Multi-Activity Multi-Person Accessibility Measure

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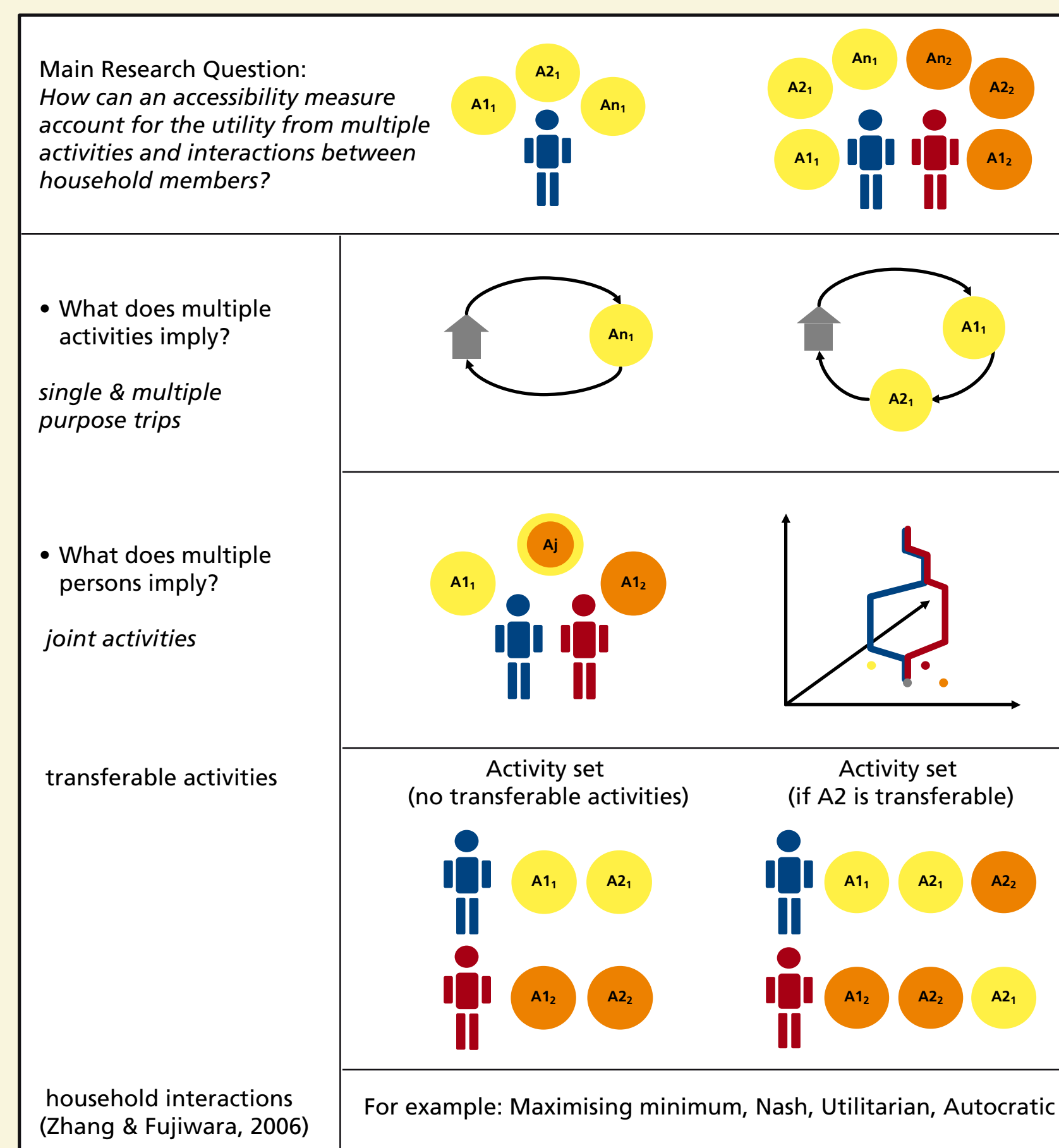### Supervisors: Dick Ettema and Henk F.L., Ottens

