Vulnerability mapping of climate sensitive systems in Germany

A concept and its journey through the turmoil of practise

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Objectives:

- global change and its impacts in Germany
- present degree of adaptation and adaptive capacity ↝ Vulnerability
- Dialog with decision-makers ↝ development of strategies of adaptation to global change in Germany

M. Zebisch, T. Grothmann, D. Schröter, C. Hasse, U. Fritsch, W. Cramer (2005)

1)Concept - where we started and where we ended up

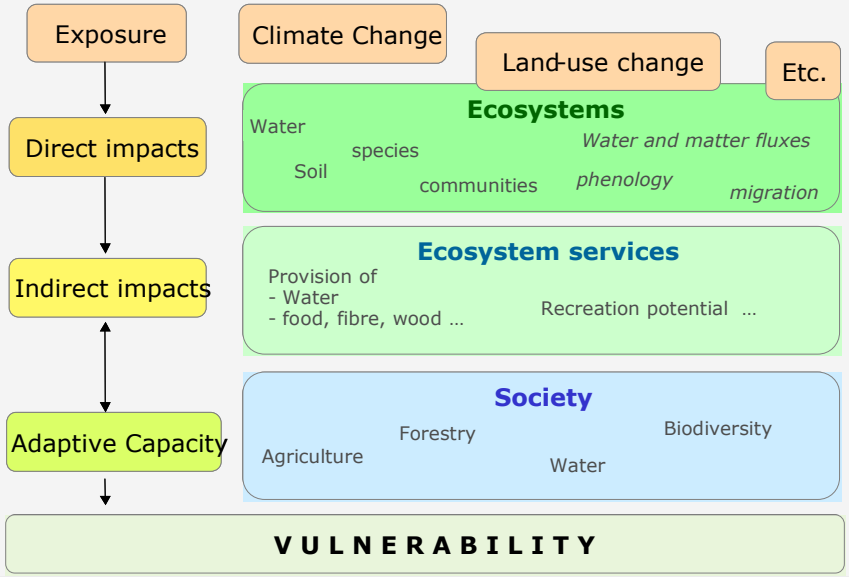
2)Results from the study

3) Conclusions

Concept – Where we started

ATEAM data and results (model outcomes for Europe)

Conceptual model of Vulnerability



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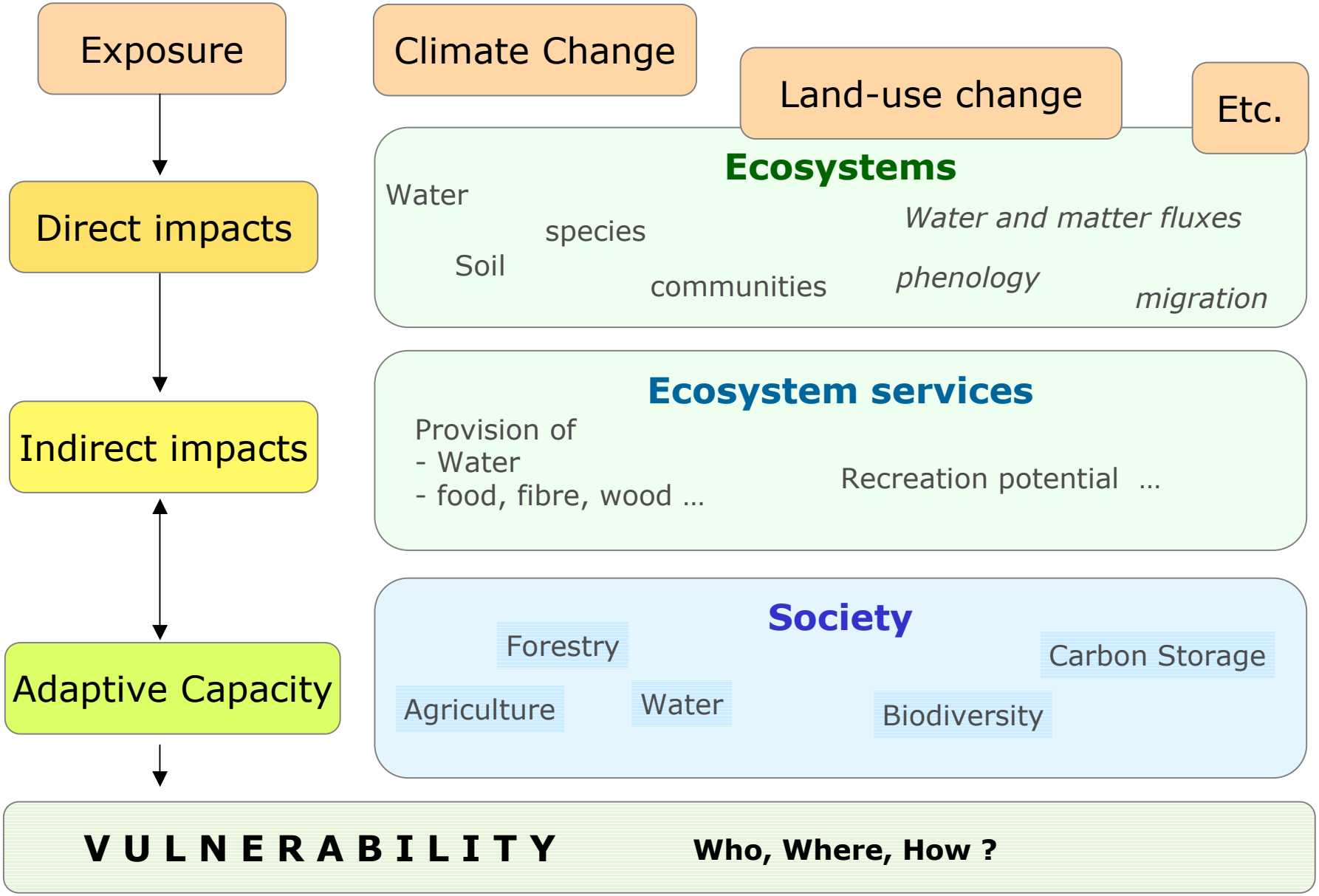

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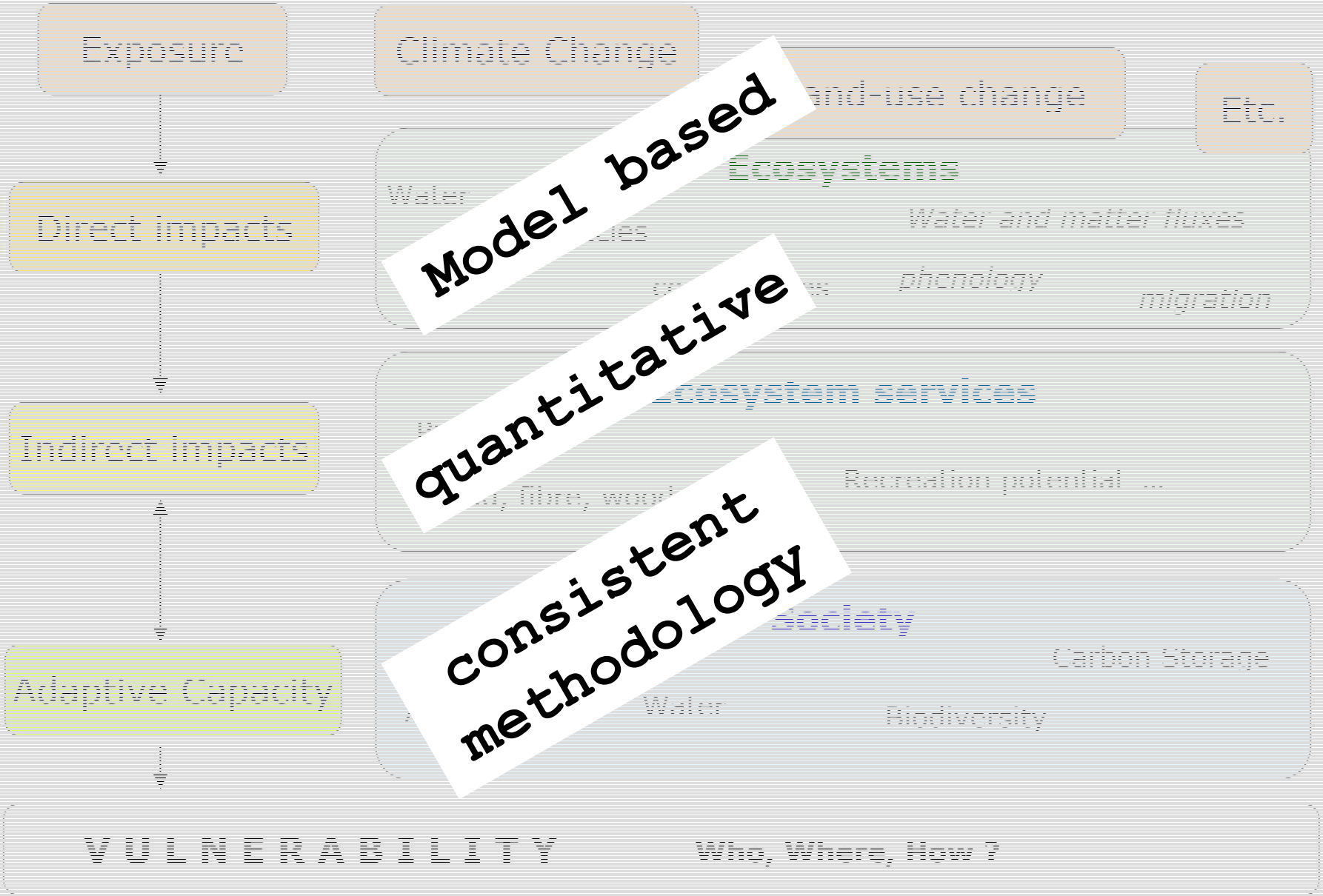


Expectations of UBA

Topic	Variables
Agriculture	Potential yield, pest + diseases, irrigation demand, crop suitability …
Forestry	Potential yield, pest + diseases, forest fires, storm damage …
Water	Groundwater level, water availability, water level in rivers …
Biodiversity	Species diversity (per ecosystem, per function), ecosystem functions, connectivity of biotopes …
Tourism	Length of ski season, swimming season, Overnight stays …
Human Health	Frequency of heatwaves and correlation to mortality, vector borne diseases
Traffic	Stress on infrastructure (by extremes)….

