Human behaviour in large scale evacuation events

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May 2012

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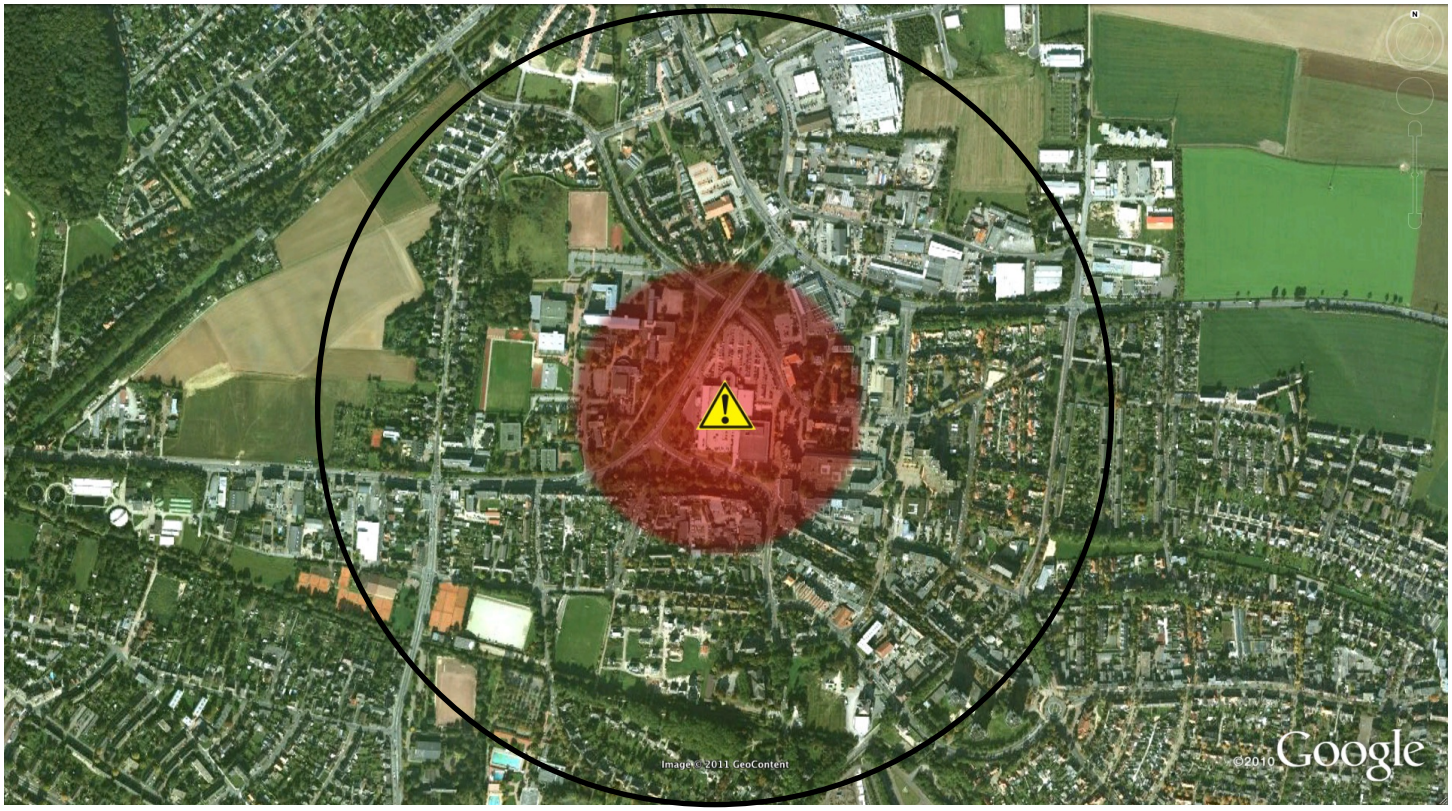
Definition: Large scale evacuation

- Areas of at least 3 km in diameter

- E.g. cities, towns, districts, villages, not single objects or households



Motivation

IVT simulates evacuation events in MATSim

Behavioural model in MATSim is Homo Economicus

Motivation (2)

Homo Economicus

→ Collect information on human behaviour in evacuations and estimate more realistic behavioural model

Collecting data: Triangulated methodology

1. Literature research

2. Expert interviews

3. Survey study

Expert interviews: Results

Hypotheses: Participation for an evacuation	Influence
…increases for ‘life-threatening’ evacuation reasons	+++
…decreases for natural disasters	++
…decreases if time span is too large or to narrow	+
…decreases with available information from reliable sources	++
…increases if people have to care for others	+++
…increases for people without emotional relations	++
…increases when family is united	+++
…decreases for old people and young adults	+++
…decreases for people from ‘isolated’ sub-groups	+++
…decreases for people with high value private property	+++
…decreases for males	+
…is likely for most people	+++
…is often done in own car	+++
…is done in a pro-social way of behaviour	+
…includes that most people find private accommodations	++
…depends on an interaction between reason and information	++