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Abstract

Increasing accessibility has been the one of the main goals in land use and transportation planning. Current accessibility measures focus on a single person's ease of participation in a single activity. In reality, people make decisions on their participation in an activity in the context of interacting with other people and also in the context of participating in many other activities. To better measure the impacts of land use and transportation policies, the effect of multiple person interaction and multiple activity participation on an individual's accessibility has to be captured and thus a new formulation is required.
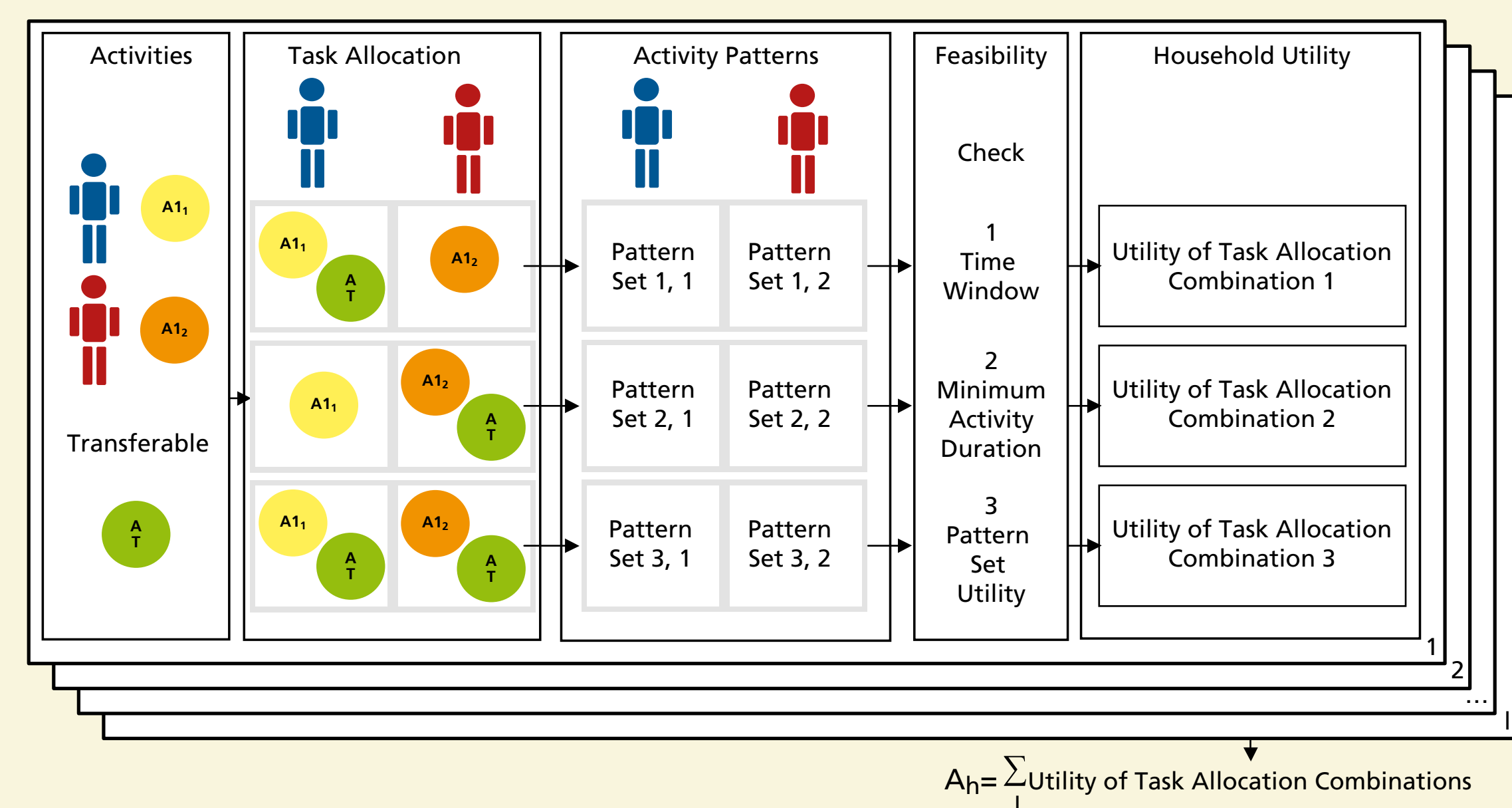
Here, a multi-activity multi-person accessibility measure (MAMPAM) will be elaborated, building on time allocation theory and space-time geography for dealing with spatial-temporal constraints.

