan

- Using LCPA results in finding the minimized cost value of routes
- Adjusted by the preference direction of city hotspots
- Influenced by: direct environment (BGT) & bigger scale (city hotspot)
- Additional paths are added (to other waste types)

Conclusion: Method household-to-retailer

- Using isochrone areas result in traveltime shaped buffer
- Possibile retailers of a household are found
- Travel time from household and floor size of retailers are used as characteristics
- Importance value is determined

7. Discussion

Discussion: Method household-to-trashcan

- Mainly based on path minimization
- Least cost path raster values
- Temporal aspects
- Promising R2 values for 0.1 adjustment

Discussion: Method household-to-retailer

- Personal decision
- Not able to validate this method
- Only based on 2 characteristics (floor size and distance)

8. Possible application

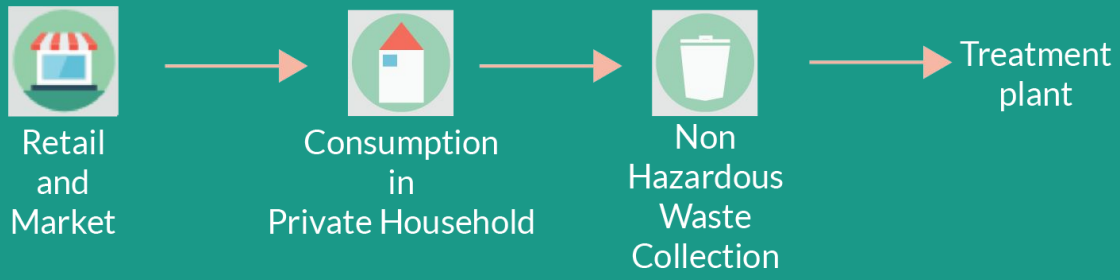
Possible application

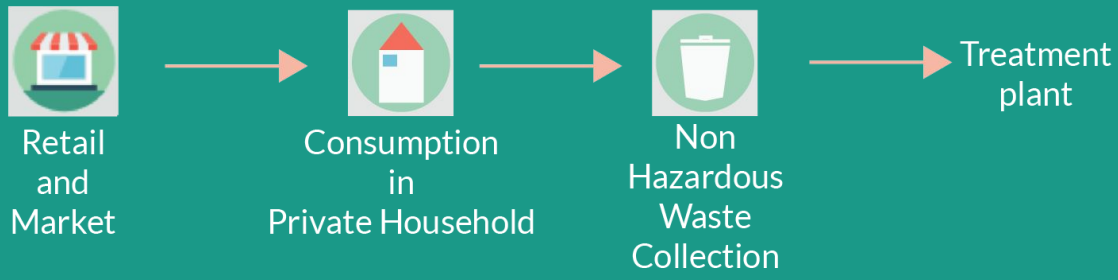
- Connection between nodes established in this research
- How can this be used on applications: sustainability?

Albert Heijn
58.126 volgers
1 w • Bewerkt

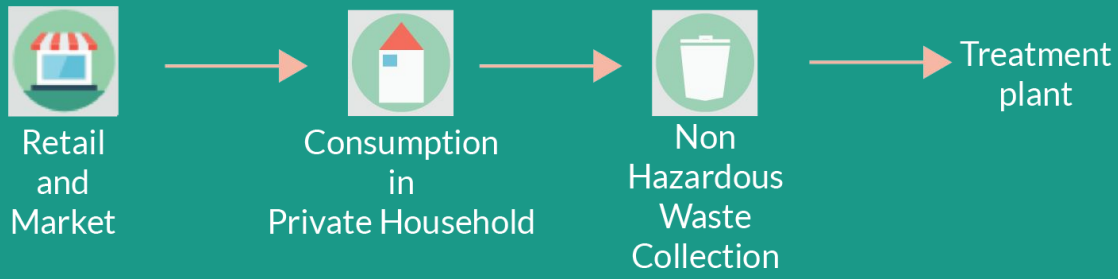
+ Volgen

Nog meer (biologische) groente en fruit zonder plastic verpakking! Dit jaar biedt onze supermarkt in de winkels en online ook Nederlandse komkommer, rode paprika, aubergine en bleekselderij zonder plastic verpakking aan.

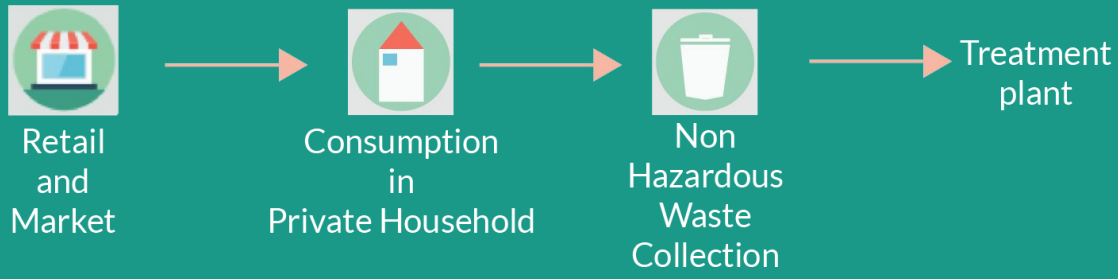

Retail and Market
Consumption in Private Household
Non Hazardous Waste Collection
Treatment plant



Vegetable without plastic package


Retail and Market
Consumption in Private Household
Non Hazardous Waste Collection
Treatment plant

??



