


# Evaluation and Quality Control from a User's Perspective

Reading, February, 2014



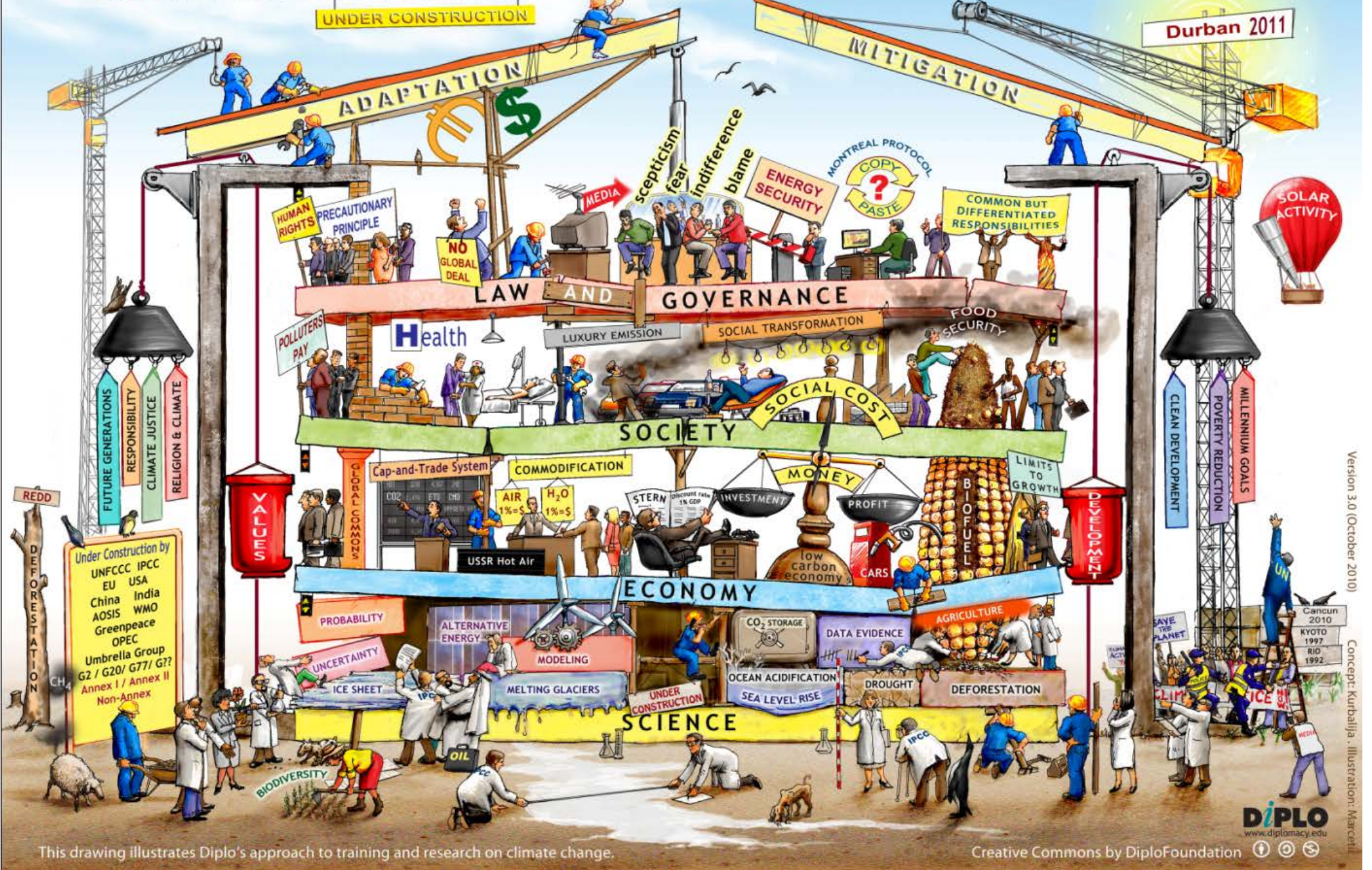
## Introduction

---



# CLIMATE CHANGE BUILDING

UNDER CONSTRUCTION



Version 3.0 (October 2010)

Concept: Kurbaļija - Illustration: Marcell

This drawing illustrates Diplo's approach to training and research on climate change.

