Für Mensch & Umwelt

Understand Risk, Venedig 18.5.2016

Risk assessment, risk reduction and risk mitigation – what role do models, numbers, text and stories play?

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

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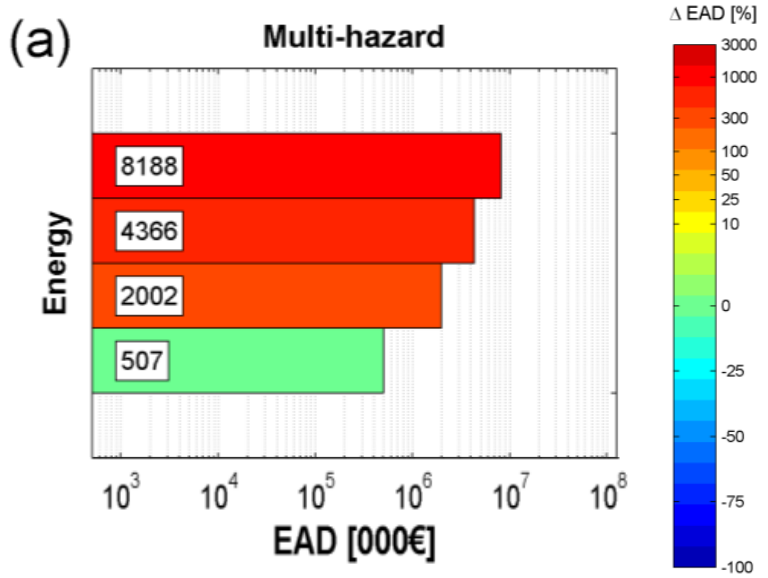
Climate change impacts on infrastructures in Europe

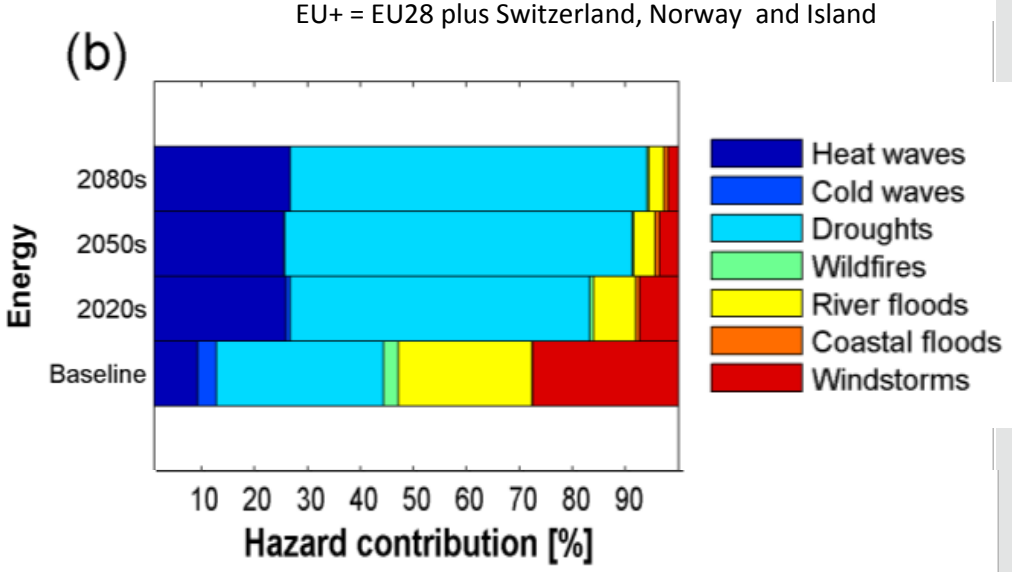
1. **Climate hazard impacts to critical infrastructures may strongly rise in Europe: Indicative estimates of total damages from 7 climate hazards to society could rise from currently 12 billion €/year to nearly 80 billion €/year by the end of this century.**
2. **Economic losses are highest for the industry,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

