



DemAnd And/OR Equity (DARE) method for implementing bike sharing systems (BSS)

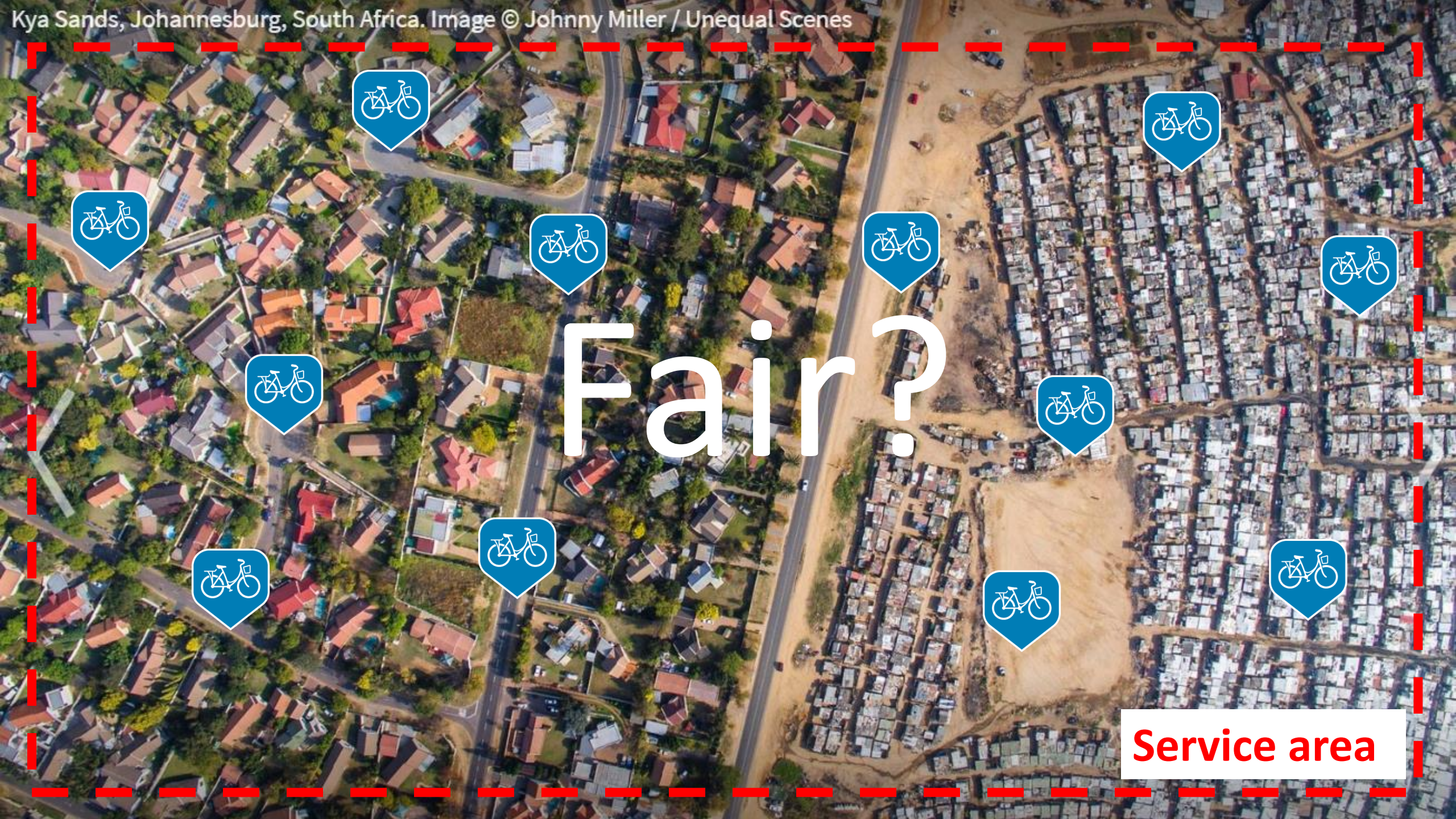
A structural equation modelling approach

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Service area



Fair?

Service area

Who
uses
BSS?



Who has access
to BSS?