Creative Commons by DiploFoundation

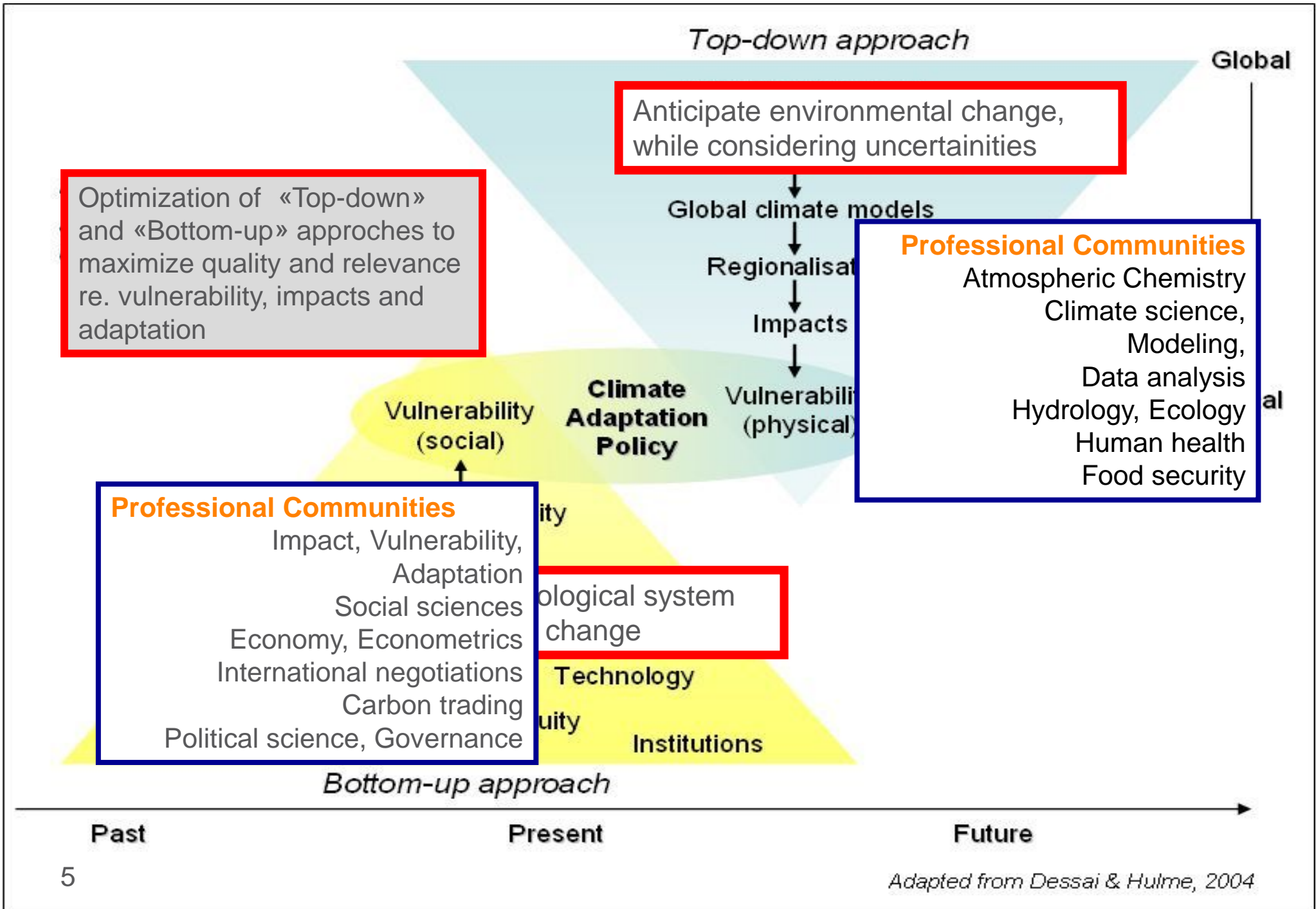
**DIPLO**  
www.diplomacy.edu



# Different Models of Climate Services

- 1. Extension of Meteorological Services
- 2. Development by a university or a group of universities
- 3. Development of expert groups by the private Sector
- 4. Creation of new institutions