Conceptual Model

Main Research Question: How can an accessibility measure account for the utility from multiple activities and interactions between household members?

- What does multiple activities imply? *single & multiple purpose trips*
- What does multiple persons imply? *joint activities*
- transferable activities

Activity set (no transferable activities)
Activity set (if A2 is transferable)

household interactions (Zhang & Fujiwara, 2006)

For example: Maximising minimum, Nash, Utilitarian, Autocratic

Model Specification

Activities | Task Allocation | Activity Patterns | Feasibility | Household Utility

Check
1 Time Window
2 Minimum Activity Duration
3 Pattern Set Utility

Utility of Task Allocation Combination 1
Utility of Task Allocation Combination 2
Utility of Task Allocation Combination 3

$A_h = \sum_l$ Utility of Task Allocation Combinations

Formally, the MAMPAM can be specified as:

$$(1)\quad A_h = \otimes_l V_l$$

$$(2)\quad V_l = \otimes_c V_{lc}$$

$$(3)\quad V_{lc} = \otimes_{p_1} \otimes_{p_2} V_{lcp_1p_2}$$

$$(4)\quad V_{lcp_1p_2} = \frac{1}{1-\alpha} \sum_x w_x V_{lcps}^{1-\alpha}$$

$$(5)\quad V_{lcps} = \sum_j \gamma_{xj} V_{psj} + \sum_j \sum_{j>j} \delta_{xj} \gamma_{xj} \gamma_{xj} V_{psj} V_{psj},$$

