Qualitative and quantitative approaches for assessing climate change impacts on future infrastructures

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Climate Change and Adaptation (KomPass)
Climate change impacts on infrastructures in Europe

1. Climate hazard impacts to critical infrastructures may strongly rise in Europe: Indicative estimates of total damages from 7 climate hazards to society could rise from currently 12 billion €/year to nearly 80 billion €/year by the end of this century.

2. Economic losses are highest for the industry, transport and energy sectors. The strongest increase in multi-hazard damages is projected for the energy sector, for which the baseline expected annual damage (EAD) of 0.5 billion €/year could rise to 2.0, 4.4, and 8.2 billion €/year by the 2020s, 2050s and 2080s, respectively.

3. Impact and adaptation costs do not fall equally across Europe. Southern and south-eastern European countries will be most impacted.

Climate change impacts on energy infrastructures in EU+

EU+ = EU28 plus Switzerland, Norway and Island

http://publications.jrc.ec.europa.eu/repository/handle/JRC98159
German Vulnerability Assessment:

**Energy infrastructures**

1. Gradual and extreme temperature changes, and other extreme weather events will impact the energy industry. The impacts of climate change are largely dependent on the current and future composition of the energy infrastructure.

2. Most climate change impacts on the energy industry will be of low to medium importance for Germany.

3. Many experts believe that the necessary restructuring of the energy industry in the context of climate protection constitutes the biggest challenge. They estimate that the energy industry has an overall high adaptive capacity so that the action field’s vulnerability (→ IPCC 2007) in the near future is considered as low.
German Vulnerability Assessment:

**User, Purpose and Aim**

Task defined in the German National Adaptation Strategy:

- **User:** National Steering Group (IMA)
- **Purpose:** “to prioritize risks and derive adaptation needs at the federal level”
- **Aim:** “consistent, actual, cross-sector vulnerability assessment including adaptive capacity “

→ rising awareness
→ allocate resources

ℱ Mix of quantitative and qualitative information/results
Excursion: qualitative vs quantitative approaches

<table>
<thead>
<tr>
<th>Quantitative results</th>
<th>Qualitative results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numbers, values, maps, graphs</td>
<td>Pictures, stories, words, estimations, narratives</td>
</tr>
<tr>
<td>+ details</td>
<td>+ summary of experience and knowledge</td>
</tr>
<tr>
<td>+ methodological transparency</td>
<td>+ not data dependent</td>
</tr>
<tr>
<td>+ calculation of complex relations and non-linearities, statistical uncertainties</td>
<td>+ involvement of stakeholders</td>
</tr>
<tr>
<td>- only apparently accurate and objective: hidden uncertainty (system understanding, data, models) and normative aspects</td>
<td>- transparency and robustness</td>
</tr>
<tr>
<td></td>
<td>- representativeness and legitimation</td>
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→ Visualisation: creating an impression/image
→ Danger: Simplification and Misuse
German Vulnerability Assessment: Methodology

Temporal and spatial consistent!

- Present: 1961-1990
- Near future: 2021-2050
- Distant future: 2071-2100
German Vulnerability Assessment: Methodology

Szenario combinations „weak change“ and „strong change“

- Climate exposure: 15. and 85. percentil of RCM ensemble until 2100
- Sensitivity: 2 socio-economic scenarios (stagnation and growth) for 2030:
  - Population (migration balance, number of older people)
  - Gross domestic income
  - Household disposable income
  - Land use
Infrastructures

Infrastructures are **socio-technical systems**. They are composed out of the infrastructure itself, its service to its users as well as the institutions needed to build and manage it.

are sensitive because of:

- Age/Condition
- Construction
- Location
- Functionality/Usages
- ....
**German Vulnerability Assessment:**

**Climate change impacts on energy industries**

### Process models

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<thead>
<tr>
<th>Hydropower</th>
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### Proxy indicators

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### Expert interviews

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German Vulnerability Assessment:
Quantitative results: Cooling energy demand
German Vulnerability Assessment:

Qualitative results: Cooling energy demand
## German Vulnerability Assessment:
### Results for the energy sector

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<th>Confidence</th>
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<td>Near Future – strong change</td>
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Energy infrastructures

1. Most **climate change impacts on the energy industry will be of low to medium importance for Germany.**

2. Many experts estimate that the energy industry has an overall high adaptive capacity so that the action field’s vulnerability **in the near future** is considered as low.

→ No information about sensitivity in the distant future
→ And only very limited information for the near future
Future Infrastructures

Change driven by

- **Environment** (and legislative) pressures, i.e. climate change (mitigation and adaptation),
- **Economic** pressures, i.e. liberalization, fossil energy availability/price,
- **Technological** change and innovations, i.e. digitalization, aging/modernization
- **Social** change, i.e. demographic change, urbanization but also social innovation, i.e. new forms of governance and private ownerships
Future Infrastructures

Pressures can lead to more

• Centralized – decentralized
• Robust/stabile – flexible
• Autonomous – connected
• Common – diverse
• Grey- Blue/green infrastructures.

→ Probably to more infrastructures,
→ But also to more resilient infrastructures?
Summary

- Sensitivity of future infrastructures is difficult to project in a changing system.
- Also for sensitivity: ensembles are needed.
- Future sensitivity can be described by trends (i.e. location) but also on changes, which can only be described qualitatively (qualitative scenarios?)
- Numbers can be a good eye catcher – but be aware of uncertainty!

Users like to have simple messages to justify decisions – but be aware of misunderstanding and misuse.