# Knowledge in Support of Decision-Making



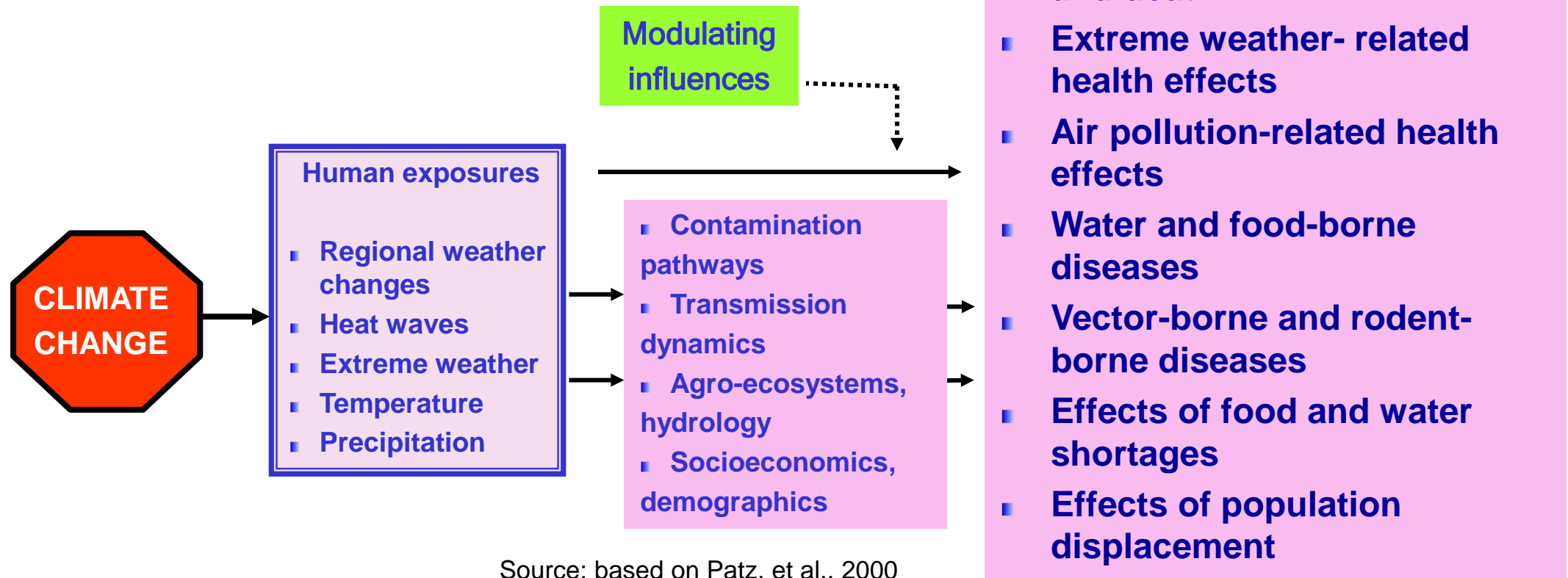
# Example: Climate Change and Health

Three kinds of health impacts have been identified:

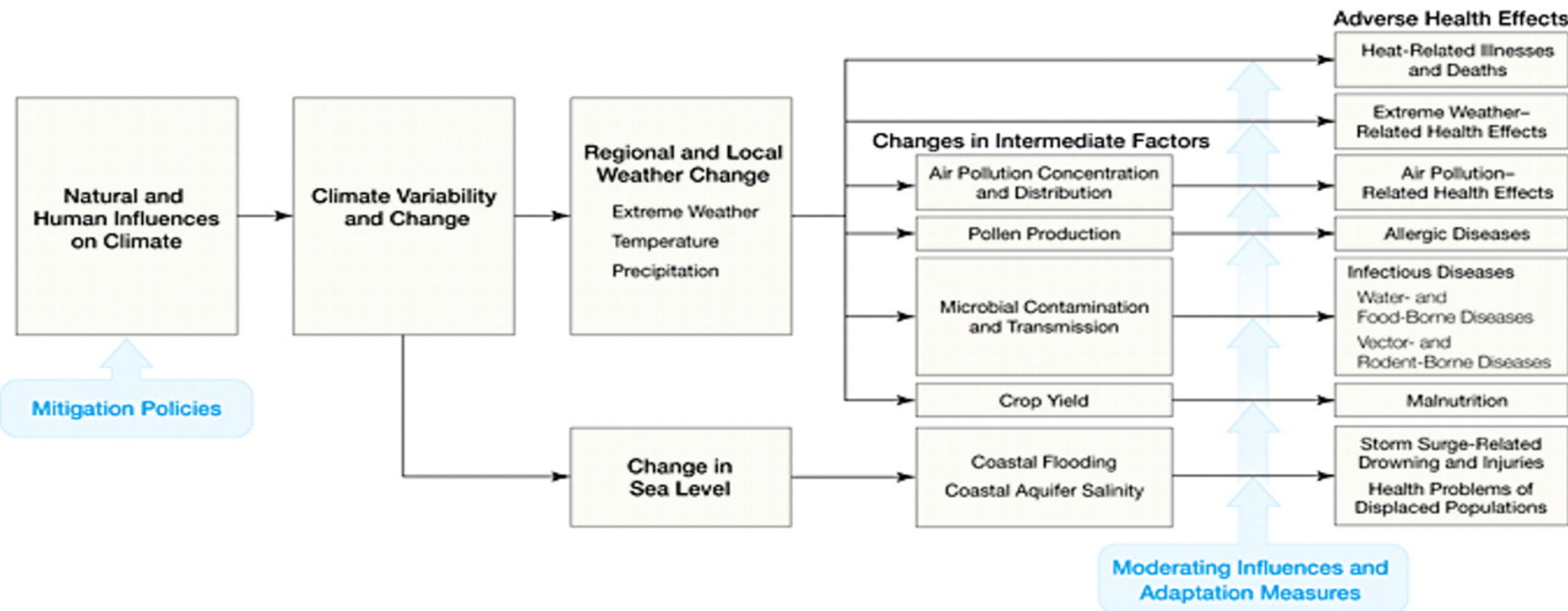
1. Relatively **direct impacts**, usually caused by weather extremes
2. Consequences of environmental change and **ecological disruption** in response to climatic change
3. Consequences that occur when **populations** are **demoralised** and **displaced** by the following climate change induced factors:
  - economic dislocation,
  - environmental decline and conflict situations including traumatic, infectious, nutritional, psychological and other health consequences.