Increase/decrease of food waste

Could removing plastic at the retailer increase the amount of food waste generated at the household?

Thank you!

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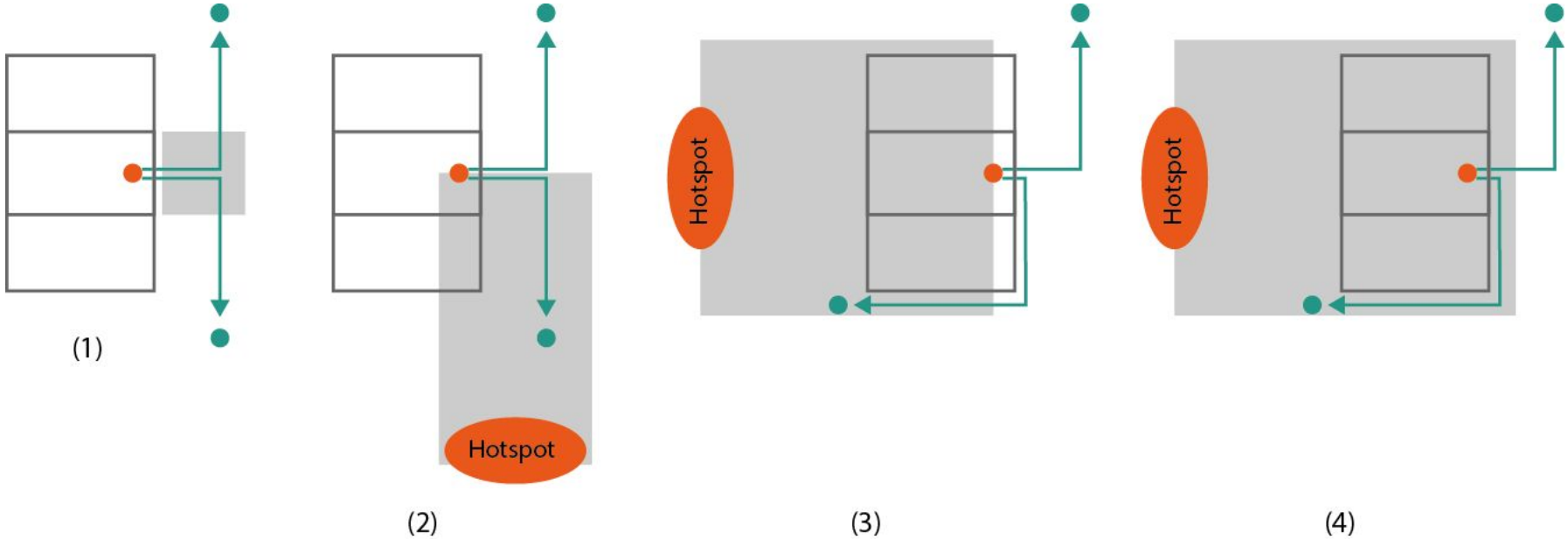