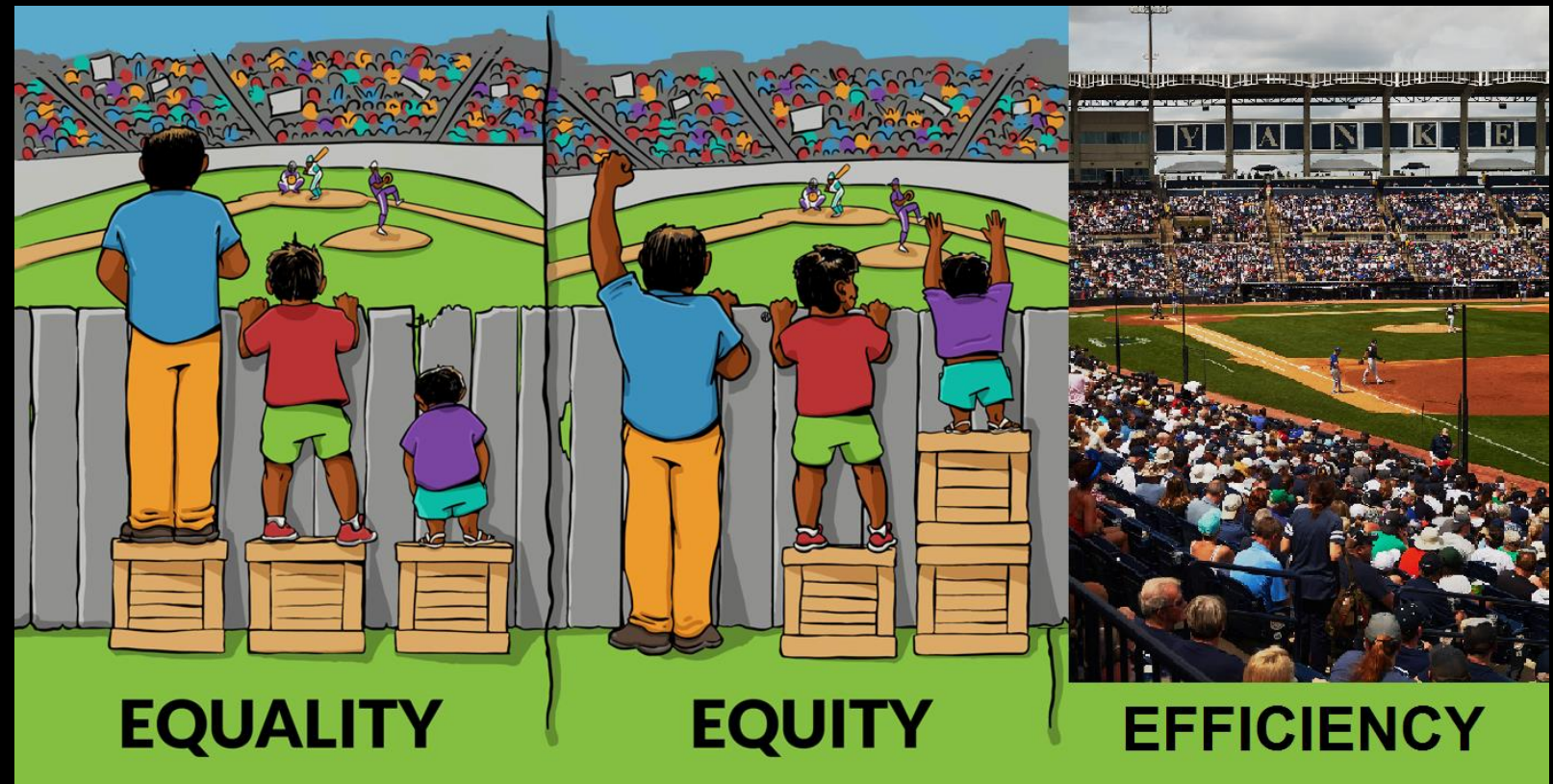


Fair?

Image source: en.wikipedia.org/wiki/Ryan_O%27Neal

<https://freshbangkok.com/wp-content/uploads/2017/02/Bangkok-CBD-Skyline-1024x674.jpg>

“What is fair for one person, however, might not be fair for others.”