# Mapping Links Between Climate Change and Health

- Most expected impacts will be adverse but some will be beneficial.
- Expectations are not for **new health risks**, but rather changes in frequency or severity of familiar health risks



# Climate Change's Impacts on Health



**Mitigation Policies for Reduction of Greenhouse Gas Emissions**  
 Energy Efficiency  
 Use of Renewable Energy Sources  
 Forest Preservation

**Moderating Influences**  
 Population Density and Growth  
 Level of Technological Development  
 Standard of Living and Local Environmental Condition  
 Preexisting Health Status  
 Quality and Access to Health Care  
 Public Health Infrastructure

**Adaptation Measures**  
 Vaccination Programs  
 Disease Surveillance  
 Protective Technologies  
 Weather Forecasting and Warning Systems  
 Emergency Management and Disaster Preparedness  
 Public Health Education and Prevention  
 Legislation and Administration



## “Customers” and Business Model

---

# Customers for Climate Services

---

## Public Services:

- National/Federal Government
- States and Provinces
- Cities

## Private Sector

- Financial and Insurances
- Infrastructure
- Agriculture, food, forest
- Tourism, logistics

## Non-Governmental Organizations

- Developed countries
- Developing countries

## Scientific Community

- Applied bio-physical sciences
- Vulnerability, Impacts, Adaptation

## Broader Public

No single product for all customers but a multitude of products tailored to the needs of the users

# ACCELERATING INNOVATION IN CLIMATE SERVICES

## The 3 E's for Climate Service Providers

**Engagement, Entrepreneurship, and Evaluation** are the keys to innovative and transformative services that will help citizens, businesses, and governments manage climate risks.

Mark s. Brooks, MBA  
BAMS, 2013

**TABLE I. Summary of the three E's for climate service providers.**

Brooks, 2013

<b>Area of importance</b>	<b>What it is</b>	<b>Why it is important</b>	<b>How to do it</b>
<b>Engagement</b>	Partnership between provider and client; core competency of climate services.	<ul style="list-style-type: none"> <li>• Builds trust between provider and client.</li> <li>• Supports learning of client needs and sensitivities to climate change.</li> </ul>	<ul style="list-style-type: none"> <li>• Identify society's climate sensitivities and information needs.</li> <li>• Increase climate literacy.</li> <li>• Actively engage sectors of the economy, build trust and collaborative relationships.</li> <li>• Catalog capabilities of all climate service providers, research, and datasets.</li> <li>• Connect research to product ideas and market needs (TPM) model.</li> </ul>
<b>Entrepreneurship</b>	Being innovative, creating something new with limited resources, and organizing social and economic mechanisms to turn resources and situations into practical outcomes.	<ul style="list-style-type: none"> <li>• Innovative accomplishments are strikingly entrepreneurial.</li> <li>• Entrepreneurial process can help climate service providers innovate better.</li> </ul>	<ul style="list-style-type: none"> <li>• Adopt management strategy and structure that support entrepreneurship.</li> <li>• Nine areas of strength are needed by climate service providers: communication, integrity, focus, adaptability, cohesion, tolerance of failure and ambiguity, hands-on management, reward, and intellectual property protection.</li> </ul>
<b>Evaluation</b>	Series of performance metrics that enable self-evaluation and self-improvement.	<ul style="list-style-type: none"> <li>• Funding sponsors will expect a return on investment.</li> <li>• Continuous improvement is necessary.</li> </ul>	<ul style="list-style-type: none"> <li>• Balanced scorecard.</li> <li>• Logic models.</li> <li>• Record testimonials about the value of climate services.</li> </ul>



# Market for „Climate Services“ (1)

## Climate change mitigation

- Need for consultation due to numerous different regulations
- Covered by well-established private consulting and service companies

## Adaptation to climate change

- Impacts of long-term climate change are currently still not company relevant
  - Potential clients have not yet developed awareness for importance of adaptation
  - New or little developed market
- Awareness raising **by providing targeted and individual advice**
- Considerable effort necessary regarding **marketing and education** of customers and users.

# Market for „Climate Services“ (2)

## Economic sectors with substantial need for Climate Services

...have to deal with **long-term investments**, e.g.

- Water management (great potential), forest management
- Infrastructure, real estate and urban development
- Investment banks and insurances

## Economic sectors with currently low demand for Climate Services

...need primarily **short-term projections** (seasonal to decadal predictions) or depend on short-term weather or hydrological variations, e.g.

- Logistics, transport
- Tourism
- Agriculture (partially)

# Service Portfolio and Business Model

## Development and innovation

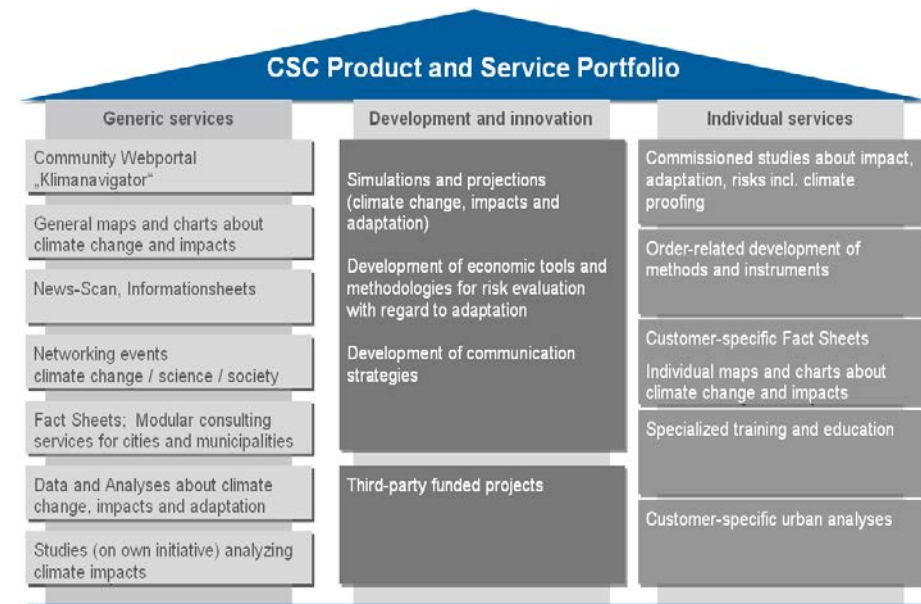
Evolution of methodologies, instruments and skills, for (1) conception development for climate services, (2) generation of new products and services and (3) improvement of knowledge transfer and communication