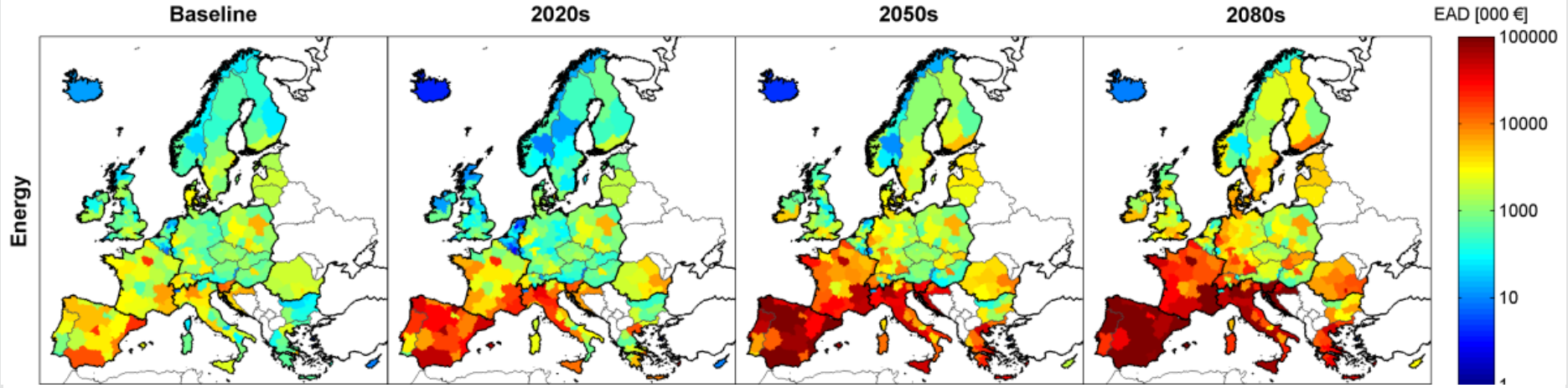
Forzieri, G., Bianchi, A., Marin Herrera, M.A., Batista e Silva, F., Feyen, L. and Lavalle, C., 2015. Resilience of large investments and critical infrastructures in Europe to climate change. EUR 27598 EN. Luxembourg (Luxembourg): Publications Office of the European Union.

Climate change impacts on energy infrastructures in EU+

EU+ = EU28 plus Switzerland, Norway and Island







Source: JRC Technical Report für EU KOM: "Resilience of large investments and critical infrastructures in Europe to climate change“ 2015
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**