Distribution based on: **ALL THE SAME** **NEEDS** **CONTRIBUTION**

Resources are limited so..
equality is hard to reach

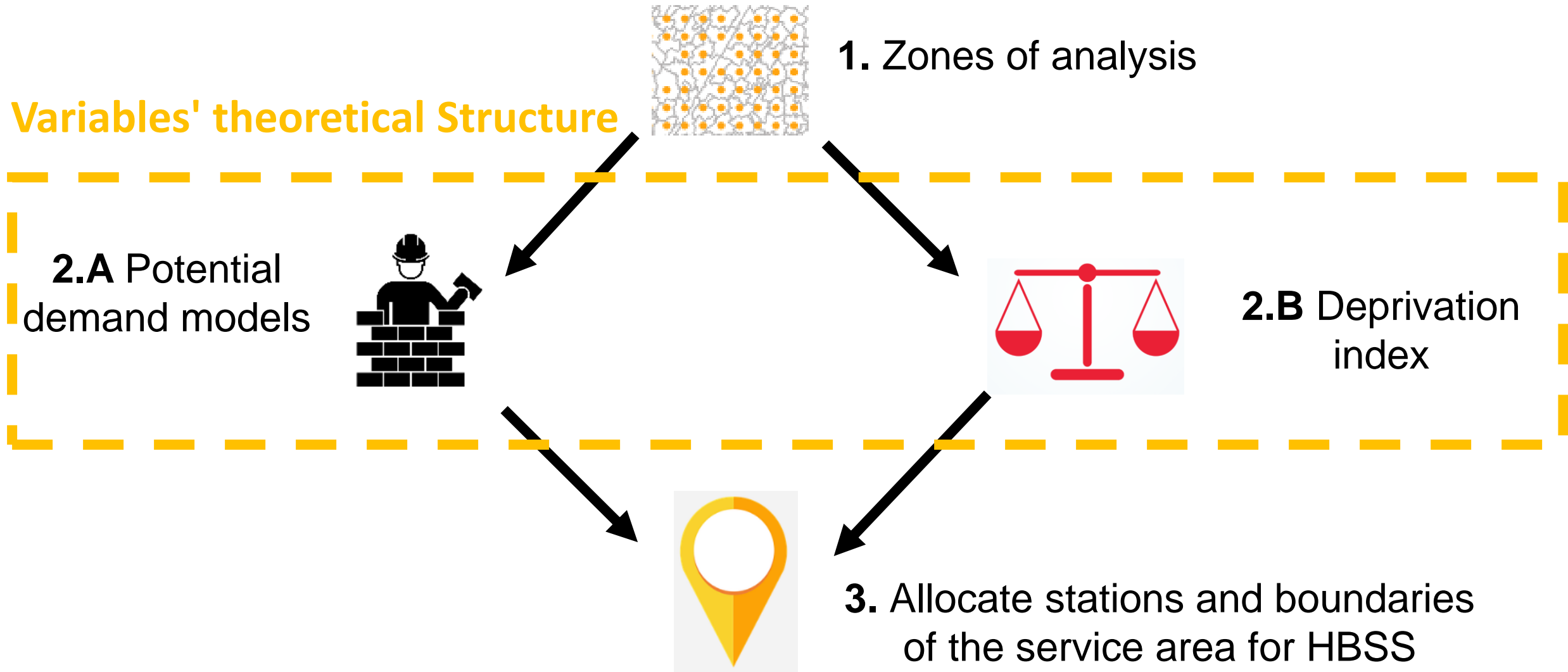
But can we balance
equity and efficiency?