Expectations of UBA

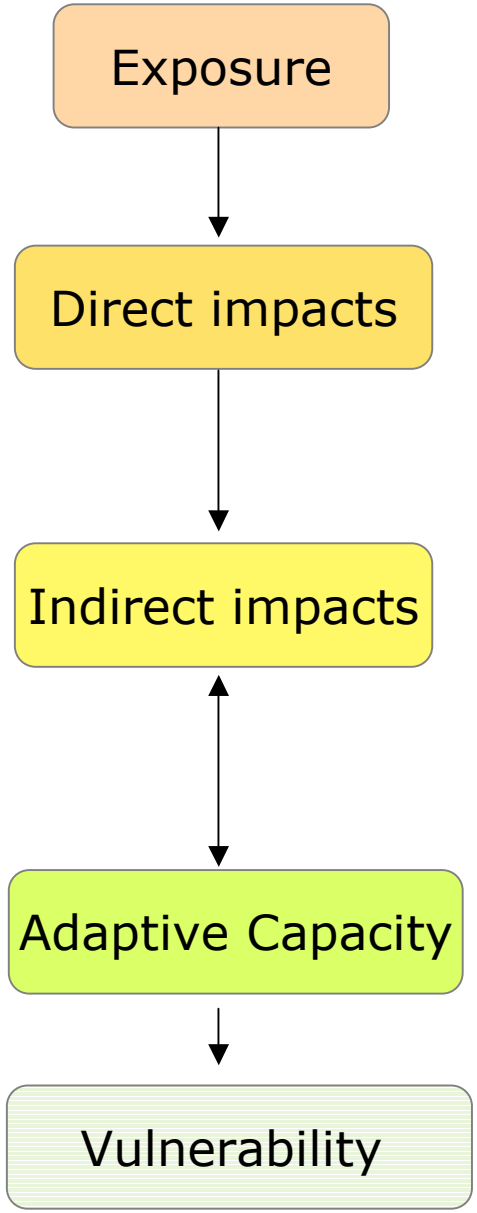
Topic	Variables
Agriculture	ield, pest + diseases, on demand, crop suitability ...
Forestry	otenti st + diseases, fo damage ...
Water	ater availability, ...
Biodiversity	ity (per ecosystem, per ecosystem functions, activi otopes ...
Tourism	Leng n, swimming season, n
Human Health	eatwaves and correlation y, vector borne diseases
Traffic	s on infrastructure (by extremes)...

focus on hot topics

no models available for many variables

No methodology for AC

How we ended up



past trends

National Reports
(DWD, BFN, BFH…)
Expert knowledge

projections

ATEAM
Regional Studies
Expert knowledge

☞ Compilation of existing knowledge on global change and its impacts in Germany for seven topics

Ecosystem Services

Only verbal link ("relevance for society")
For many topics not suitable (e.g. health, traffic)

Adaptation and Adaptive Capacity

Survey with focus on status and effectiveness of adaptation and perceived risk of global change
(No perceived risk no future adaptation)

Vulnerability

Sector and regions specific.
Qualitative synthesis of impacts and Adaptation/AC

Adaptation and Adaptive Capacity - questionnaire

- Per topic, per region
- Perceived impacts of climate change (per topic, region)
  - History, now, short-, medium-, long term
  - Risks and chances
- Adaptation
  - Effectiveness of measure
  - Implementation of measures (discussed – implemented)
  - Causes for implementing and constraints for not implementing specific measures (e.g. financial, legislative, administrative …)
  - Expense of implementation

➪ Focus on current adaptation and adaptive capacity

1)Concept - where we started and where we end up

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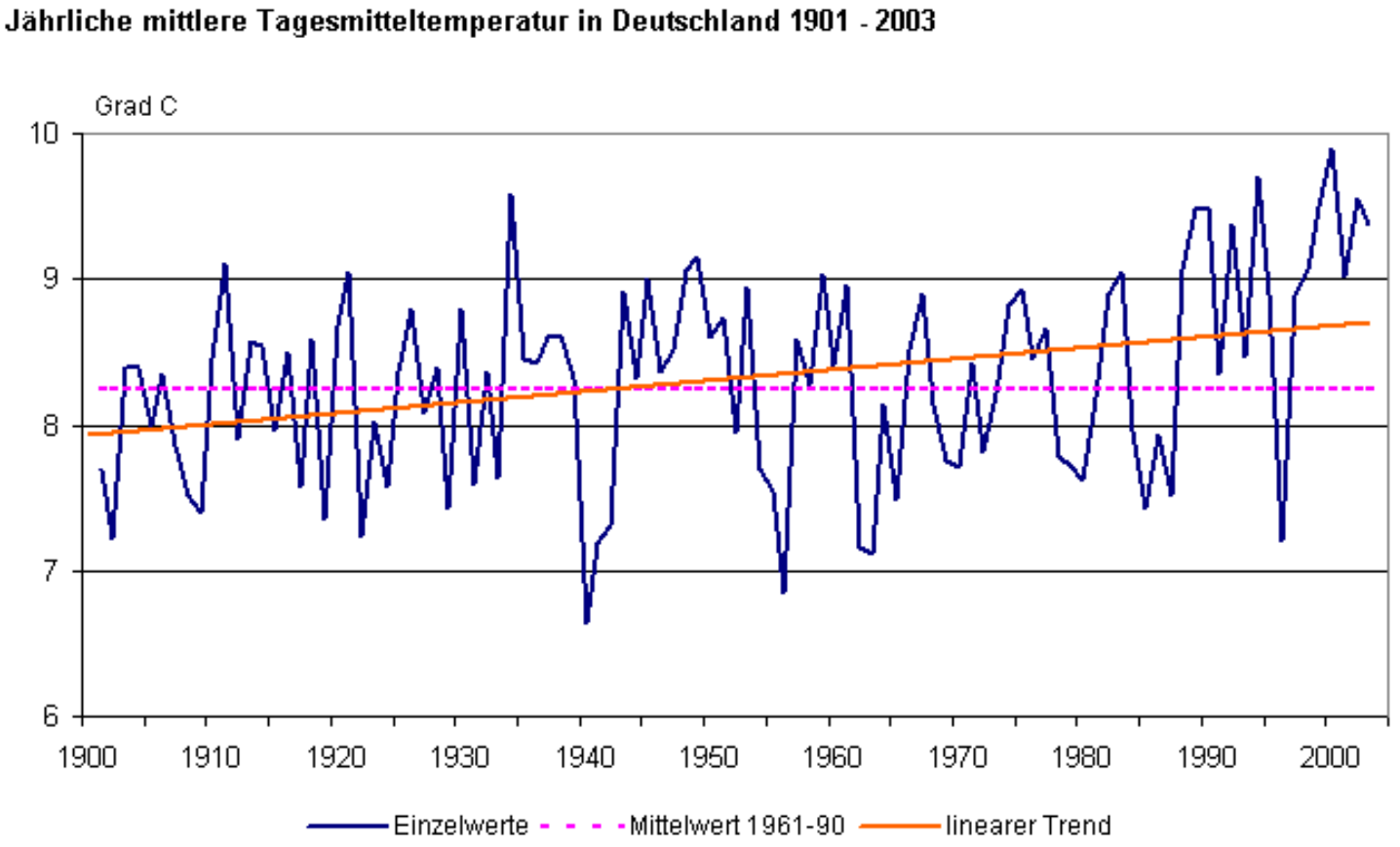
Exposure: Climate Change in Germany