➢ **Mix of quantitative and qualitative information/results**

Excursion: qualitative vs quantitative approaches

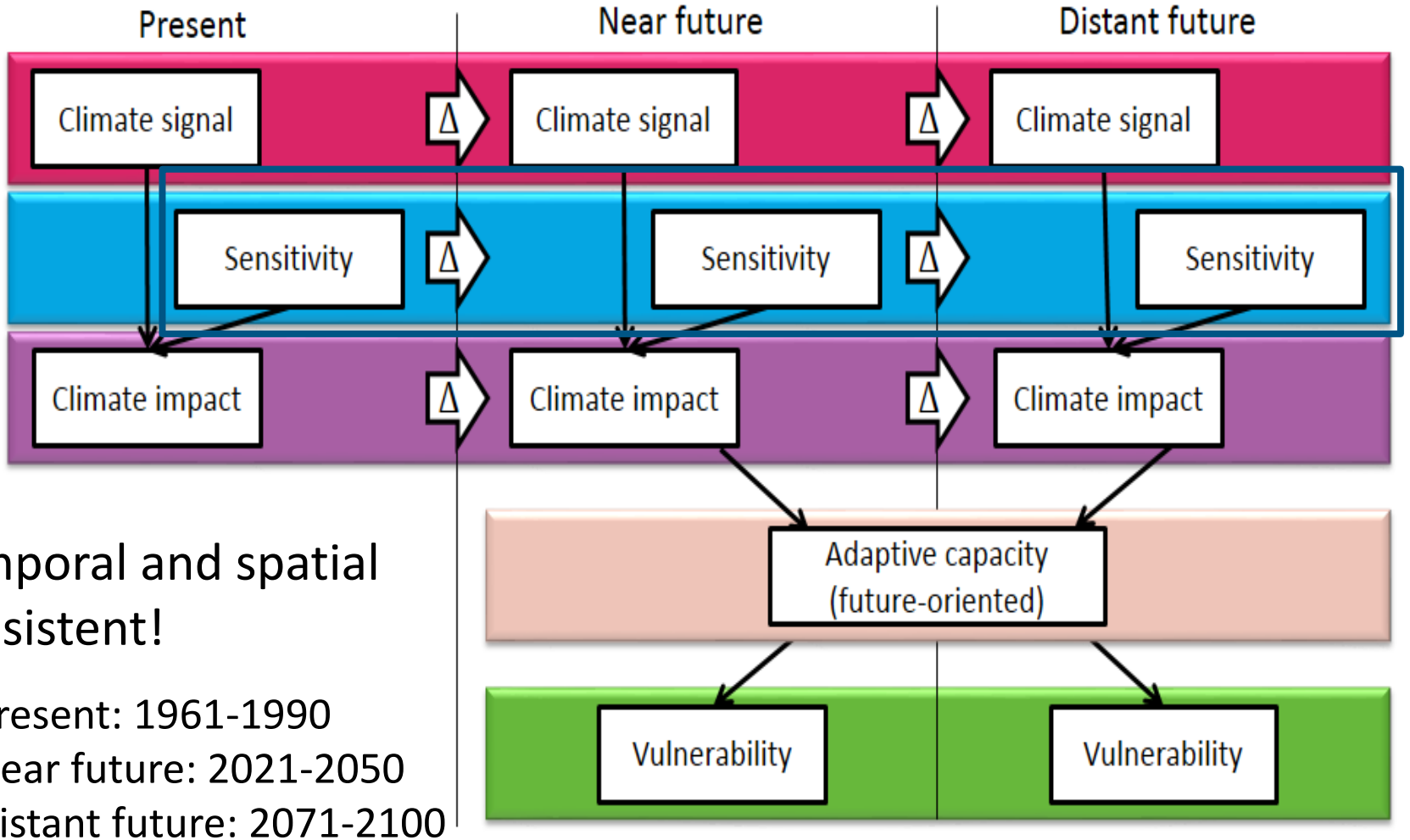
Quantitative results	Qualitative results
Numbers, values, maps, graphs	Pictures, stories, words, estimations, narratives
+ details + methodological transparency + calculation of complex relations and non-linearities, statistical uncertainties	+ summary of experience and knowledge + not data dependent + involvement of stakeholders
- only apparently accurate and objective: hidden uncertainty (system understanding, data, models) and normative aspects	- transparency and robustness - representativeness and legitimation

→ **Visualisation: creating an impression/image**

→ **Danger: Simplification and Misuse**

German Vulnerability Assessment:

Methodology



Temporal and spatial consistent!