$$(6)\quad V_{psj} = \rho_{xj} \ln t_{psj}$$

Such that

$$\sum_x w_x = 1 \qquad \text{and} \qquad \sum_j t_{psj} = T_x$$

Household accessibility under different time windows • *(a) Base scenario (b) Time window extension of 30 minutes for both persons (c) Time window extension of 30 minutes for one person (d) Time window extension of 60 minutes for both persons*
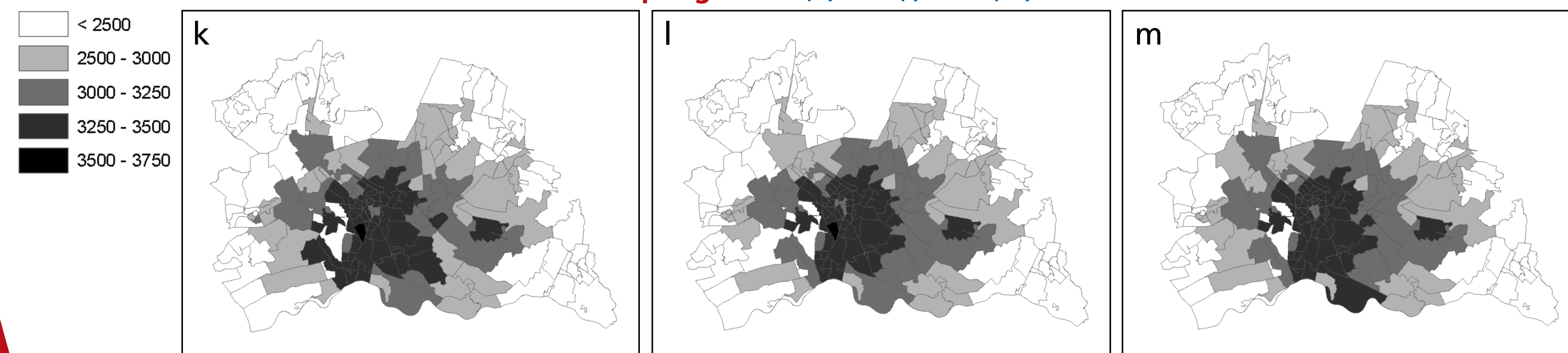
< 2500
2500 - 3000
3000 - 3250
3250 - 3500
3500 - 3750
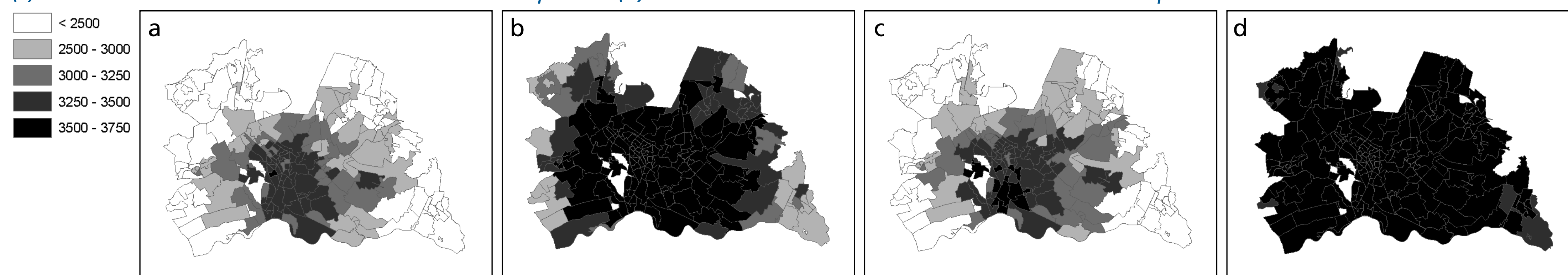
Household accessibility under different interaction parameters • *(e) α = 0.5 (Base scenario) (f) α = 0(g) α = -0.5*

< 3250
3250 - 4250
4250 - 5250
5250 - 6250
6250 - 7500
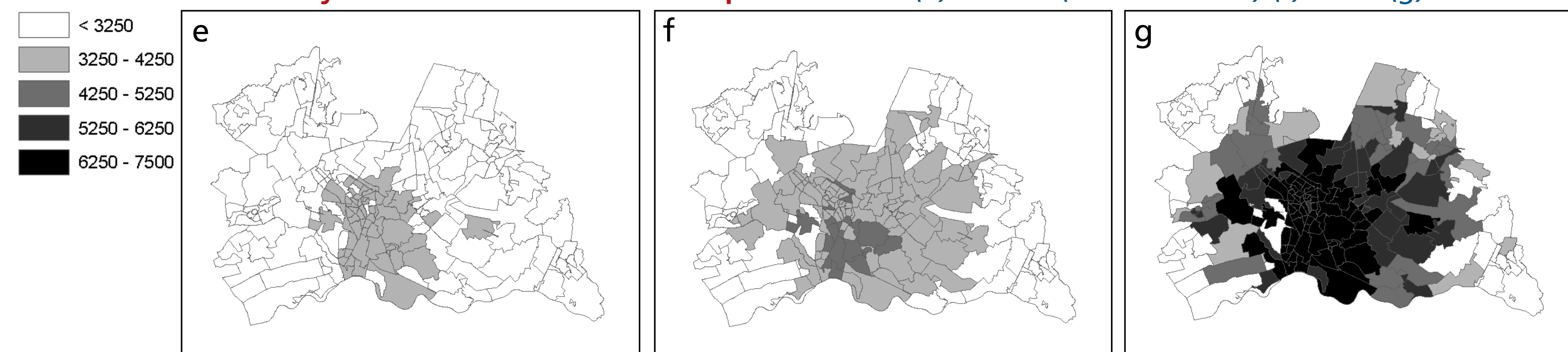
Household accessibility under different spatial settings • *(h) Base scenario (i) Accounting for varying shopping and service quality (j) Changing the work locations of both persons to Utrecht city centre*