Survey study: Stated choice experiment

Attributes	Flood	Chemical accident	Nuclear accident	Fire, toxic gasses
Source of initial warning	1. Siren 2. Mass media (Radio & TV) 3. Social contacts			
Source of warning confirmation	1. Rescue teams (Police & fire fighters) 2. Mass media (Radio & TV) 3. Social contacts			
Status of household community	1. United 2. Divided			
Time for evacuation	1. Immediately 2. 8 hours 3. 16 hours	1. Immediately 2. 8 hours	1. Immediately 2. 8 hours 3. 16 hours	1. Immediately
Distance to evacuation source	1. 2 kilometers 2. 5 kilometers	1. 2 kilometers 2. 5 kilometers	1. 2 kilometers 2. 5 kilometers 3. 10 kilomters	1. 2 kilometers 2. 5 kilometers
Distance to evacuation border	1. 2 kilometers 2. 5 kilometers	1. 2 kilometers 2. 5 kilometers	1. 2 kilometers 2. 5 kilometers 3. 10 kilomters	1. 2 kilometers 2. 5 kilometers
Choice	1. Immediate evacuation; 2. Later evacuation; 3. No evacuation			

MNL Model

BIOGEME

$$V_{imm} = ASC_{imm}$$

$$+ \beta^1_{atom} * d_{atom} + \beta^1_{chemie} * d_{chemie} + \beta^1_{fire} * d_{fire}$$

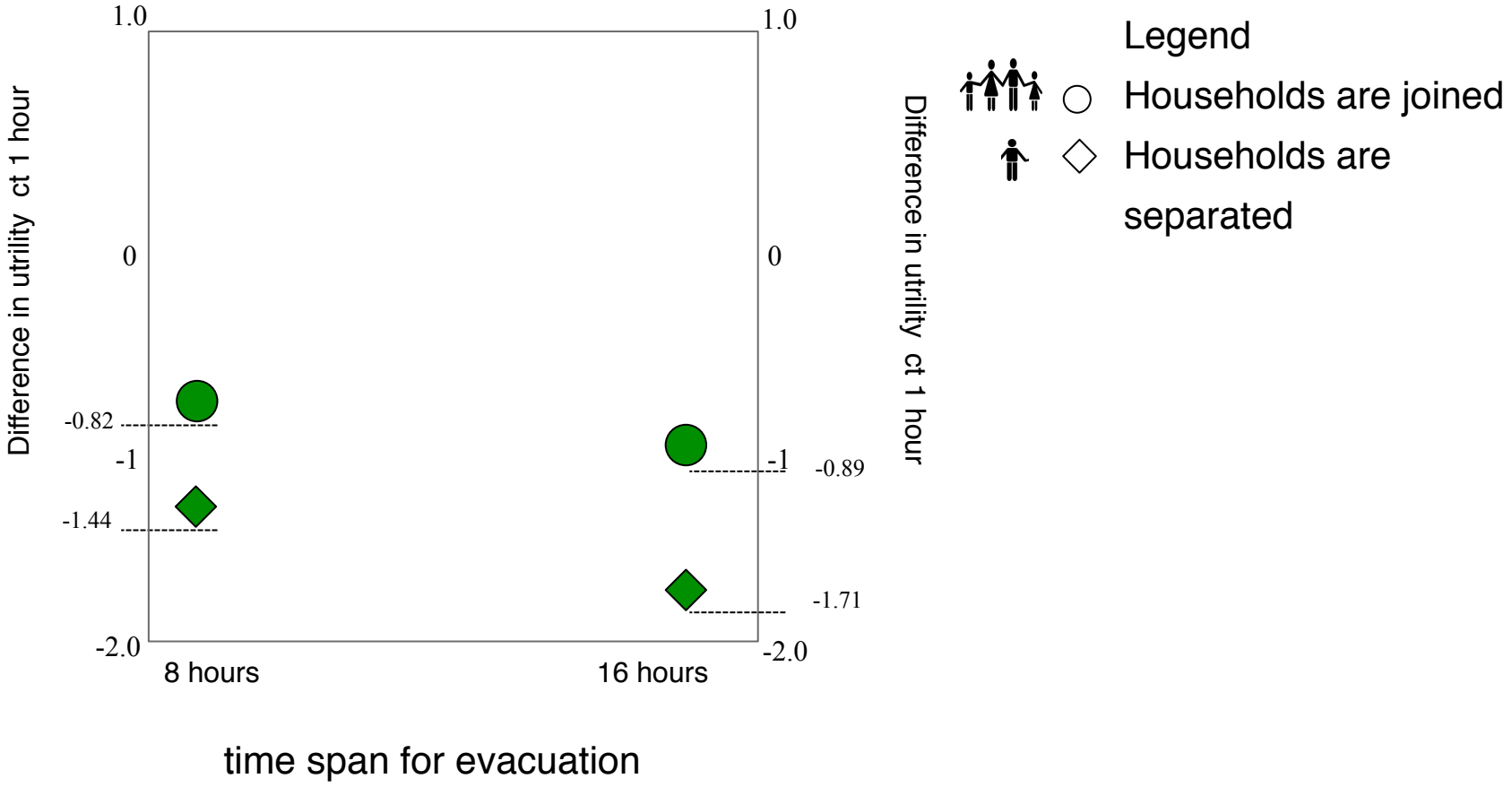
$$+ \beta^1_{age30} * d_{age30} + \beta^1_{age60} * d_{age60}$$

$$+ \beta^1_{time8} * (1 + \beta^1_{hhunit1} * d_{hhunit}) * d_{time8} + \beta^1_{time16} * (1 + \beta^1_{hhunit2} * d_{hhunit}) * d_{time16}$$