Trends in the last 100 years

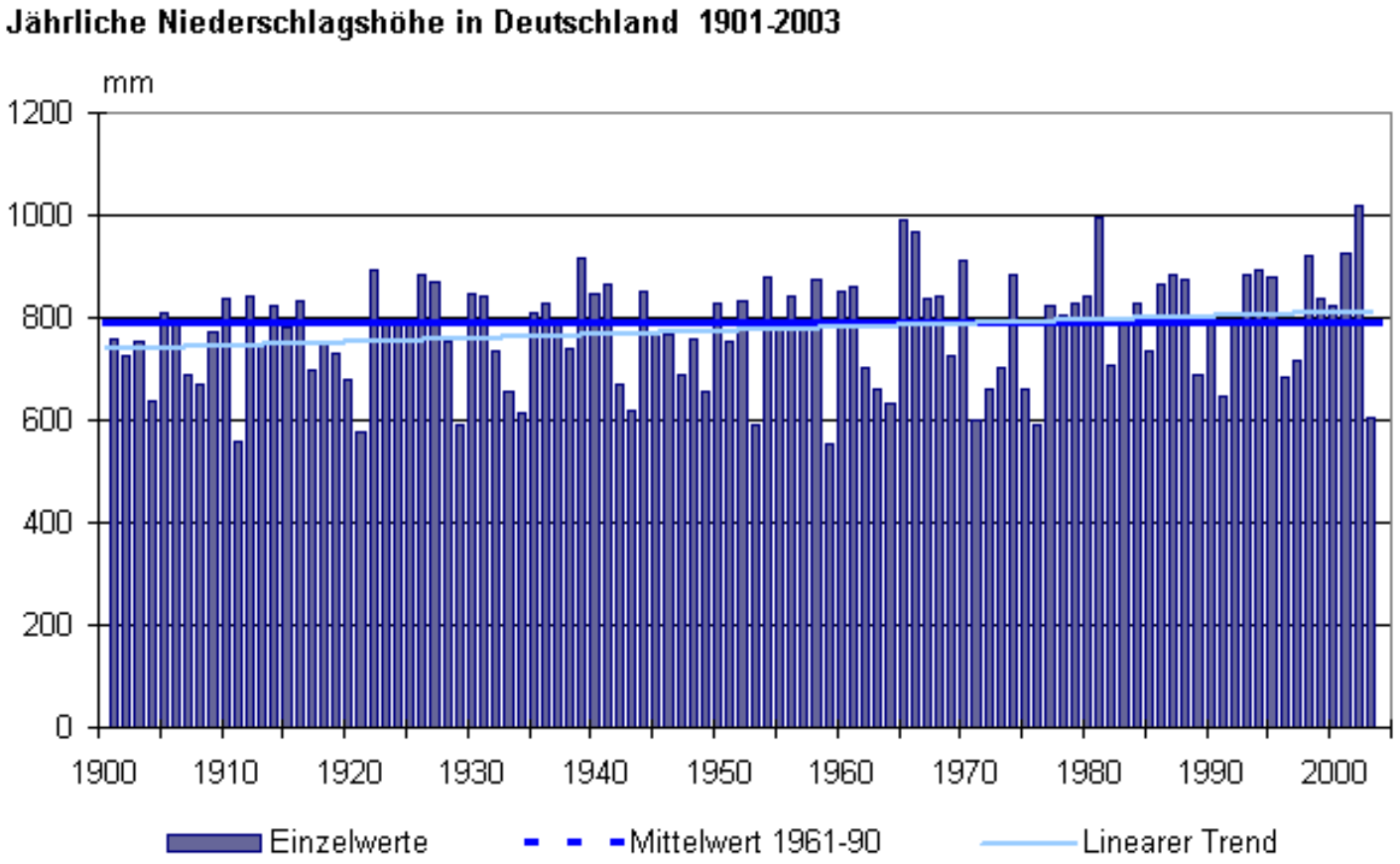
Climate change since 1900 – temperature



Quelle: Deutscher Wetterdienst, Mitteilung vom 15.06.2004

- Warming since 1900: + 0,8 °C
- 1990th warmest decade
- Local "hot spots": South and South-West

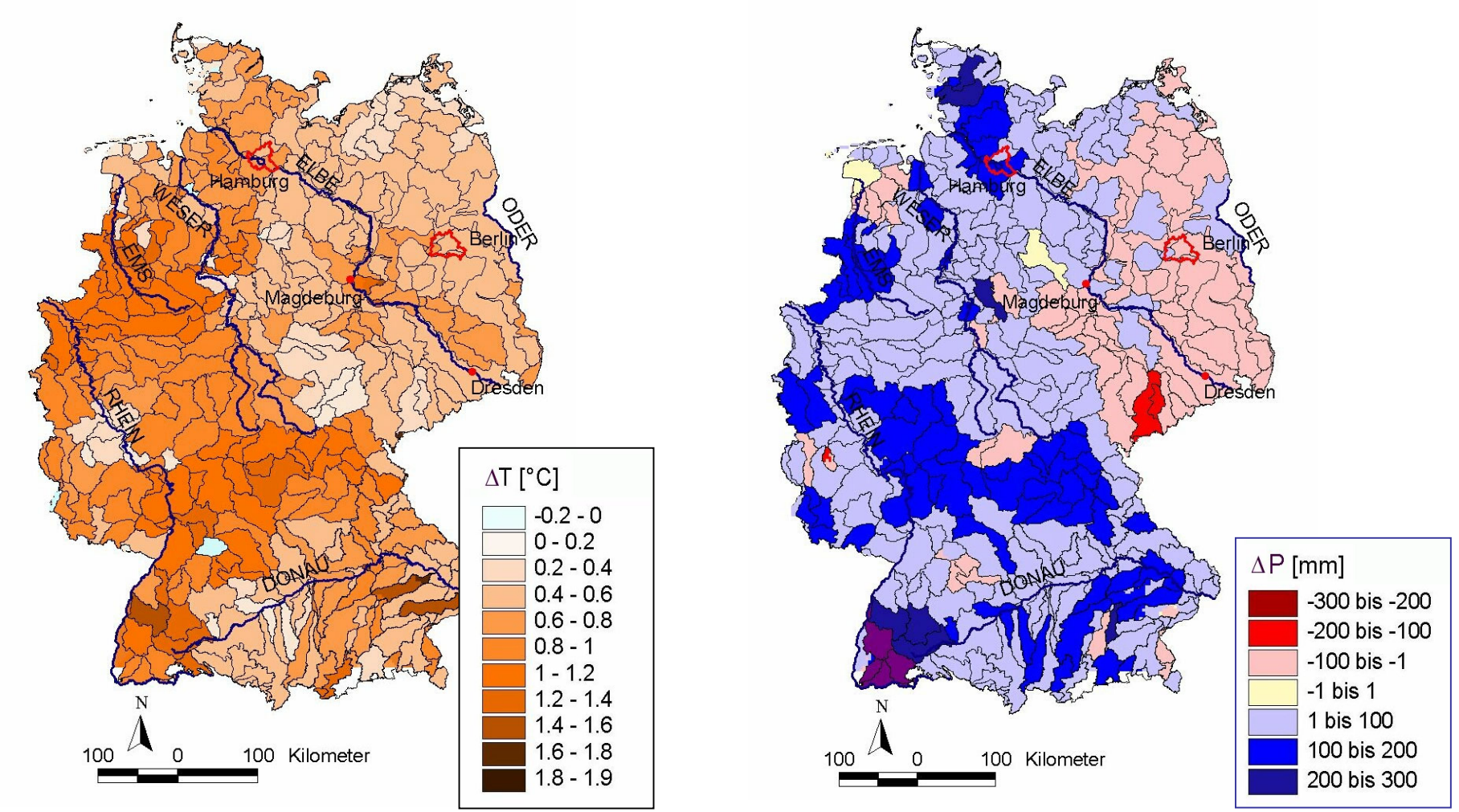
Climate change since 1900 – precipitation



Quelle: Deutscher Wetterdienst, Mitteilung vom 15.06.2004

- Slight increase but no significant trend
- In the last 30 years: Shift of precipitation to winter season
- High variability (inter-annual, seasonal, regional)

Climate change since 1900 – spatial distribution



a) Mean annual temperature (ΔT) b) Annual precipitation (ΔP)

(from DWD data, after Gerstengarbe et al. 2003)

Climate change since 1900 – extreme events

- More heat extremes (e.g. hot day and moth)
- Less cold extreme (e.g. ice days)
- More extreme precipitations in winter
- In summer: likely higher frequency of weather conditions with extreme precipitations
- Frequency of storms: No evidence of increasing frequency

Exposure: Climate Change in Germany

Future Scenarios (-2080)

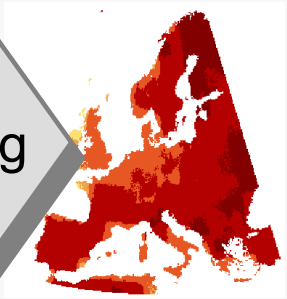
Multiple scenarios of global change from ATEAM

7 Scenarios		4 General Circulation Models (GCMs)			
		CGCM2	**CSIRO2**	**HadCM3**	**PCM**
4 SRES Scenarios	**A1f**			X	
	A2	X	X	X	X
	B1			X	
	B2			X	

ATEAM
Advanced Terrestrial Ecosystem Analysis and Modeling

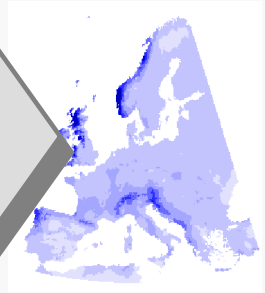
www.pik-potsdam.de/ateam

Downscaling



7 climate scenarios
+ land use
+ nitrogen
+ ...