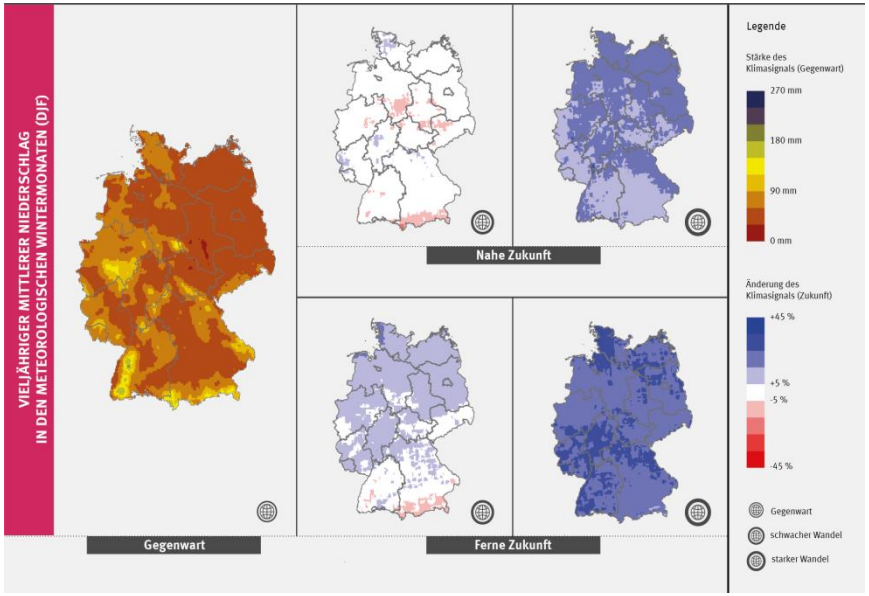
- Present: 1961-1990
- Near future: 2021-2050
- Distant future: 2071-2100

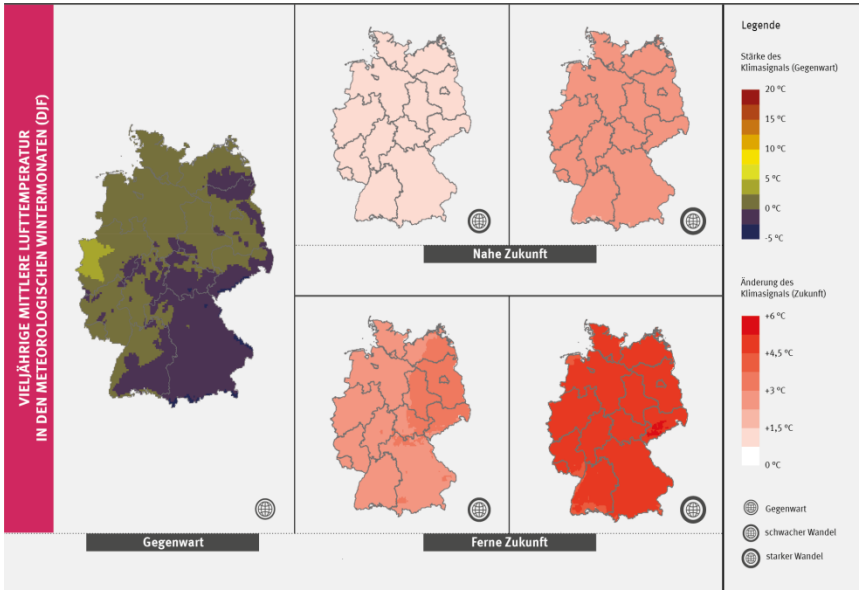
German Vulnerability Assessment:

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

Hydropower	Cooling water for thermal power plants	Wind energy

Proxy indicators

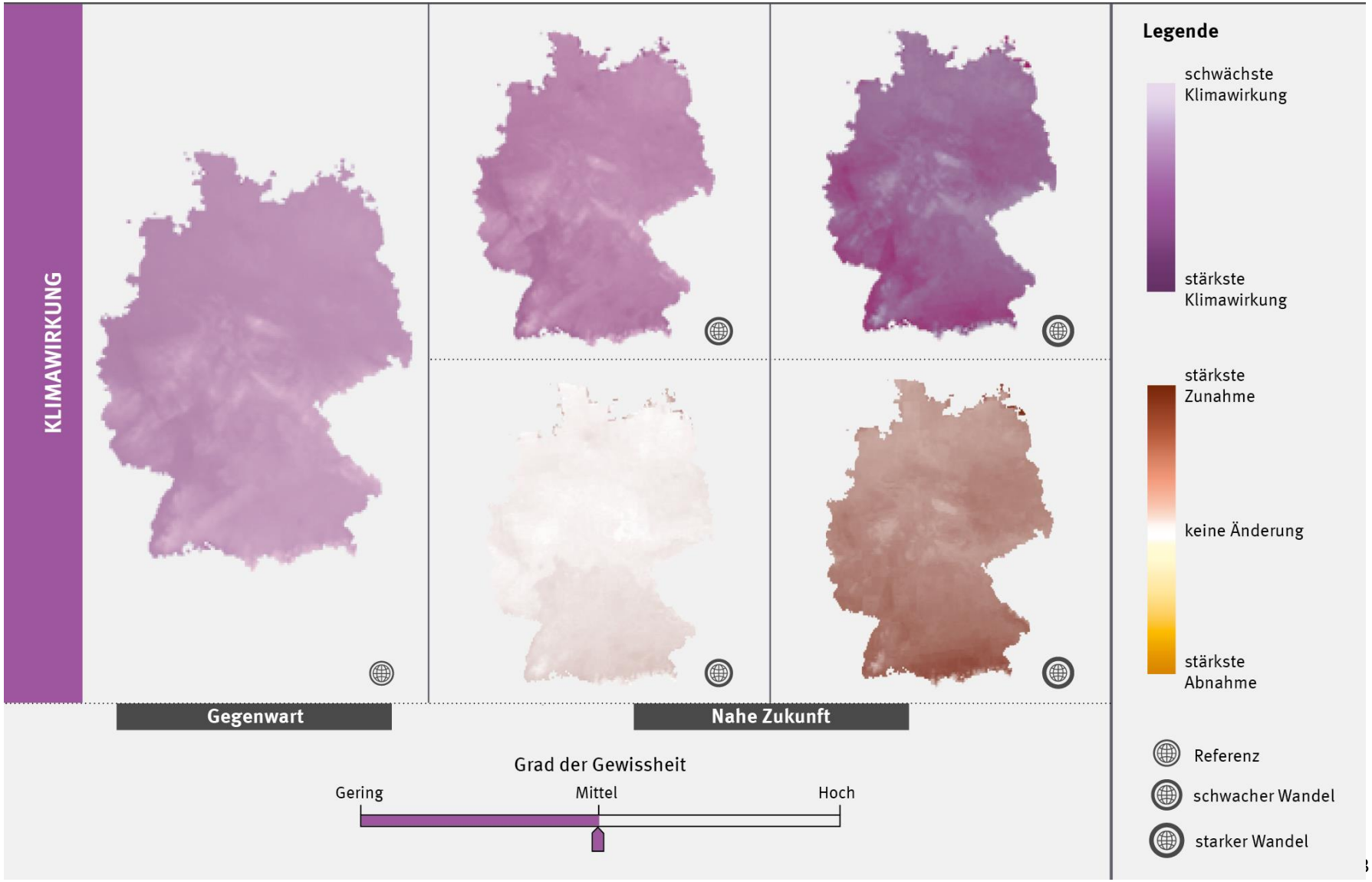
Heating energy demand	Cooling energy demand	Damage to power plants