## Generic services:

Freely available products and services, free of charge

## Customer specific, individual services

**(usually liable to pay costs):** Order-related, target group addressed products and services, subject to a charge



Product examples

## Business Model

---

To what degree does CCS develop its **own products and services**, its own market with an **aggressive marketing strategy** and customer relations, sectoral networks?

Or is CCS the **data keeper for others** who will develop products and services?

Or does CCS **develop prototype products and services** and let others (e.g., national climate services) to work with users and customers?

**What is the business model?** Free generic products accessible to all and individual customer-specific products against retribution?

---



**What are the  
questions of the  
“customers”?**

---

## Which Information ?

---

**Not many customers require generic data** from a large database. They require analyses and **expert judgment** using data and other information.

The questions involve local aspects, but at a location that may be well outside Europe since the **economy is global** and corporations operate in many regions of the world.

The customers require information about the **robustness** of the data and information about **uncertainties**.

---

# An Example: Information required by an Investment Bank

---

Project Managers must assess if proposed **investments make sense from the climate point of view.**

These managers have no expertise in climate science. They do not know where and how to access data.

Raw data is not helpful. Information must be pre-digest and easily understandable.

**Climate Services are asked to provide fact sheets** with brief information on present and future climate, including the robustness of the information.

---

# Climate-Fact-Sheets

## Summarizing climate change information

### Example pages of the Climate-Fact-Sheet for Pakistan



**Aim:** Concise summary of available state-of-the-art climate change information for a country/region

**Current climate**

Observed mean values are taken from literature and available global data sets (averaged over the whole country).

- Major climate zones (see also climate diagrams - CD1-3): Northern half of the country is semi-arid (BSn - see CD3) to humid (Ch - see CD1). Southern half of Pakistan is mostly arid to hyper arid (BWh - see CD3).
- Annual mean temperature: -20 °C
- Annual total precipitation: ~300 mm/yr
- Annual mean actual evaporation: ~300 mm/yr (Annual mean potential evaporation is ~1900 mm/yr)
- Annual mean climatic water balance: -0 mm/yr
- Intensity of heavy rain events\*: 3.1 mm/yr
- Mean duration of dry spells\*: 115 days
- Mean duration of "heatwaves":\* 8 days
- Mean duration of cold spells\*: 10 days
- Annual mean solar irradiance (surface): 1500 kWh/(m<sup>2</sup> and yr)
- Annual mean wind speed (10 m above surface): 2.5 m/s

Reported recent extreme events:

- Pakistan was hit by a major flood in 2010 that affected more than a 18 Million people and had an economic damage of about 9.5 Billion US\$.

The climate parameters marked with \* are defined in the manual 'How to read a Climate-Fact-Sheet'. Whenever mentioned in the fact-sheet, statistical significance is indicated at the 95 percent confidence level. The description of the climate zones is based on the Köppen-Geiger climate classification.

**Historical climate trends (based on the global CRU data set and literature sources)**

- Spatially averaged over the whole country mean annual temperature has slightly increased by approximately 0.6 °C since the beginning of the 20<sup>th</sup> century. However this increase is over major parts of the country statistically not significant.
- Significant (above average) annual mean temperature increase has been observed in the south-western provinces.
- A slight decrease in annual mean temperature has been observed in the sub-montane zone and western highlands in the north.
- No. of cold (warm) nights has generally decreased (increased) over Pakistan in the period 1961 to 2000, however a station in the greater Himalayas in the north showed opposite behaviour.
- Spatially averaged annual total precipitation has slightly increased when the full 20<sup>th</sup> century is considered. Strongest increase is observed in the northern parts of Pakistan, where precipitation significantly increase by 15 to 25 percent mainly during the monsoon season. Negative rainfall trends are observed in the southern parts.
- For the period 1976 to 2005, however a decreasing rainfall trend (-1.2 mm/decade) is observed when averaged all over the country, which may be attributed to the presence of drought period during 1998-2001.
- No coherent trends are seen with respect to observed changes in precipitation extremes for the period 1961-2000.

**Summary of projected future climate (for the end of the century and combined for all scenarios)**

**Temperature** The median projection of change in annual mean temperature is for an increase of 3.8 °C by 2100, with projected change very likely to fall in the range from 2.1 to 5.1 °C. Confidence in these figures is high. The change in temperature can be considered to be strong. The median projection of change in maximum temperature is for an increase of 3.4 °C by 2100 and in the minimum temperature for an increase of 3.8 °C.

**Heatwaves** The median projection of change in the duration of long-lasting heatwaves is for an increase of 28 days by 2100, with projected change very likely to fall in the range from 11 to 69 days. Confidence in these figures is medium. The change in the duration of long-lasting heatwaves can be considered to be strong.