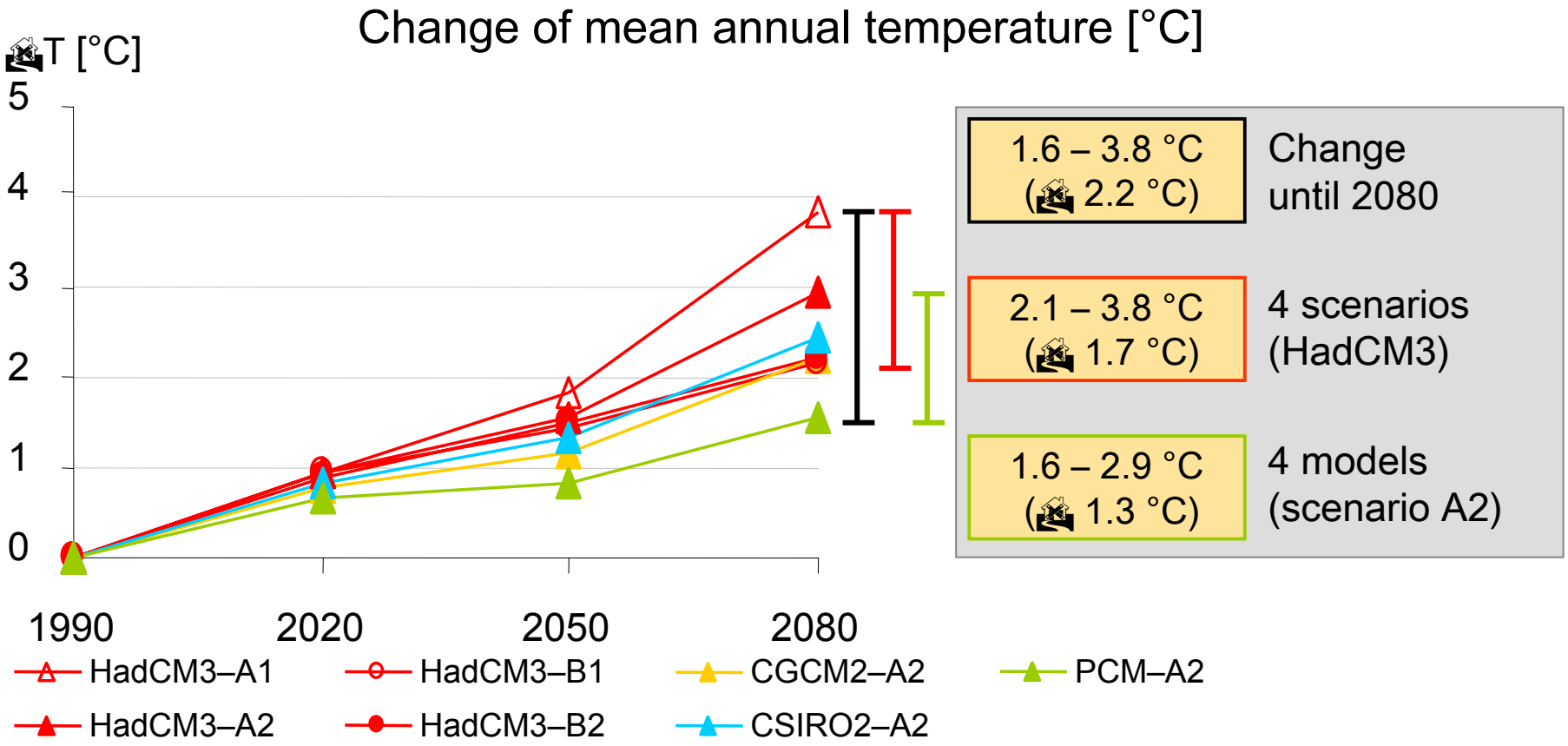
Ecosystem models



Impact on Ecosystem Services

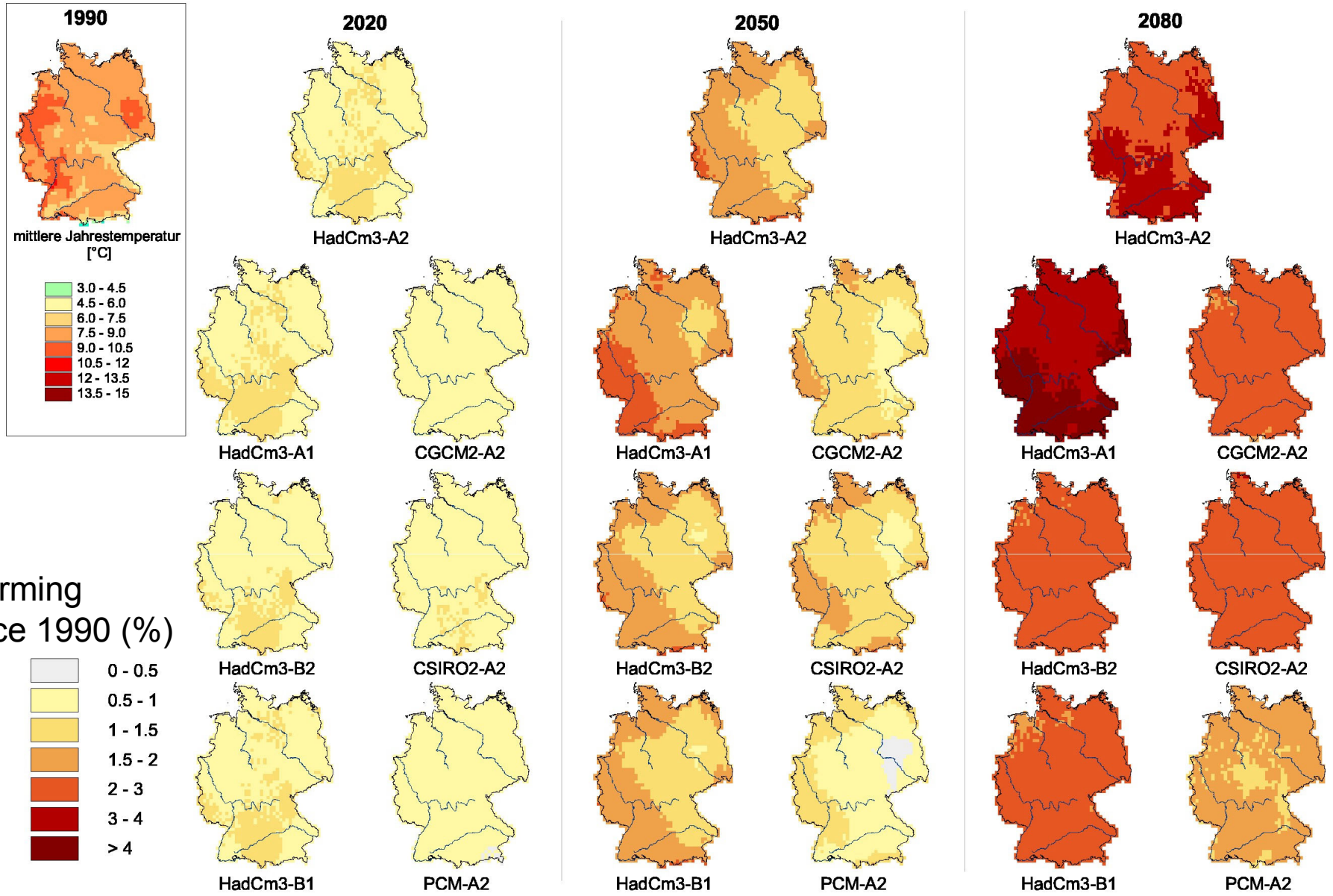
- Spatial extend: Europe
- Spatial resolution: 10‘x10‘ (ca. 15x15km)
- Temporal resolution: monthly means until 2100; 30 year means for 2020, 2050, 2080

Mean annual temperature

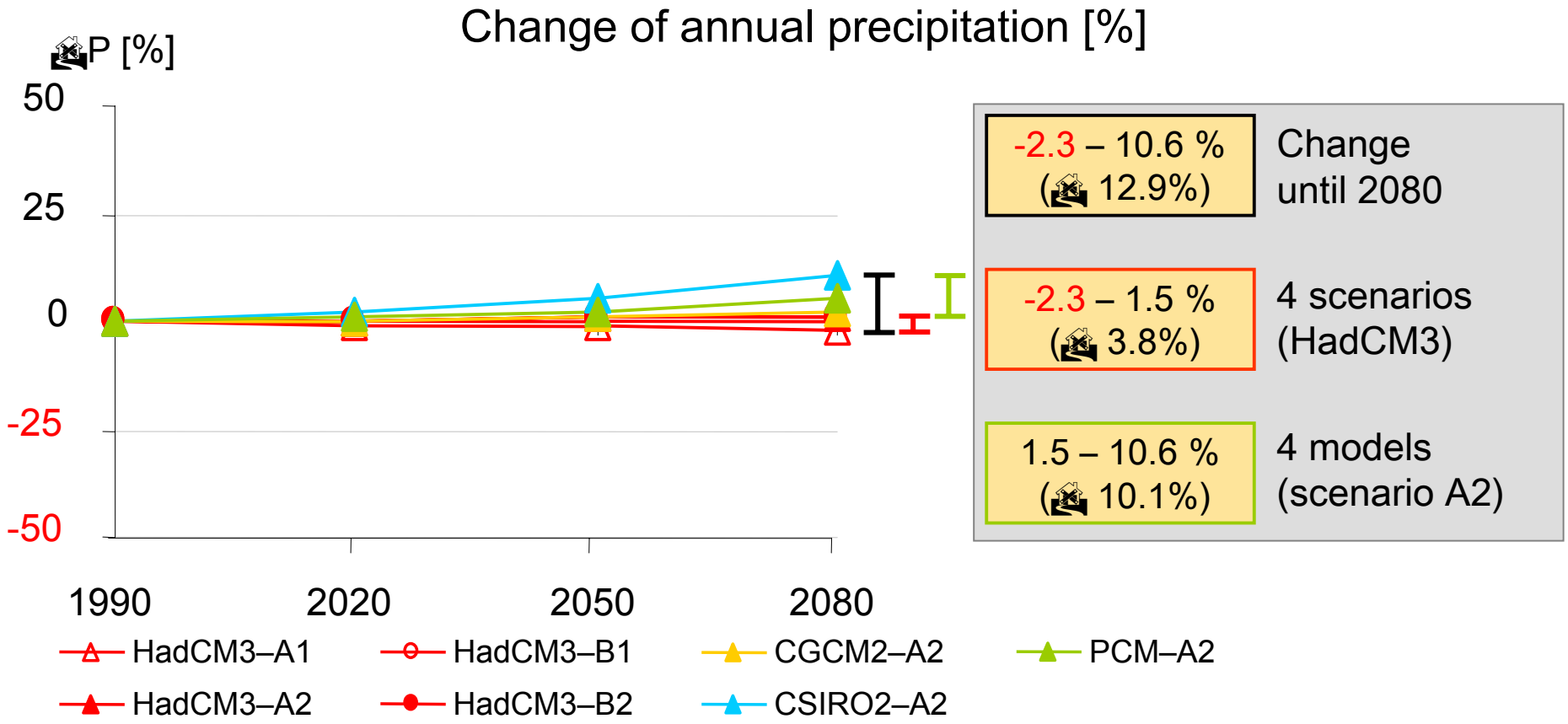


- Significant increase in all scenarios
- Uncertainty: SRES-scenarios > GCM
- In many scenarios: warming in SW-Germany extraordinary high