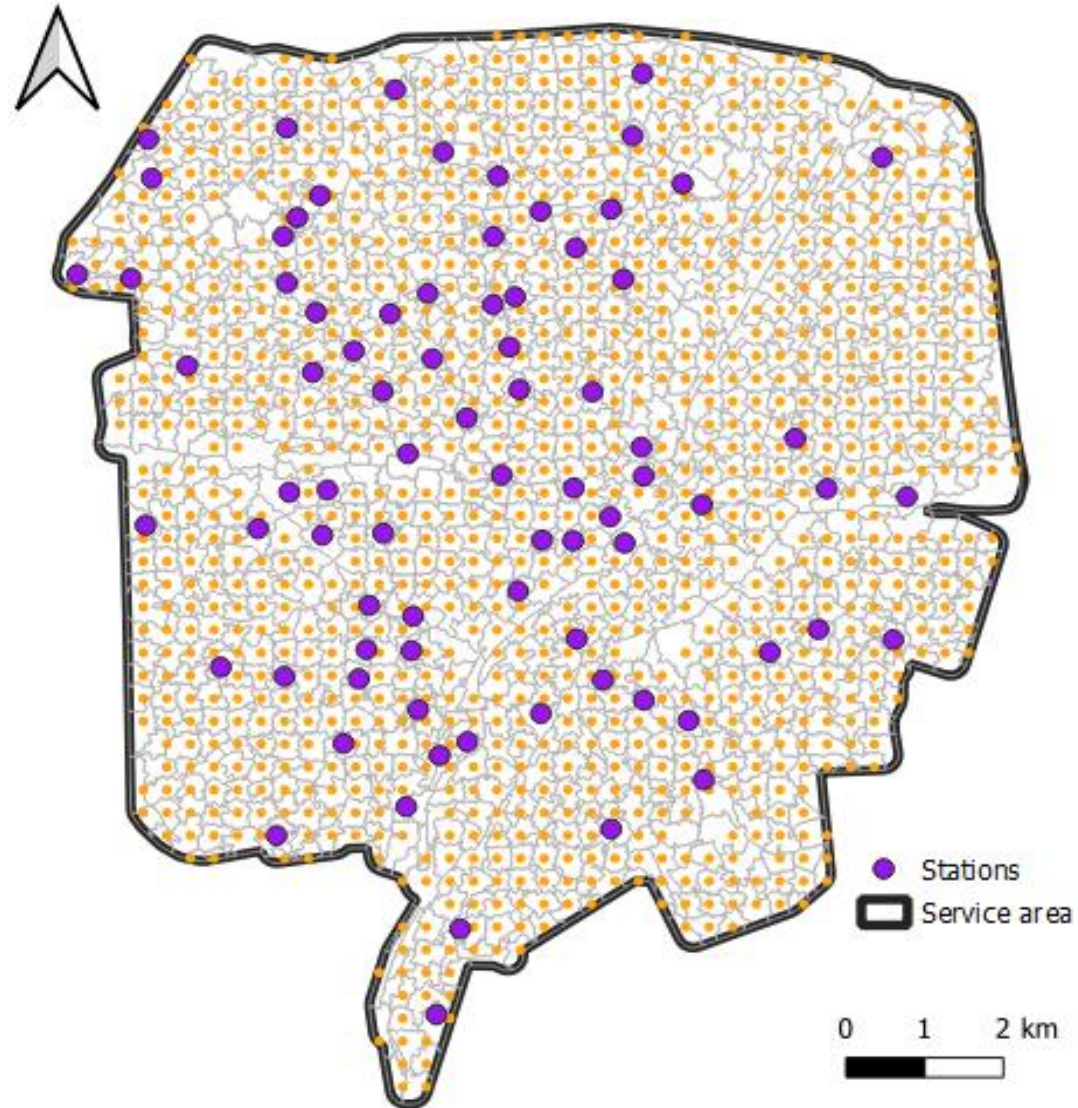
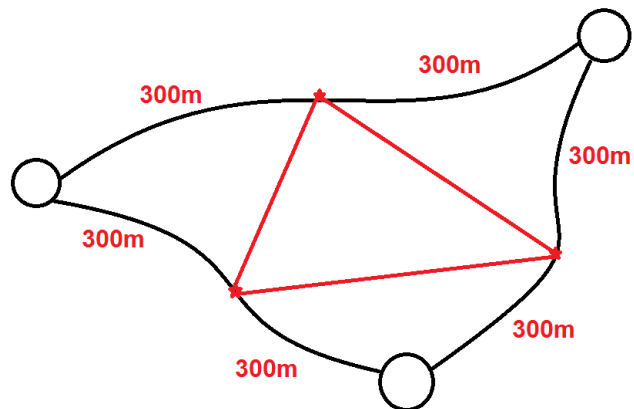
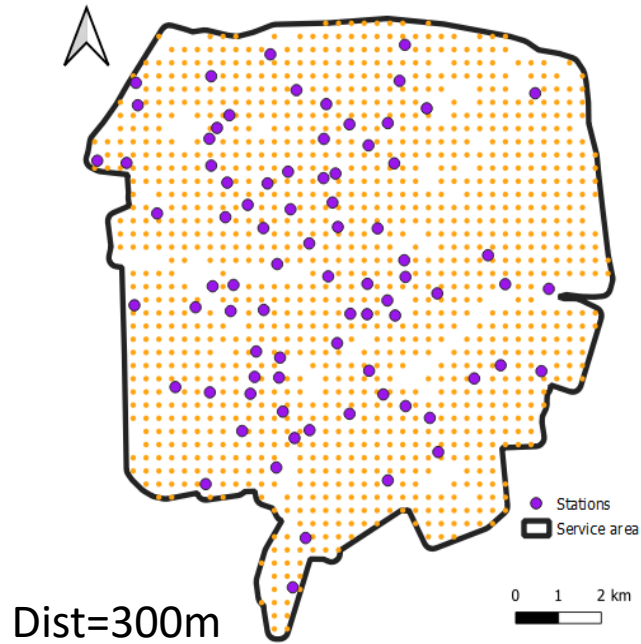
Vondelpark,
Amsterdam June 2019

- To develop a fairness-based method to implement BSS depending on a justice focus desired:
 - ✓ deprivation (spatial equity)
 - ✓ potential demand (spatial efficiency)
 - ✓ a mix of both.
- To apply the method in the hybrid BSS system in Munich
- To use and validate a theoretical structure for potential demand prediction merging three theoretical models:
 - a) land-use and transport interactions (Wegener, 1999; Wulfhorst, 2003)
 - b) urban mobility cultures (Deffner et al 2006)
 - c) spatial fairness assessment (Duran-Rodas et al 2020)