**Cold spells** The median projection of change in the duration of long-lasting cold spells is for a decrease of 4 days by 2100, with projected change very likely to fall in the range from -11 to +1 days. Confidence in these figures is medium. The change in the duration of long-lasting cold spells can be considered to be strong.

**Solar irradiance** The median projection of change in annual mean solar irradiance is for no substantial change until 2100, with some projections showing an increase and some a decrease. Projected change is very likely to fall in the range from -6 to +1 percent. Confidence in these figures is medium. The change in annual mean solar irradiance can be considered to be weak.

**Precipitation** The median projection of change in annual total precipitation is for no substantial change until 2100, with some projections showing an increase and some a decrease. Projected change is very likely to fall in the range from -25 to +26 percent. The projected change in precipitation is for a decrease in the first half of the year (January to May - up to -17%) and a slight increase in the second half (up to +12 percent). Confidence in these figures is low. The change in annual total precipitation can be considered to be weak.

Climate-Fact-Sheet Pakistan 2

**Legend** Statistical information: very likely (light-coloured, 95 % of model simulations), likely (dark-coloured, 66 % of model simulations)

Median (50 percent value of model simulations)

Emission scenarios: all scenarios combined, low scenario (B1), medium scenario (A1B), high scenario (A2)

**Projections of possible development of temperature, heatwaves and cold spells**

**Annual mean temperature**

- Median projection of change in annual mean temperature is for an increase of 3.8 °C by 2100.
- Likely range: 2.8 to 4.8 °C, very likely range: 2.1 to 5.1 °C
- Separate scenario examination (by 2100):
  - Low-Scenario B1: Median +3.0 °C
  - High-Scenario A2: Median +4.7 °C

**Maximum and minimum temperature**

The trends of maximum and minimum temperature are consistent with the trend of annual mean temperature depicted above.

- Median projection of change in maximum temperature is for an increase of 3.4 °C by 2100.
- Median projection of change in minimum temperature is for an increase of 3.8 °C by 2100.

Scenario	Measure	Max-Temperature	Min-Temperature
ALL	likely	2.8 to 4.4	2.8 to 5.0
	very likely	1.9 to 5.6	2.1 to 5.8
B1	likely	1.9 to 3.3	2.2 to 3.4
	very likely	1.0 to 4.3	2.1 to 4.3
A1B	likely	2.8 to 4.4	3.1 to 4.8
	very likely	2.0 to 5.6	3.1 to 5.8
A2	likely	3.4 to 4.9	3.9 to 6.2
	very likely	+	+

**Heatwaves**

- Median projection of change in the duration of long-lasting heatwaves is for an increase of 28 days by 2100.
- Likely range: 14 to 51 days, very likely range: 11 to 69 days
- Separate scenario examination (by 2100):
  - Low-Scenario B1: Median +13 days
  - High-Scenario A2: Median +42 days

**Cold spells\***

- Median projection of change in the duration of long-lasting cold spells is for a decrease of 4 days by 2100.
- Likely range: -8 to -3 days, very likely range: -11 to -1 days
- Separate scenario examination (by 2100):
  - Low-Scenario B1: Median -4 days
  - High-Scenario A2: Median -6 days

**Projections of possible development of solar irradiance**

- Median projection of change in solar irradiance is for no substantial change until 2100, with some projections showing an increase and some a decrease.
- Likely range: -3 to 0 percent, very likely range: -6 to +1 percent
- Separate scenario examination (by 2100):
  - Low-Scenario B1: Median -1 percent
  - High-Scenario A2: Median -2 percent

\*Note that it is possible that the absolute decrease in the duration of cold spells might be larger than the actual cold spell length (as given in the current climate record) due to a slight misalignment between model and observations.

All projected changes presented in the Climate-Fact-Sheet are with respect to the reference period from 1961 to 1990. The evaluation of the signal strength includes not only the actual climate change signal but also the statistical significance of the projected change. The assessment of the confidence in the climate model projections is based on the model's performance in simulating today's climate as well as on the bandwidth of projected climate change. This bandwidth results from the fact that every climate model projects a slightly different climate change signal.

Climate-Fact-Sheet Pakistan 4



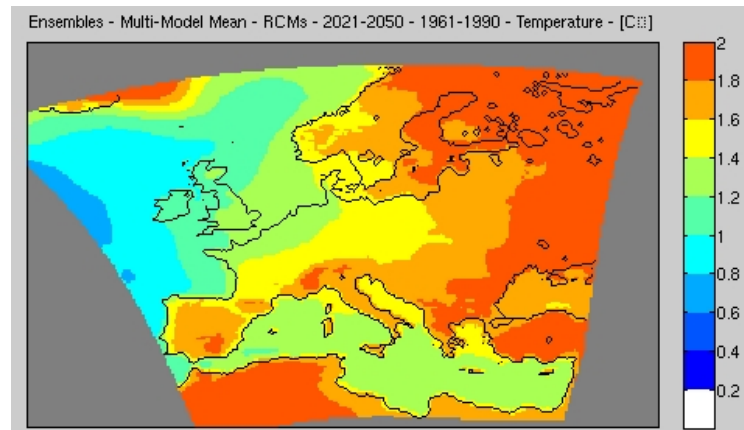
# Data basis of the „Climate-Fact-Sheets“