Mean annual temperature - map

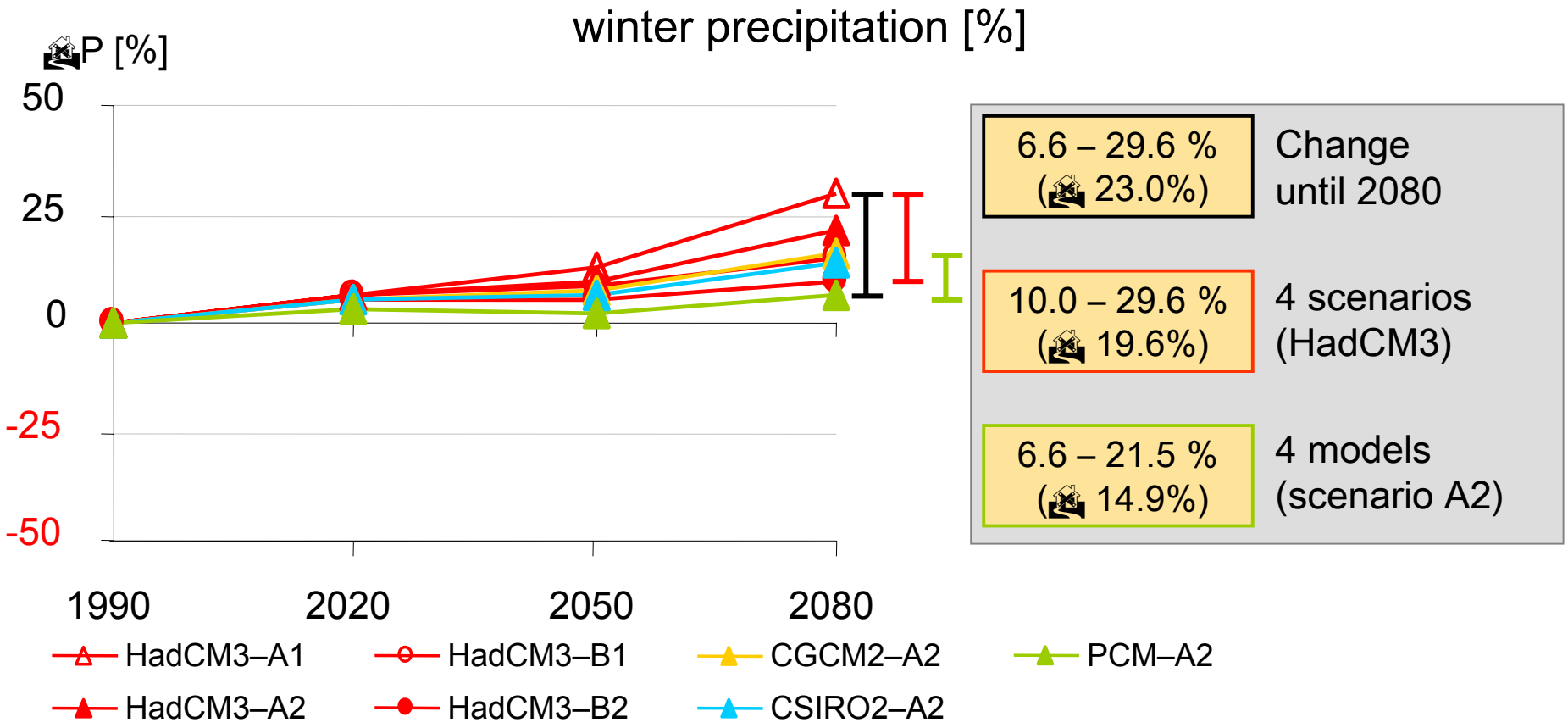


Annual precipitation



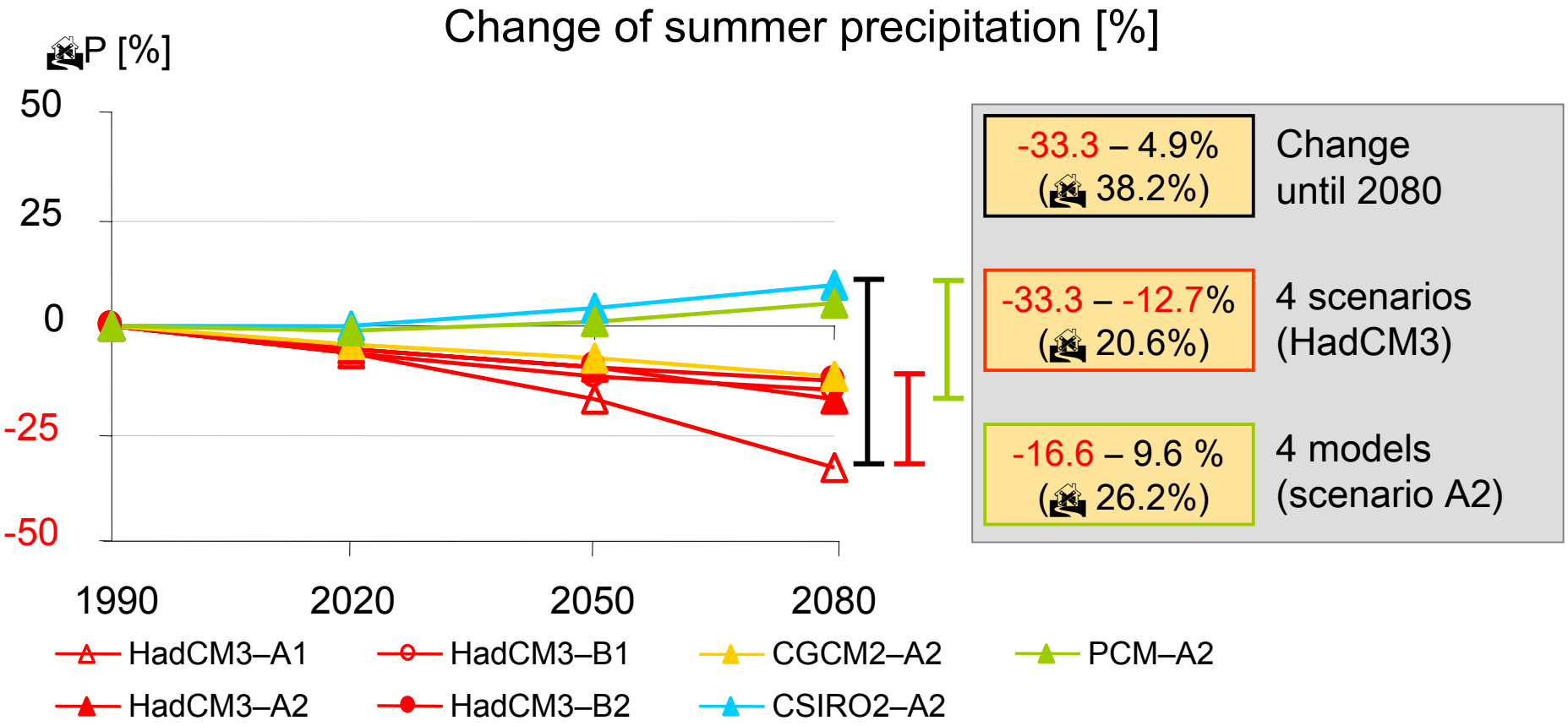
- Very little change (< 10%)
- Uncertainty: GCM > SRES-scenario
- Spatial distribution of trend uncertain

Winter precipitation



- Increase of winter precipitation in all scenarios

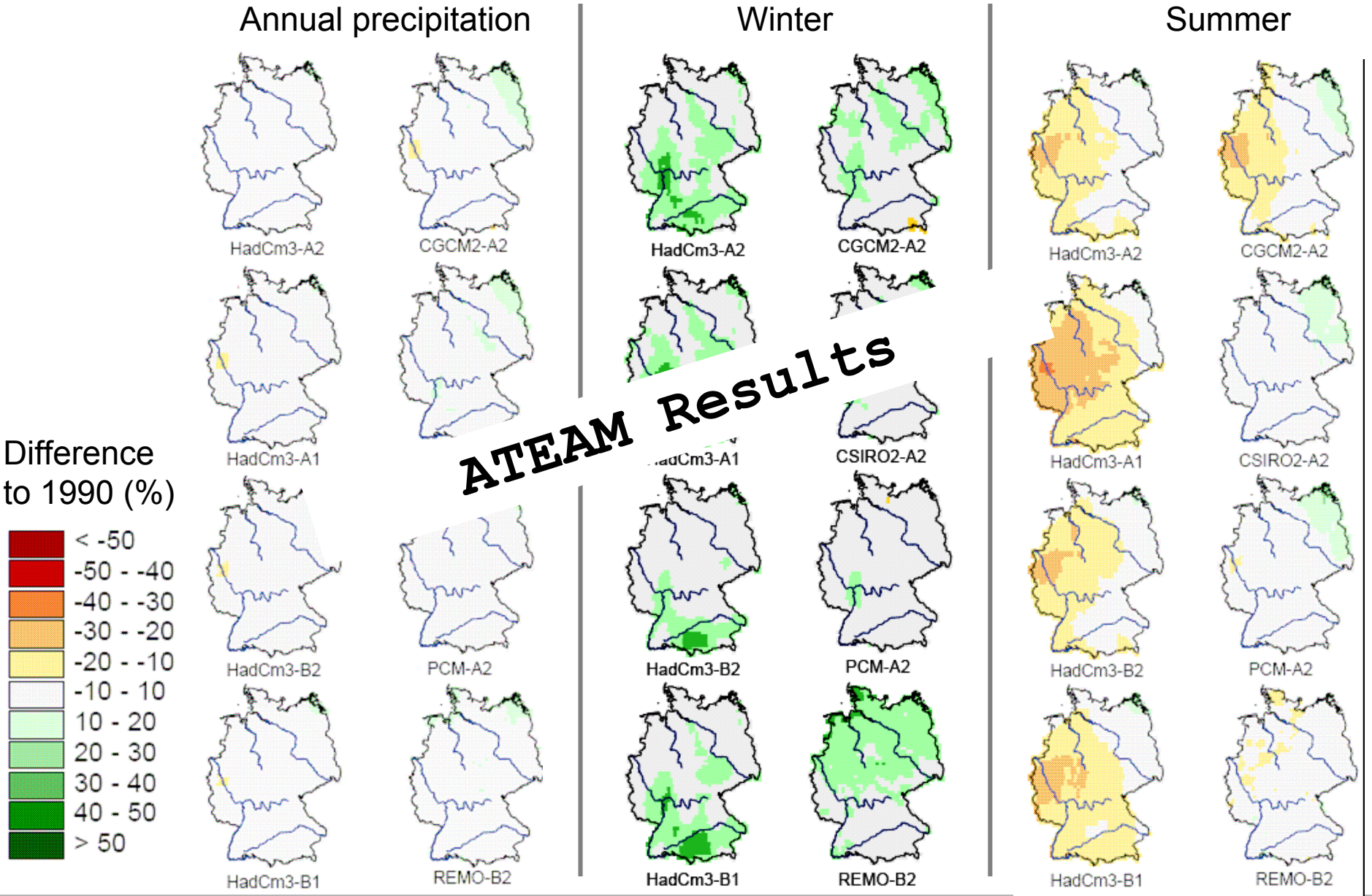
Summer precipitation



- Increase of winter precipitation in all scenarios
- Decrease of summer precipitations in many scenarios