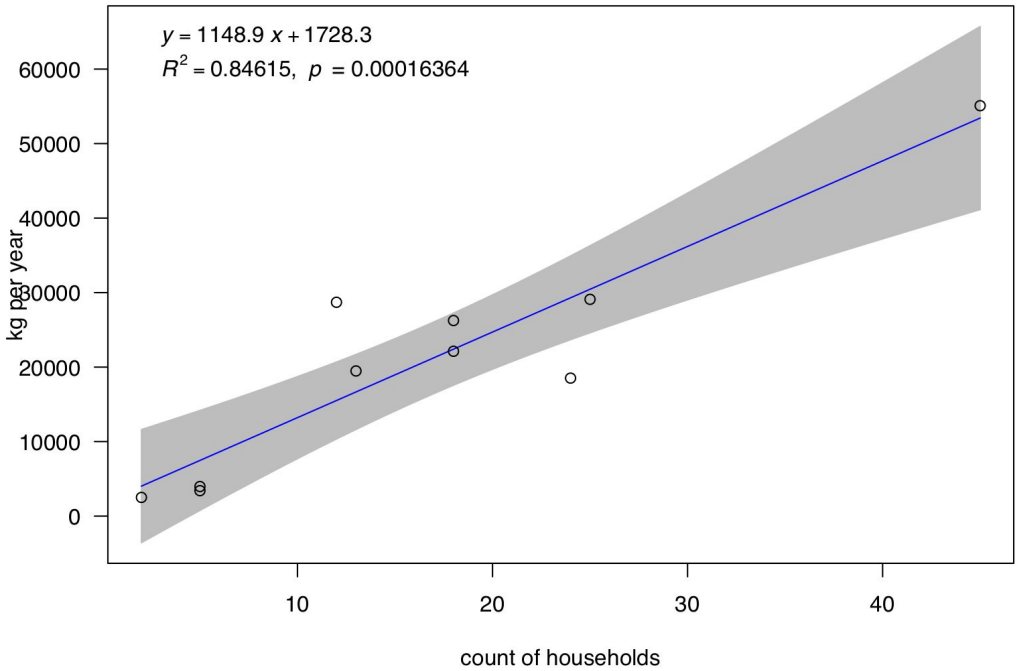
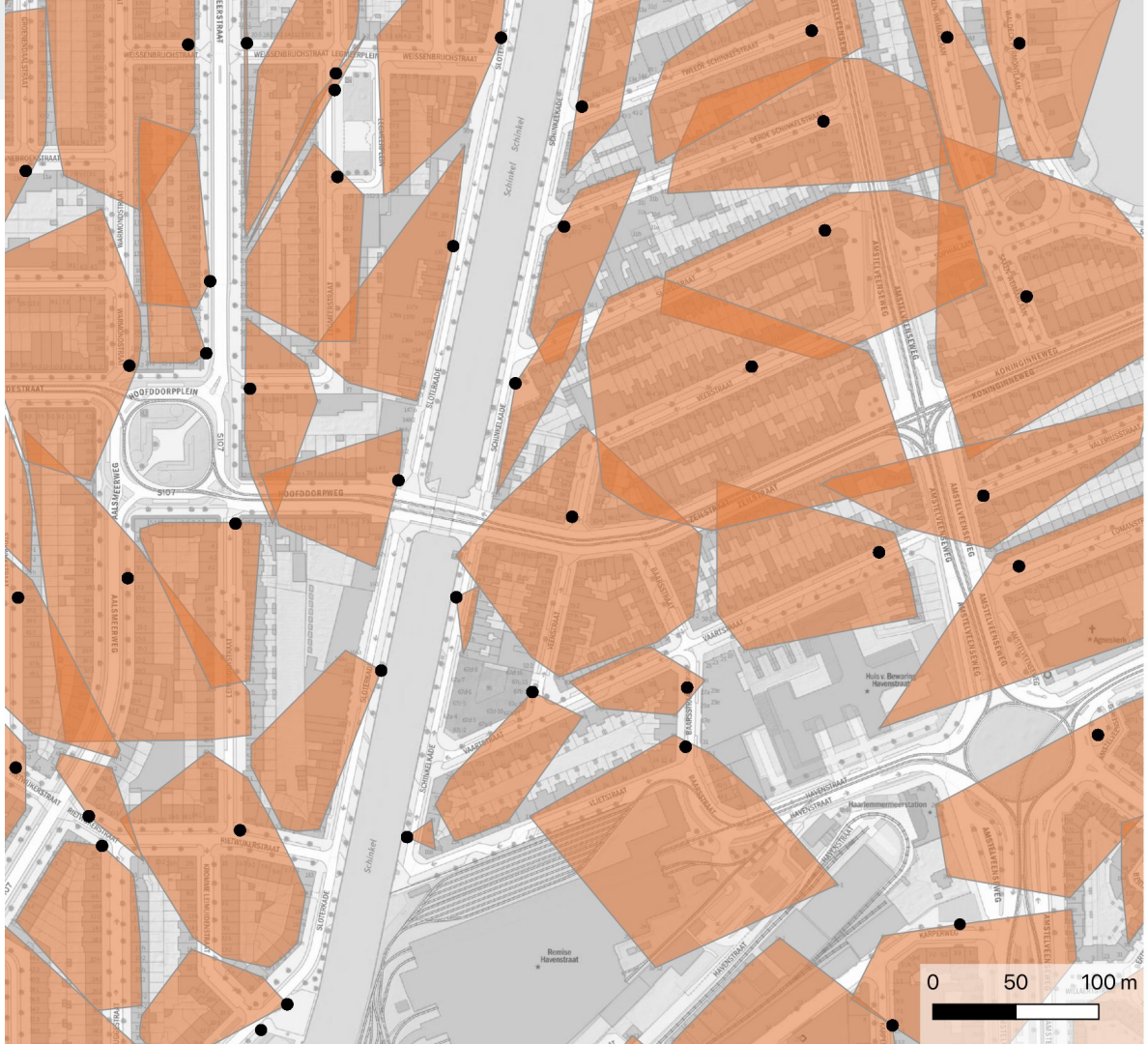

(1)
Hotspot
(2)
Hotspot
(3)
Hotspot
(4)

0.01 adjustment





Convex hull of the households using a specific trashcan