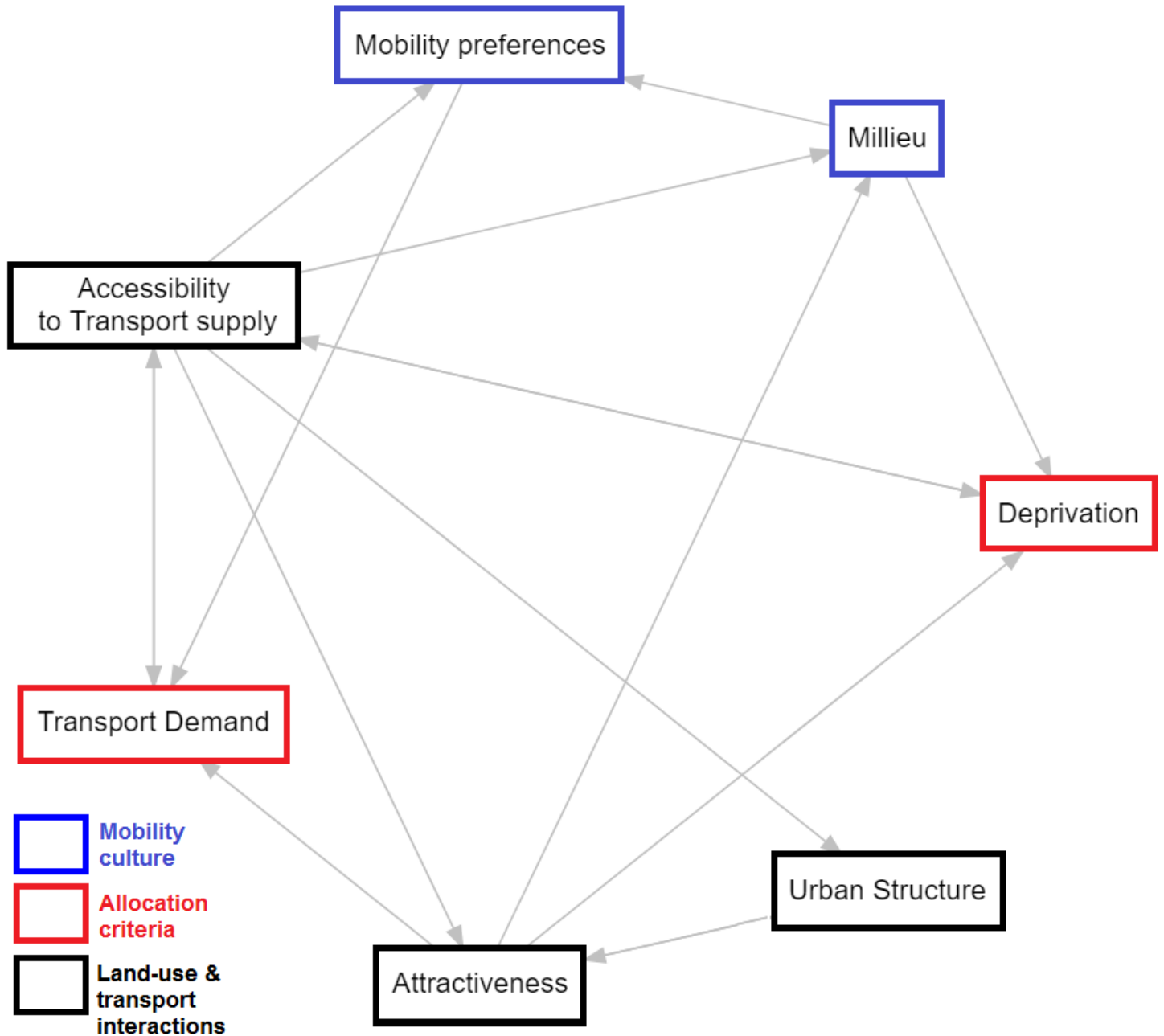
DARE: DemAnd And/Or Equity



1. Zones of analysis: Network based delimitation

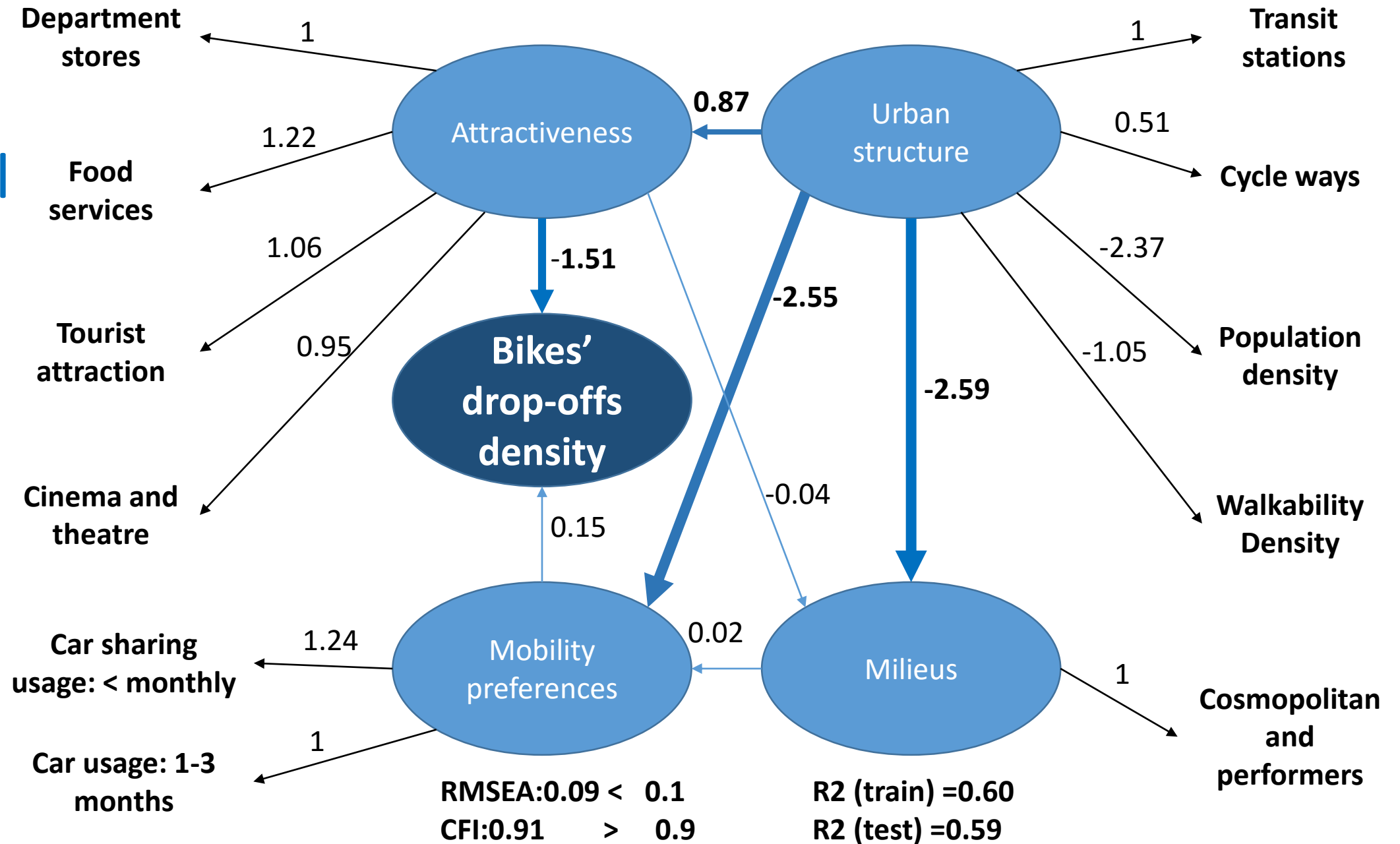


2. Potential demand + Deprivation



2.A SEM

Potential Demand



2.B. Deprivation index