↝ Shift of precipitation from summer into winter likely

Precipitation – change until 2050



Extreme events

- Expectation: Continuation of recent trends
- More heat extremes (e.g. hot day and moth)
- Less cold extreme (e.g. ice days)
- More extreme pre
- In summer: like equency of weather conditions with extreme precipitations
- Frequency of storms: No evidence of increasing frequency

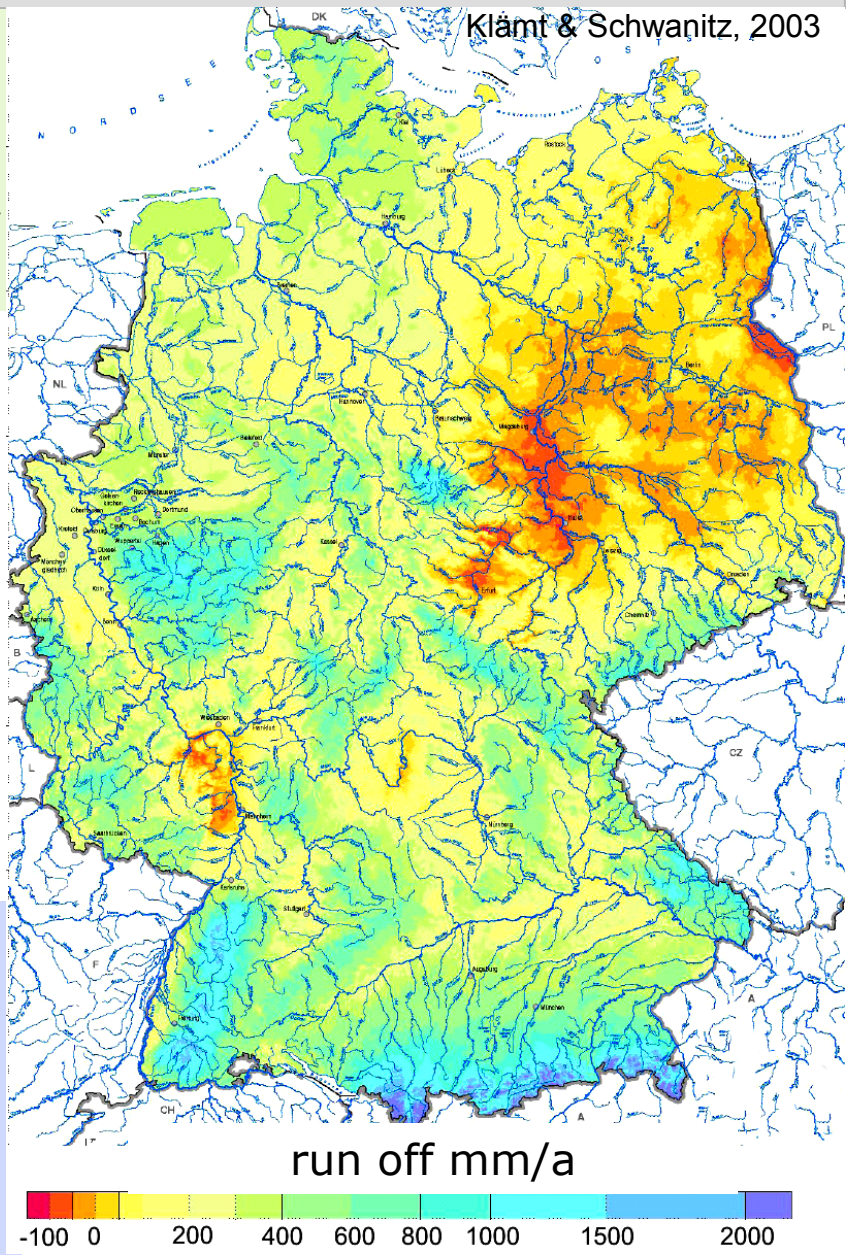
Qualitative expert statements

Impacts I

Topic: Water

Run off – status quo

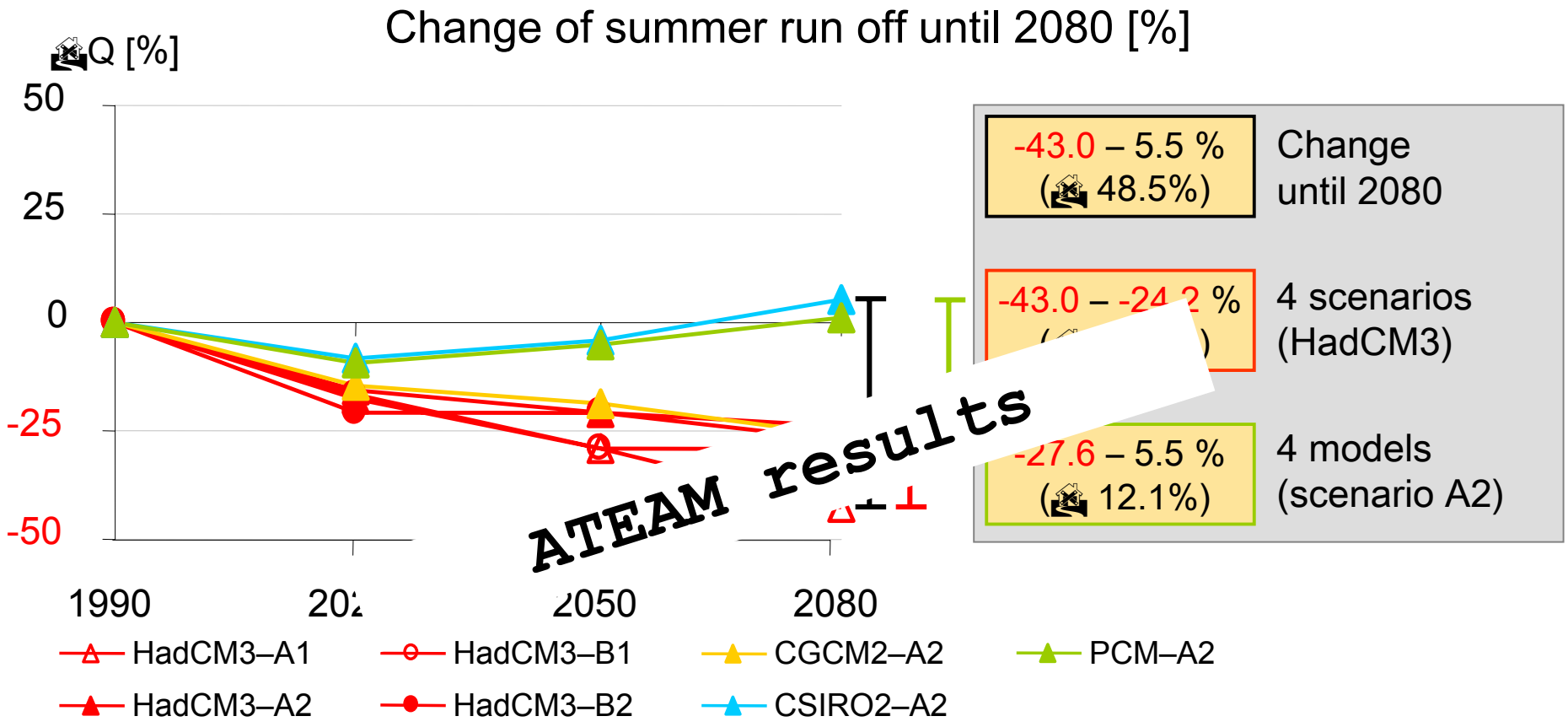
Run off
= precipitation – evapotranspiration
Indicator for water surplus and availability



<u>Status quo</u>

- All year: suboptimal conditions mainly in East Germany
- In summer: suboptimal in many regions