< 2500
2500 - 3000
3000 - 3250
3250 - 3500
3500 - 3750
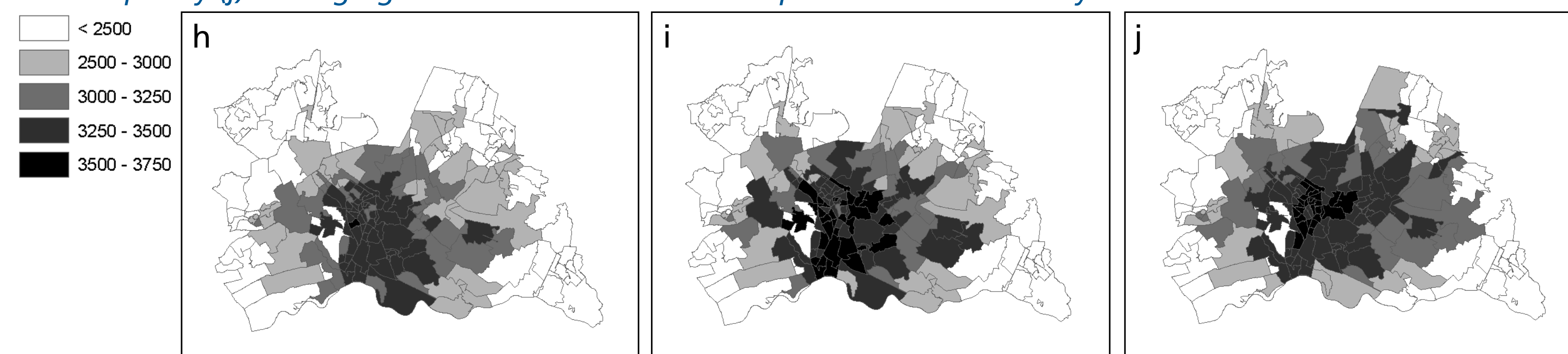
Base Scenario with different location set sampling size • *(k)100 (l) 250 (m) 1000*

< 2500
2500 - 3000
3000 - 3250
3250 - 3500
3500 - 3750

Preliminary Results

To illustrate the ability of MAMPAM to reflect household interactions, temporal and spatial changes, an activity-travel diary of a household is used. This household comprises of two working adults, each engaging in one discretionary activity (shopping), and both having to juggle or share one maintenance activity (banking) between them.

Base scenario:
- Person 1 in the household has two time windows, 7 a.m. - 9 a.m., and 5 p.m. - 7 p.m.
- Person 2 in the household has two time windows, 7 a.m. - 10 a.m., and 5 p.m. - 7 p.m.

Assume: $w_i = 0.5$ for both persons
$\alpha = 0.5$.

Household accessibility is calculated for each possible household location in the spatial context of the province of Utrecht in the Netherlands.

References
Zhang, J., Fujiwara, A. (2006). Representing household time allocation by endogenously incorporating diverse intra-household interactions: A case study in the context of elderly couples. Transportation Research Part B 40, 54-74.

Work Progress

- Ongoing Development
- Calibrating the household time allocation model
- Analysing the parameter outcomes for different household types

- Additional Research Questions
- *Do certain household types reside more frequently on locations for which multi-activity multi-person accessibility is high?*
- *How can the insights gained from MAMPAM be interpreted in terms of Dutch spatial planning policy?*

Geosciences