$$EI_j = \frac{Milieu_{low\ status}}{1/n \sum_{i=1}^n \alpha_1 * e^{-\alpha_2 * Di}}$$

Low -> Privileged Area

High-> Deprived area

n=Basic POIs classes

D= distance to basic opportunities from Area centroid

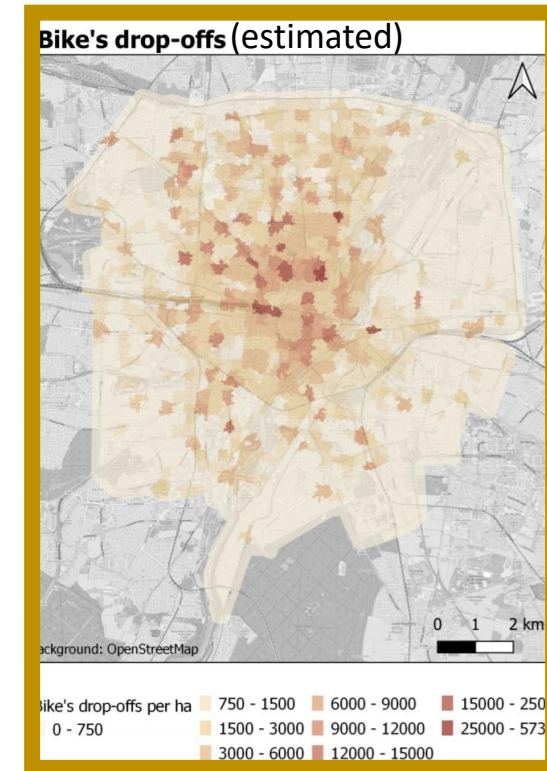
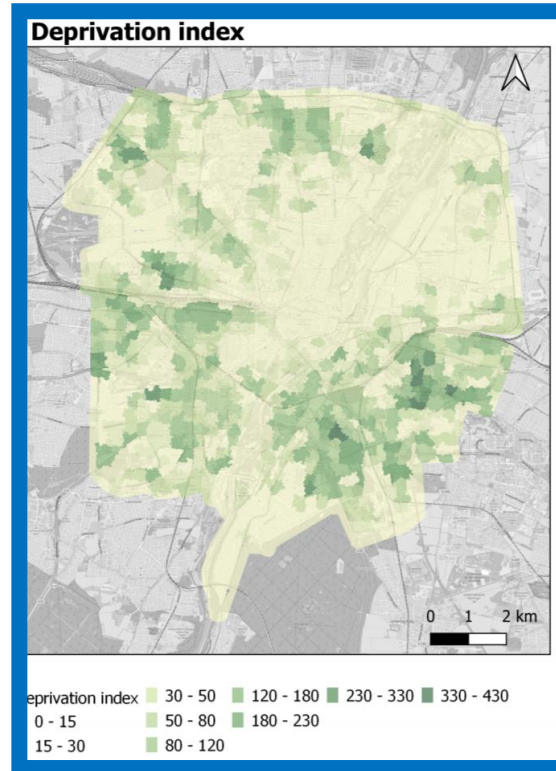
Milieu_low status= % low social status in Area

