Modelling the provision of adaptation public goods: The case of neighbourhood support during heat waves

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Neighbourhood support and actor heterogeneity

• To what extent can neighbourhood support supplement public health care during periods of extreme weather?

• Social mobilisation for neighbourhood support may be conceptualised as the collective provision of a public good.
  – Decision making situation of the individuals has the structure of a social dilemma.
  – I.e. under the assumption of purely rational actors social mobilisation will not occur.
  – On the other hand, collective action is observed in many contexts. To assess this phenomenon the explicit consideration of heterogeneous individual preferences and social structure plays a key role.

• Represent social mobilisation as the collective provision of a public good in an agent-based computer simulation.

• Which regions have high potential for collective action?

• How may mobilisation measures take effect?
Model setup – Neighbourhood support as a public good

- Individual group members each contribute a fraction $x$ of a given time budget.
- Sum of contributions determines the success of neighbourhood support (i.e. level of the public good).
- Agent $i$ contributes investment $x_i$
- Calculate success $c(x_1, \ldots, x_n)$ of neighbourhood support:

\[
c(x_1, \ldots, x_n) = \text{Average of contributions } x_1, \ldots, x_n
\]
Model setup – goals guiding individual behaviour

- Agent$_i$ decides about its next investment level $x_i$ from $\{0.0, 0.1, \ldots, 1.0\}$.
- Selection of a behavioural option is guided by four different goals/criteria.

<table>
<thead>
<tr>
<th>#</th>
<th>Goal</th>
<th>Preference (example value)</th>
<th>Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Strive for working neighbourhood support</td>
<td>publicGoodPreference $\ (1.0) )</td>
<td>$c(x)$</td>
</tr>
<tr>
<td>2</td>
<td>Achieve a desired ratio between own and other’s contributions</td>
<td>selfPreference $\ (0.1) )</td>
<td>$1.0 - x$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>othersPreference $\ (0.3) )</td>
<td>$1.0 - \text{mean } x \text{ of other group members}$</td>
</tr>
<tr>
<td>3</td>
<td>Achieve social conformity: behave like peers in social network</td>
<td>socialConformityPreference $\ (0.15) )</td>
<td>$1.0 - \text{abs}(x - \text{mean } x \text{ of peers})$</td>
</tr>
</tbody>
</table>

- Agents weight goals in a subjective way according to their preferences.
Representative neighbourhoods and social networks

- Agent types represent lifestyles
  - different preference sets
- Agent groups reflecting
  - lifestyle composition
  - size
  - spatial location
- Social network reflecting
  - spatial closeness
  - lifestyle properties
Climate baseline
Simulation setup

- Baseline period from 2001 to 2010
- Explore effects of intervention scenarios during 2011 to 2020
Baseline – Model warm-up

Temporal development baseline period

- Mean investment (normal days)
- Mean investment (heat days)
- Successful neighbourhoods (%)

Time


Mean investment

Neighbourhoods (%)

Temporal development full mobilisation

- Mean investment (normal days)
- Mean investment (heat days)
- Successful neighbourhoods (%)
- Campaign coverage (% of agents)
Impact of intervention: Spatial effects

Spatial distribution of neighbourhood support baseline period

Legend
mean success last 3 years
- 0.0 - 0.2
- 0.2 - 0.5
- 0.5 - 0.75
- 0.75 - 1.0

0 1 2 3 km
Impact of intervention: Spatial effects

Spatial distribution of neighbourhood support
full mobilisation

Legend
mean success last 3 years
0.0 - 0.2
0.2 - 0.5
0.5 - 0.75
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0 1 2 3 km
Impact of intervention: Behavioural heterogeneity

Distribution of behaviours during last 3 years
baseline period

Distribution of behaviours during last 3 years
full mobilisation
Discussion and outlook

• **Observe** how intervention campaigns help to break prevailing habits in a population and establish new behavioural patterns that persist after the end of the intervention.

• **Assess** socio-behavioural impact of interventions

• **Identify** city regions with substantial potential for neighbourhood support and a small region where even comprehensive information campaigns show insignificant effect.

• Model validation

• Higher order dynamics like the emergence of new lifestyles over time
References