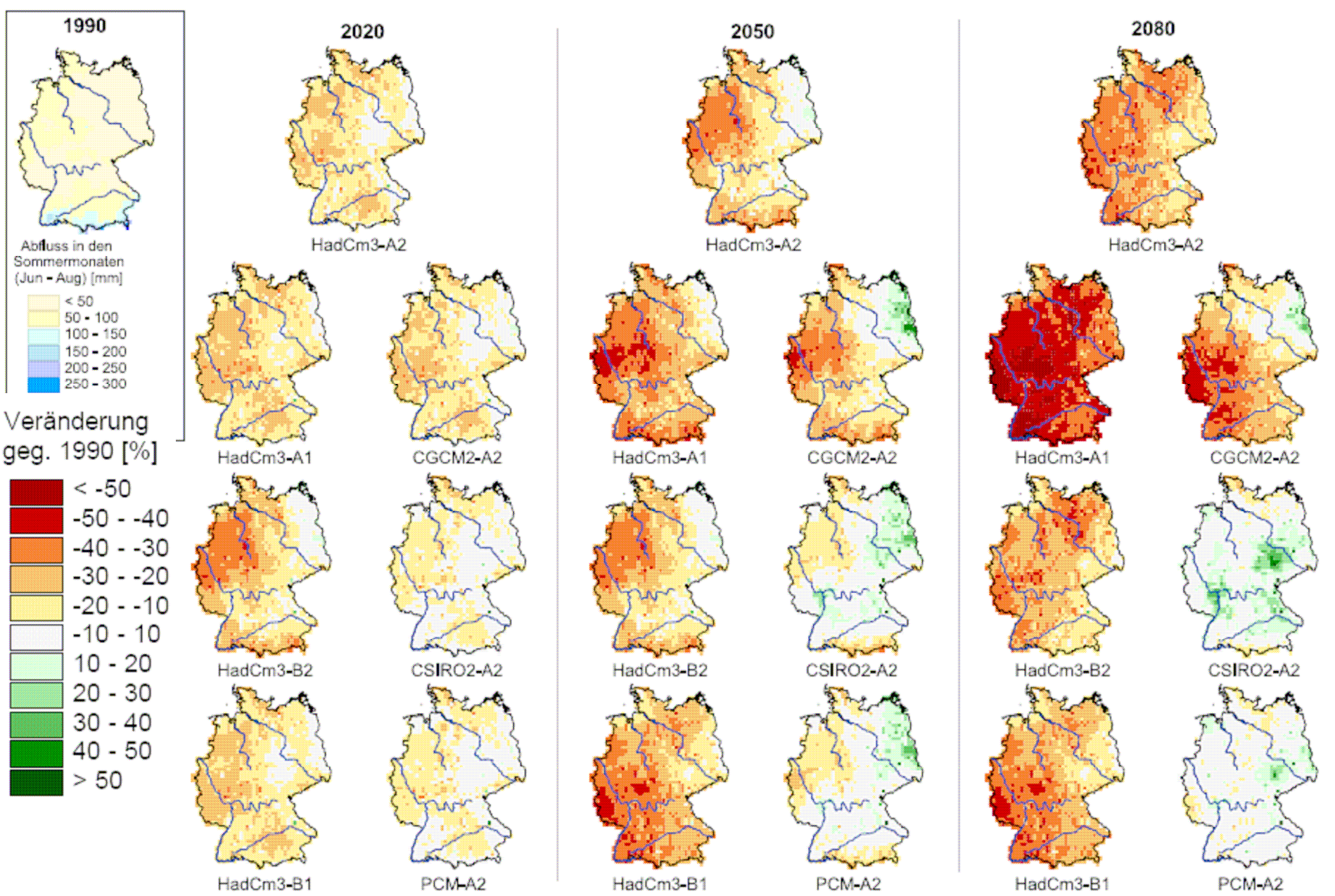
Run off – scenarios



scenarios

- Decrease of water availability in summer
- Risk of droughts and lowering of groundwater level
- Affected: agriculture, forestry, energy production, industry, water transport ...
- Highly affected: large parts of East Germany

Change of summer run off until 2080 [%]



River floods – causes and status quo

Causes for river floods

- Precipitation
  - advective (continuing rain in larger areas): river floods in large catchments
  - convective (local extreme precipitation): river floods in small catchments
- Melting water

Rhine: 1993,1995
Oder: 1997
Danube: 1999, 2002
Elbe: 2002

Status quo

- remarkable accumulation of '100 year river floods' in the 90'th

River floods – scenarios

Mean monthly run off (Rhine, gauge Kaub)

scenarios

- Increase of flood risk mainly in winter and spring (shift of precipitation, increase of extreme events)
- High uncertainty about summer river floods
- Lower flood risk due to melting water
- Regional scenarios uncertain (cause: precipitation scenarios)

Water – summary and vulnerability

- Main impacts:
  - Risk of river floods:
    - late winter to early spring. Summer uncertain.
    - Regions: All regions. Particular: Alpine region
  - Water shortage
    - In summer
    - Regions: East Germany
- Adaptation
  - River floods: medium (CC often not considered)
  - Water shortage: low
- Vulnerability
  - River floods: high in all regions
  - Water shortage: high in central East Germany

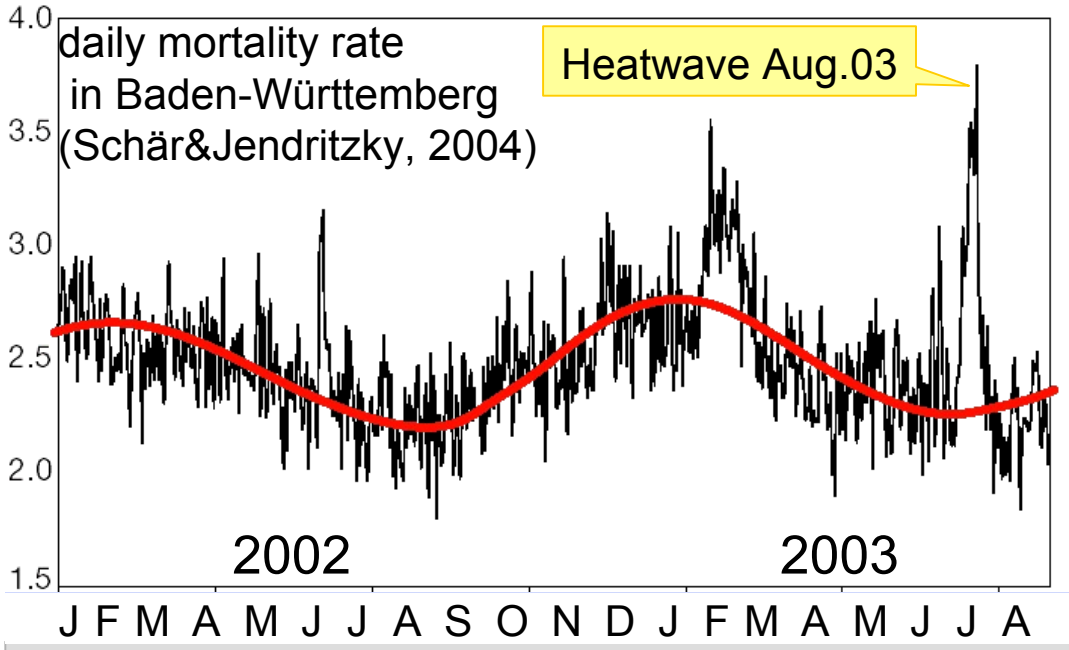
Impacts II

Topic: Human Health

Human health – status quo

General climate impact

- Heat: cardiovascular system, respiration
- Cold: frostbite...
- Vector borne diseases: tics (Lyme borreliosis), mosquitoes..
- Air: ozone, allergens (pollen)
- Water: water quality (cyanic alga)
- Extreme events (river floods, storms, ...)



Status quo

- heatwave 2003:
  min. 7000 death in Germany
- 50‘000 borreliosis cases/year
  (and high estimates of undetected cases)

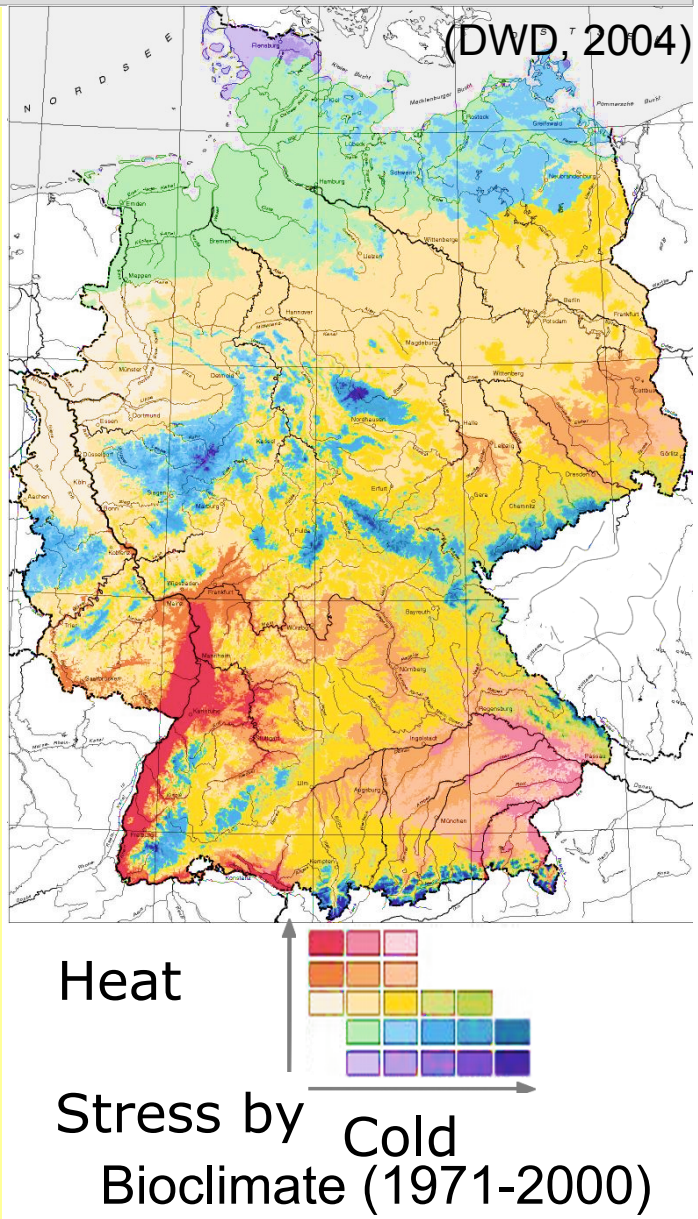
Human health (projections)

projections (no model results!)