## Europe

### Daily data of high-resolution climate change projections

- time period from 1960 to 2100
- horizontal resolution 25 x 25 km (50x50 km)
- only one emissions scenario (moderate A1B - Scenario)

**Altogether 20 model simulations available**

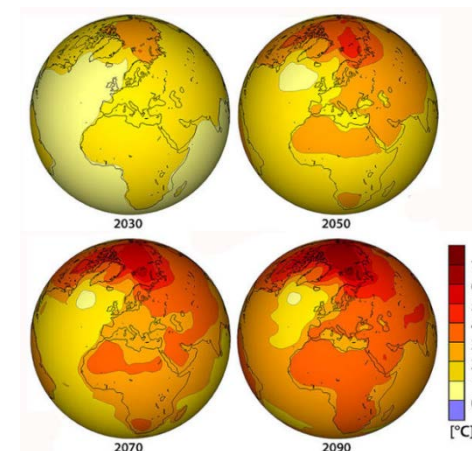


## Globally

### Monthly and daily data of global (low-resolution) climate projections

- Time periods: monthly 1950-2100; daily for three time slices (1961-1990; 2046-2065; 2081-2100)
- Horizontal resolution 100 to 500 km
- Three emission scenarios (low - B1; moderate - A1B; high - A2) with about 20 simulations each

**Altogether about 60 model simulations available**



# Concept of the „Climate-Fact-Sheets“

---

## List of parameters presented in the climate-fact-sheets?

- Temperature (annual mean, minimum and maximum temperatures)
  - Annual total precipitation and the annual precipitation cycle
  - Actual evaporation
  - Climatic water balance (derived from difference between annual total precipitation and annual total actual evaporation)
  - Annual mean wind speed
  - Annual mean solar irradiance
- 
- Heatwaves & cold spells
  - Dry spells
  - Intensity & frequency of heavy rainfall events
  - Intensity & frequency of storm events
- 
- Change in mean sea level (if appropriate)
-

# Concept of the „Climate-Fact-Sheets“

- Concise summary of the major information about the climate of a country for past, current and future development
- Focus of the climate-fact-sheets is on the projected future changes
- Fact-sheets usually have some 4 to 6 pages with short text passages, tables and different diagrams
- Information is based on primary data (e.g. projections from global and regional climate models or continental wide observational datasets) and literature review



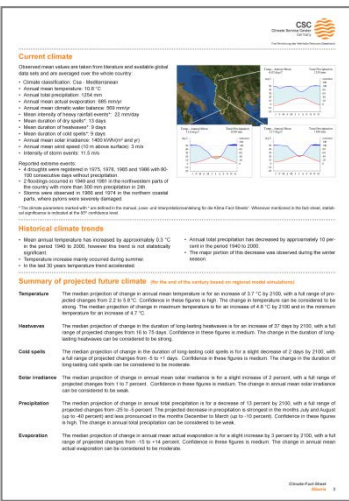
**Climate-Fact-Sheet**

Based on Regional Climate Model Data

**Zusammenfassung**

Abstract

Climate Service Center



**Current climate**

Observed climate indicators taken from literature and evaluated against the actual mean and standard deviation for the country

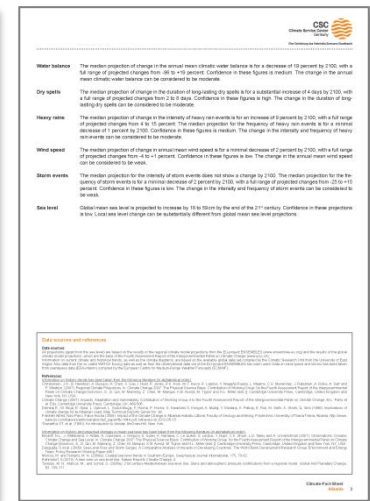
- Climate classification: Cfb, Mediterranean
- Annual mean temperature: 10.2 °C
- Annual mean precipitation: 1026 mm
- Annual mean relative humidity: 69.9 %
- Mean duration of frost-free period: 210 days
- Mean duration of snow-free period: 210 days
- Annual mean lake volume: 442 (km³) and 471 (km³)
- Annual mean lake level: 2.16 m above sea level, 2.16 m

**Historical climate trends**

- Mean annual temperature has increased by approximately 0.3 °C in the period 1960-2020, however the trend is not statistically significant. For the period 1980-2020, however the trend is not statistically significant.
- Mean annual precipitation has decreased by approximately 10% in the period 1960-2020, however the trend is not statistically significant.
- Mean annual relative humidity has decreased by approximately 0.5% in the period 1960-2020, however the trend is not statistically significant.
- Mean duration of frost-free period has increased by approximately 10 days in the period 1960-2020, however the trend is not statistically significant.
- Mean duration of snow-free period has increased by approximately 10 days in the period 1960-2020, however the trend is not statistically significant.
- Annual mean lake volume has increased by approximately 10% in the period 1960-2020, however the trend is not statistically significant.
- Annual mean lake level has increased by approximately 10 mm in the period 1960-2020, however the trend is not statistically significant.