Expert interviews

Cooling energy demand	Damage to transition networks	Reliability of energy supply

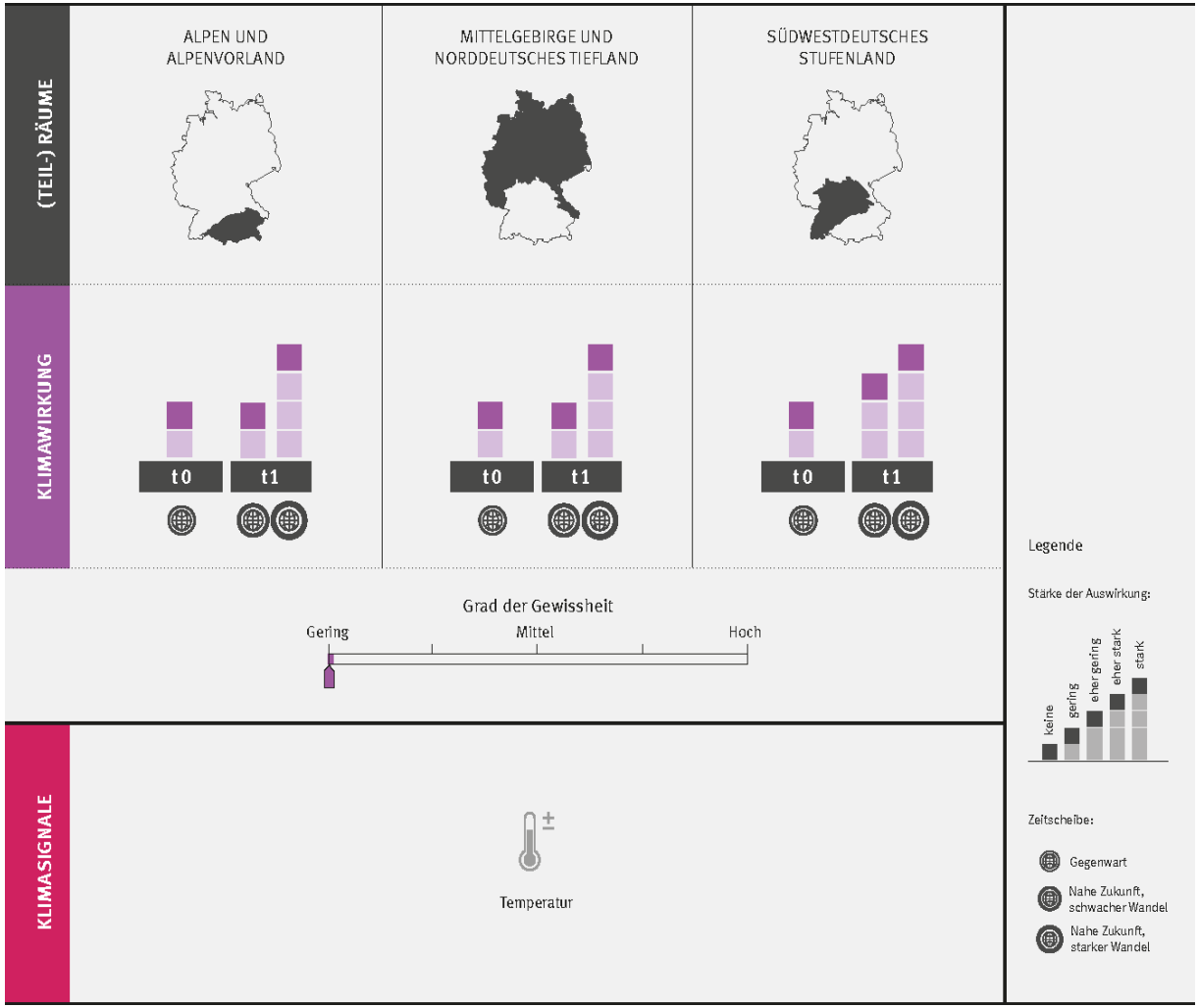
German Vulnerability Assessment:

Quantitative results: Cooling energy demand



German Vulnerability Assessment:

Qualitative results: Cooling energy demand



German Vulnerability Assessment:

Results for the energy sector

Climate change impact	Importance			Confidence
	Present	Near Future – weak change	Near Future – strong change	
Cooling water for thermal power plants				medium
Heating energy demand				medium
Cooling energy demand	low	low	medium	low
Damage to power plants				low

German Vulnerability Assessment:

Results for the energy sector

Climate change impact	Importance			Confidence
	Present	Near Future – weak change	Near Future – strong change	
Hydropower				Medium to high
Wind energy				low
Damage to transition networks				medium
Reliability of energy supply				low

German Vulnerability Assessment:

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

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