- Increasing heat related problems
- Hot spot: SW-Germany (Upper Rhine)
- affected groups: elderly and ill people
- Decrease of stress by cold

- Vector borne diseases:
  - Risk by migration of vectors to the North and in higher altitudes
  - Risk of new vectors (e.G. Anopheles)
  - Risk by higher infections rate

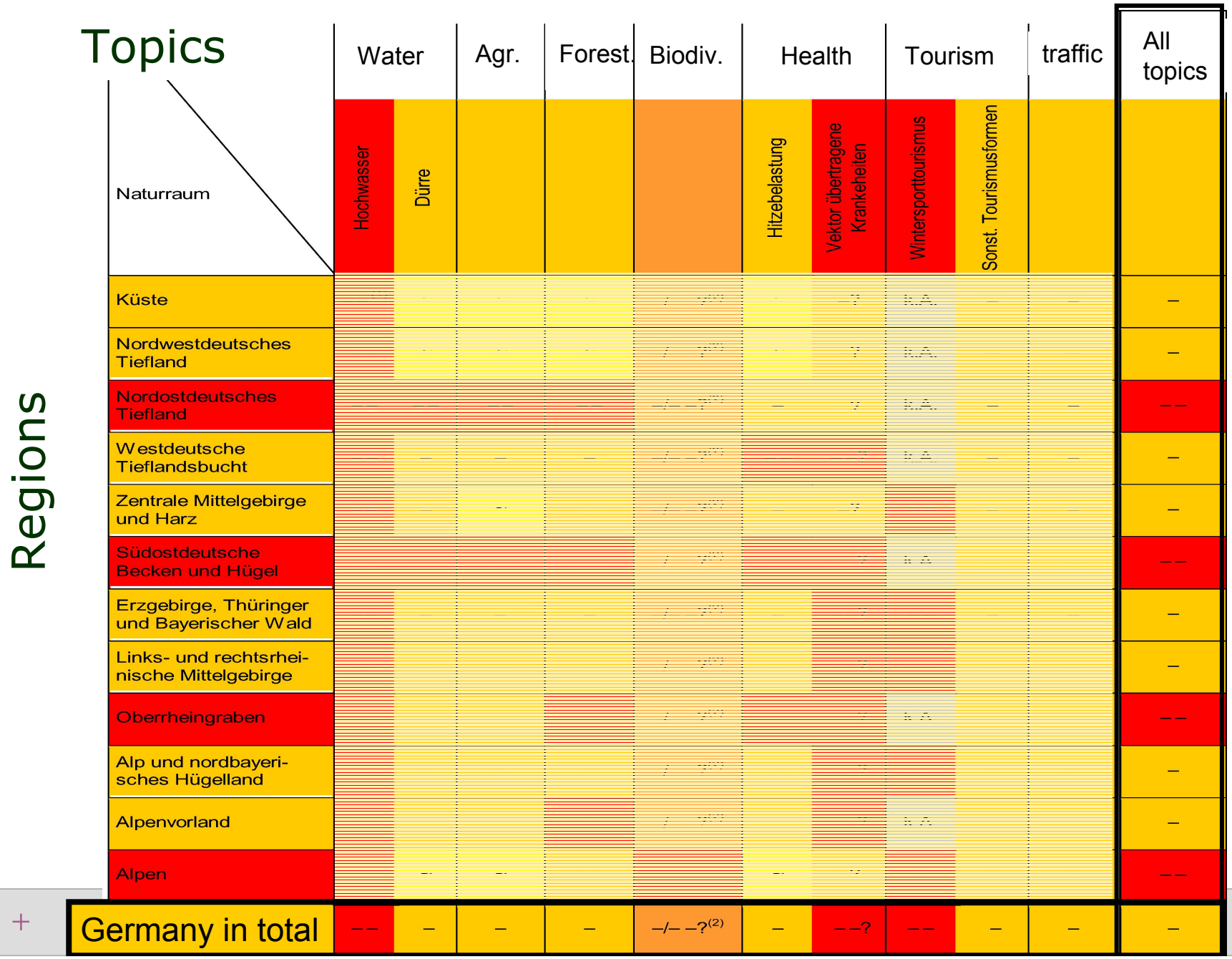
☞ High uncertainty, high risk



Human health – summary and vulnerability

- Main impacts
  - Heat related problems
    - Regions: South-West (South-East)
    - Group: Elderly and ill people
  - Vector borne diseases
    - High uncertainty, mainly in warmer regions with mild winters
- Adaptation
  - Heat: medium (since 2003: warning system)
  - Vector borne diseases: very low
- Vulnerability
  - Heat: high South-West and South-East
  - Vector:high in warmer regions

Vulnerability table



1)Concept - where we started and where we end up

2)Results from the study

3) Conclusion

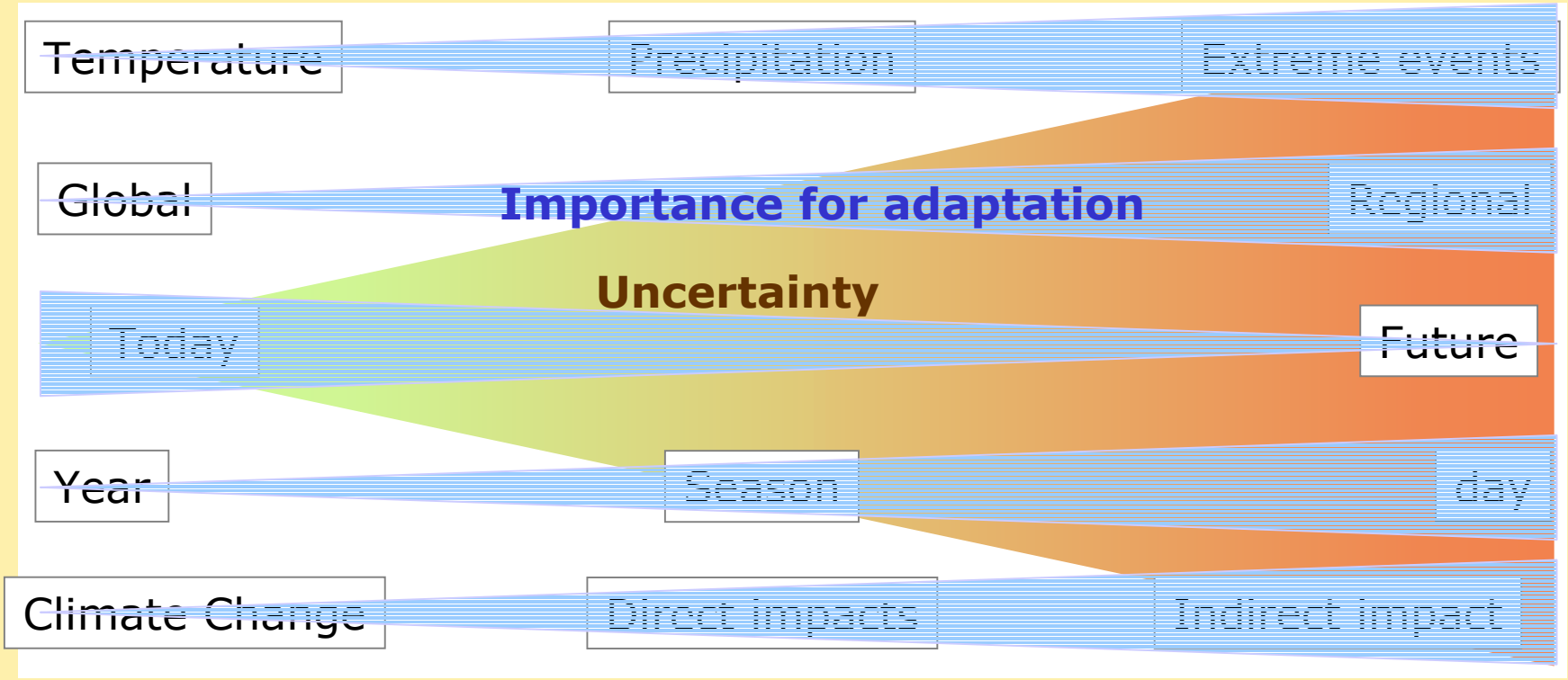
General concept

- Don’t be afraid of qualitative approaches
  - Uncertain numbers allow only qualitative statements too
  - Complex phenomena can often only be assess qualitatively
  - Hot topics are often complex
- Multi scenarios approach reveals uncertainties
- Don’t be afraid of contradictions
- learn from historical trends and events
- Diversify your methods or at least: compare to others

Uncertainty is everywhere

Uncertainty in information and knowledge on:

- Trends of driving forces (CO2, Land-use) (☞ options for mitigation)
- Climate system and climate impact (complexity of the system)



But: impacts of climate change already apparent

☞ **Adaptation necessary, even under uncertain conditions!**

Results and Communication

- Results
  - Predisposition (status quo) very important
  - Other models, other results
  - Climate change is sometimes just an other driver
  - Climate Change in Germany: Risks and chances

- Communication
  - Uncertainty is difficult to accept (“We have seen more precise results”)
  - Uncertainty is difficult to communicate (“How should I tell this to my minister”)
  - It’s difficult to decide under uncertainty and to adapt to uncertain conditions

Vulnerability

- Critical point: Adaptive Capacity
  - Methodology
  - Consideration of perceived risk
  - Time reference
  - AC per sector
  - Vulnerability assessment: 90% Impact, 10% AC

- Vulnerability adds extra value to impact assessments
  - Example New Orleans
  - In future: more interdisciplinary approaches
- Don’t forget mitigation

Thank you for your attention!