Survey study: MNL-Model of stated choices

$Rho^2 = 0.365$ N = 7232	Alternative: Evacuate immediately		Alternative: Evacuate later	
Coefficient	value	t-value	value	t-value
Constant	2.93	14.55	2.19	9.40
Chemical accident	1.40	3.33	0.89	2.14
Nuclear accident	1.72	8.70	0.60	3.11
Fire, toxic gases	0.54	1.57	0.29	0.80
Age 31 - 60	-0.36	-3.63	-0.00	-0.00
Age > 60	-0.60	-3.88	-0.00	-0.00
Time 8 hours	-1.44	-5.87	0.55	2.26
Household united	-0.43	-2.32	-0.62	-1.24
Time 16 hours	-1.71	-6.97	0.39	1.63
Household united	-0.48	-3.34	0.12	0.16

Effect of spatial segregation of household members



Factor analysis

Variable	Factor 1 (care takers)	Factor 2 (assistance needy)
Children	0.67	
Partner	0.52	
DriverLic	0.18	-0,48
PublicTransport	-0.18	0.27
Student		0.15
Age > 60	-0.27	
Income_High	0.24	-0.12

Latent class model

Indicators: households with children & driver license

Class “care takers” : household members: joined/ separated

Class “assistance needy” : influence of age

rho^2 : 0,391 (compared to basic model of 0,365)

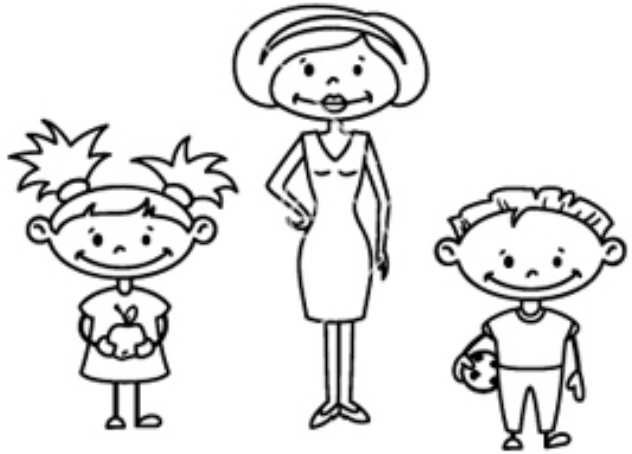
Marginal differences: Latent classes vs basic MNL

	Evacuate immediately	Evacuate later
Coefficient	value	value
Constant	1,91	1,17
Chemical accident	0,36	0,18
Nuclear accident	0,21	0,09
Fire, toxic gases	0,05	0,01
Age 31 - 60	-2,76	-1,90
Age > 60	-2,89	-2,13
Time 8 hours	-0,22	-0,09
Household united	-0,30	-2,33
Time 16 hours	-0,28	-0,12*
Household united	-0,15	-1,81*

* = not significant

Other input for MATSim

1. Addresses at 12 am, 9 am, 5 pm → geo coordinates



2. Car-sharing model

Conclusion

- Behaviour of people can be included in MATSim
- Cause of accident, age, time span available and household status have impact on evacuation decision
- Account for latent classes

But…

Evacuation is an exceptional event.

More latent classes?

Outlook

- Comparison with other models
- Sensitivity analysis of relevant parameters in MATSim
- Re-run evacuation scenarios with estimated parameters
- Compare simulation results

Dinner time!

Thank you for your attention!

Dinner time!

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Back-up slides

Representativeness

	Attribute	Survey data	Microcensus Switzerland
Sex [%]	Male	50.3	49.7
	Female	49.0	51.3
Civil status [%]	Single	25.3	29.9
	Married	58.1	54.5
	Divorced	11.0	7.60
	Widowed	3.6	6.6
	Living separated	2.0	1.4
Age [% of people in class | Ø age within the class]	0-20	0.7 | 19.3	0.05 | 19.0
	21-40	29.7 | 31.7	28.9 | 31.4
	41-60	43.7 | 50.4	31.0 | 50.0
	61-80	25.8 | 67.7	18.5 | 69.4
	81+	0.1 | 84	2.8 | 84.6
Household income	<8000	57.9	73.0
	8001 – 12000	28.2	19.1
	>12.000	13.9	7.9
Citizenship	Swiss	91.9	80.0
	German	2.6	2.3
	French	0.4	1.3
	Italian	1.2	4.6
	Other	4.0	11.8
Drivers license	Available	91.8	80.7
	Not available	8.2	19.3