$\alpha_{1,2}$ = parameters

3.1. Rank index

$$RankIndex_j = nor(EI_j) * Equity_{weight} + (nor(Bookings_j) * Demand_{weight})$$

$0 < Equity_weight < 1$
 $0 < Demand_weight < 1$
 $Equity_weight + Demand_weight = 1$



nor () -> max value = 1, min value = 0

3.2. Allocation algorithms



Top-N

11	18	17	10	26	5
4	19	6	9	24	25
21	20	7	1	27	28
8	12	16	29	14	13
3	22	23	30	15	2

Neighbor

11	18	17	10	26	5
4	19	6	9	24	25
21	20	7	1	27	28
8	12	16	29	14	13
3	22	23	30	15	2

Island

11	18	17	10	26	5
4	19	6	9	24	25
21	20	7	1	27	28
8	12	16	29	14	13
3	22	23	30	15	2

Island-weighted

11	18	17	10	26	5
4	19	6	9	24	25
21	20	7	1	27	28
8	12	16	29	14	13
3	22	23	30	15	2

Stations=6

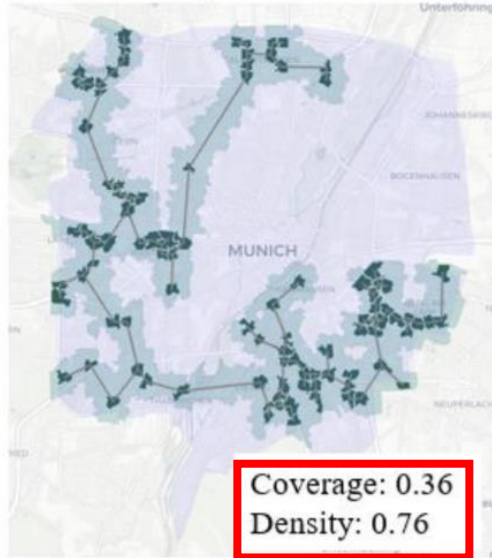
Islands= 3

$$\frac{n - x_i}{n^2 - \sum_{i=1}^n (x_i)}$$

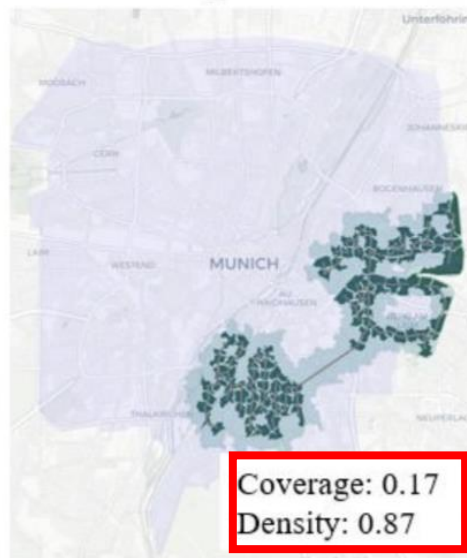
- 1st-> 0.66 * 3 = 2
- 2nd-> 0.33 * 3 = 1
- 3rd-> 0 * 3 = 0

