Approaching Vulnerability in Socio-technical Emergency Response Systems

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Outline

1. Agents and links of influence as a social dimension of an emergency response system

2. The balance between top-down and bottom-up

3. The vulnerable system

4. Discussion and Q&A
Agents and links of influence as a social dimension of an emergency response system

Dynamics over time

ERS at $t_x$

Subsystem (ERSS) A, B, C........n.

Subsystem representing interacting decision makers

System dependencies

Link of influence

Agent
Agents and links of influence as a social dimension of an emergency response system

Emergent phenomena and self-organization...

Ad hoc spontaneous

Dynamical and adaptive processes – no external control

...take place in the subsystems of agents and their links of influence
The balance between top-down and bottom-up

**Top-down** – “activities undertaken by responsible decision makers which provide a direction or regulation for employees” / Heiss, Stoeckl and Hausknotz (2006) → traditional C2. Deriving from a central authority(ies)

**Bottom-up** – “voluntary activities undertaken by employees for certain management aspects which influence planning and decisions of decision makers in a relevant way” / Heiss, Stoeckl and Hausknotz (2006) → Emergent phenomena and self-organization
### Hypothetical system characteristics

#### Top-down

<table>
<thead>
<tr>
<th>possible advantages</th>
<th>possible disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear distribution of responsibility</td>
<td>Low flexibility/redundancy</td>
</tr>
<tr>
<td>Low risk for local dysfunctional behaviour</td>
<td>Low creativity</td>
</tr>
<tr>
<td>Facilitates distribution of information</td>
<td>Slow reaction time</td>
</tr>
</tbody>
</table>

#### Bottom-up

<table>
<thead>
<tr>
<th>possible advantages</th>
<th>possible disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>High flexibility/redundancy (adaptive)</td>
<td>Indistinct distribution of responsibility</td>
</tr>
<tr>
<td>High creativity</td>
<td>Scope for local maladaptive behaviour</td>
</tr>
<tr>
<td>Fast reaction time</td>
<td>Depending on inventiveness and individuals</td>
</tr>
</tbody>
</table>
Example of empirical findings
The vulnerable system

**Perturbations** – influences that affect the ERS in a negative way in its endeavor to find an optimal balance between top-down and bottom-up

“Complex adaptive systems theories presume that the adaptation of a system to its environment emerges from the adaptive efforts of individual agents that attempt to improve their own payoffs” (Anderson, 1999)
Discussion

- The ERS can be seen as an CAS that to a certain degree has to be open to influences, even the “destructive” ones.

- This makes the ERS vulnerable by nature.

- The consequence of an ERS “out of balance” is a reduced capability to respond to an event and achieve its system goal.

- An important task for emergency response managers is to deal with perturbations and aim for a contextually dependent balance between top-down and bottom-up influences.