$E_{q_w}: 1; E_{ff_w}: 0$

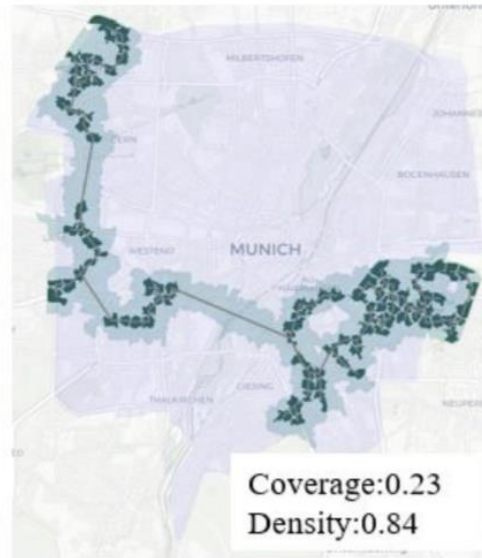
Top N



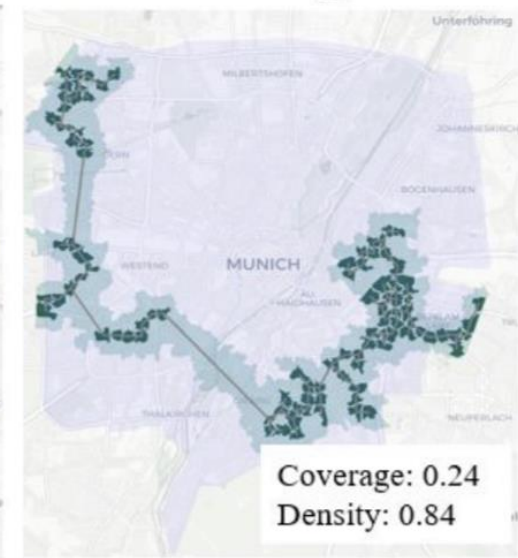
Neighbor



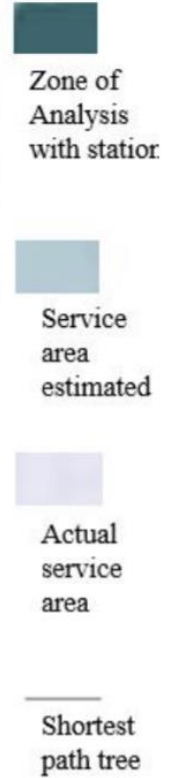
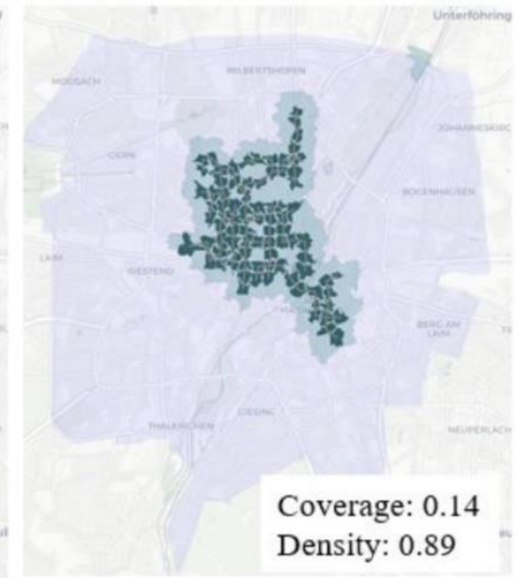
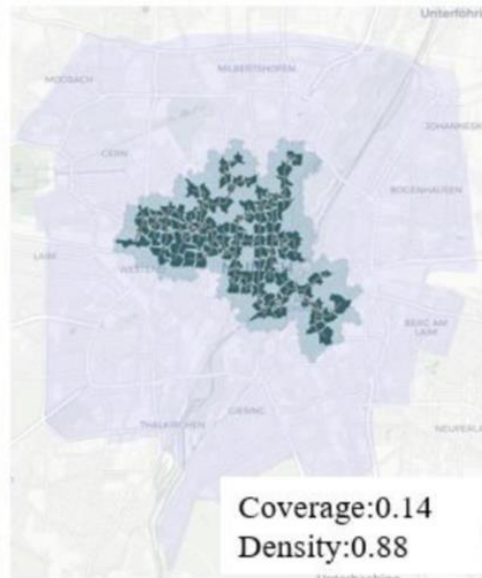
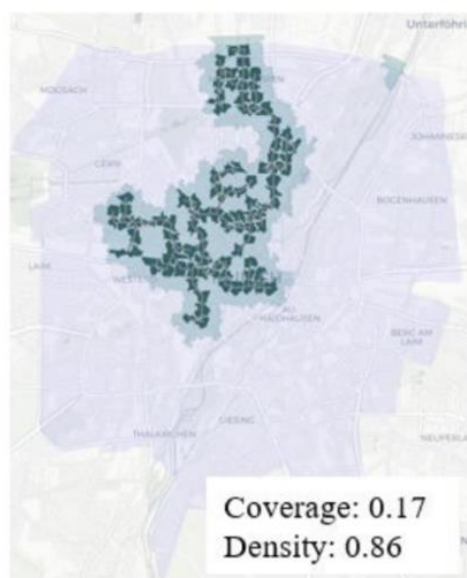
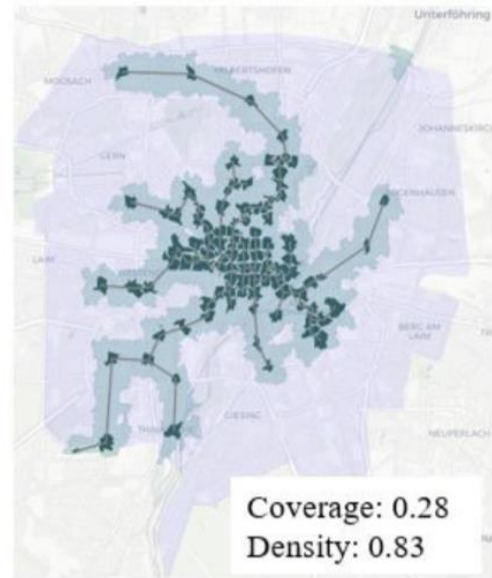
Island



Island weighted



$E_{q_w}: 0; E_{ff_w}: 1$



Stations = 100, Islands = 10

- DARE is an alternative so that benefits do not only go to the most privileged.
- Fairness is part of the input on the planning process for BSS.
- Direct association of BSS usage in areas with
 - low car usage
 - leisure, touristic and shopping activities
- **Further applications:**
 - implementation of other BSS and shared systems or public transport
 - include an **environmental and public participation** weight in the rank index

Thank you for your attention

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Do you DARE?

Thank you for your attention

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How fair is the allocation of bike-sharing infrastructure? Framework for a qualitative and quantitative spatial fairness assessment

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