**Summary of projected future climate**

The median projection of change in annual mean temperature for the year 2050 is a slight increase of 0.7 °C by 2100, with a full range of projected changes from 0.1 to 1.4 °C. Confidence in these figures is medium. The change in annual mean lake level is projected to increase by 0.1 m by 2100, with a full range of projected changes from 0.0 to 0.2 m. Confidence in these figures is medium. The change in annual mean relative humidity is projected to decrease by 0.1% by 2100, with a full range of projected changes from 0.0 to 0.2%. Confidence in these figures is medium. The change in annual mean duration of frost-free period is projected to increase by 10 days by 2100, with a full range of projected changes from 5 to 15 days. Confidence in these figures is medium. The change in annual mean duration of snow-free period is projected to increase by 10 days by 2100, with a full range of projected changes from 5 to 15 days. Confidence in these figures is medium. The change in annual mean lake volume is projected to increase by 10% by 2100, with a full range of projected changes from 5% to 15%. Confidence in these figures is medium. The change in annual mean lake level is projected to increase by 10 mm by 2100, with a full range of projected changes from 5 to 15 mm. Confidence in these figures is medium.



**Water balance**

The median projection of change in the annual mean climatic water balance is for a decrease of 10 mm by 2100, with a full range of projected changes from 0 to 20 mm. Confidence in these figures is medium. The change in the annual mean climatic water balance can be considered to be moderate.

**Dry spells**

The median projection of change in the duration of long-lasting dry spells for a slight increase of 4 days by 2100, with a full range of projected changes from 2 to 6 days. Confidence in these figures is high. The change in the duration of long-lasting dry spells can be considered to be moderate.

**Wet spells**

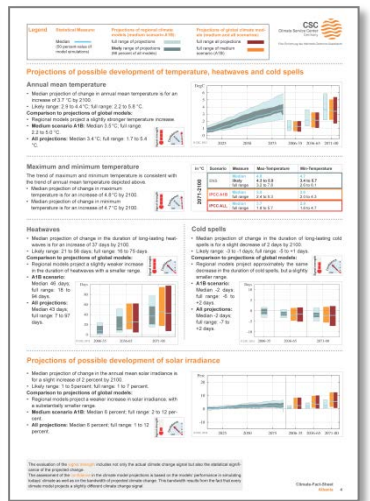
The median projection of change in the duration of long-lasting wet spells for a slight increase of 2 days by 2100, with a full range of projected changes from 0 to 4 days. Confidence in these figures is high. The change in the duration of long-lasting wet spells can be considered to be moderate.

**Storm events**

The median projection for the intensity of storm events does not show a change by 2100. The median projection for the frequency of annual heavy precipitation events is for a slight decrease of 2% by 2100, with a full range of projected changes from 0 to 4%. Confidence in these figures is low. The change in the intensity and frequency of storm events can be considered to be weak.

**Sea level**

Global mean sea level is projected to increase by 18 to 26 cm by the end of the 21st century. Confidence in these projections is low. Local sea level changes can be substantially different from global mean level projections.



**Projections of possible development of temperature, heatwaves and cold spells**

**Annual mean temperature**

- Median projection of change in annual mean temperature is for a slight increase of 0.7 °C by 2100.
- Full range of projected changes from 0.1 to 1.4 °C.
- Confidence in these figures is medium.

**Heatwaves**

- Median projection of change in the duration of long-lasting heatwaves for a slight increase of 2 days by 2100.
- Full range of projected changes from 1 to 3 days.
- Confidence in these figures is high.

**Cold spells**

- Median projection of change in the duration of long-lasting cold spells for a slight increase of 4 days by 2100.
- Full range of projected changes from 2 to 6 days.
- Confidence in these figures is high.

**Maximum and minimum temperature**

- Median projection of change in maximum temperature is for a slight increase of 0.2 °C by 2100.
- Full range of projected changes from 0.0 to 0.4 °C.
- Confidence in these figures is medium.

**Heatwaves**

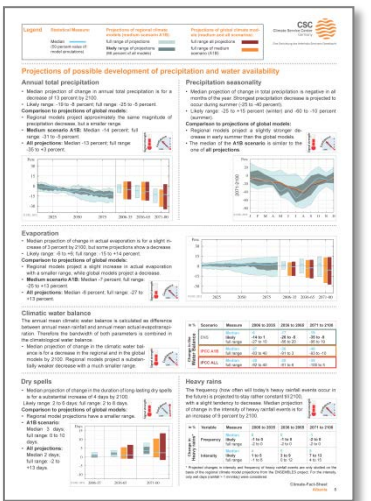
- Median projection of change in the duration of long-lasting heatwaves for a slight increase of 2 days by 2100.
- Full range of projected changes from 1 to 3 days.
- Confidence in these figures is high.

**Cold spells**

- Median projection of change in the duration of long-lasting cold spells for a slight increase of 4 days by 2100.
- Full range of projected changes from 2 to 6 days.
- Confidence in these figures is high.

**Projections of possible development of solar irradiance**

- Median projection of change in annual mean solar irradiance is for a slight increase of 0.2 kWh/m² by 2100.
- Full range of projected changes from 0.0 to 0.4 kWh/m².
- Confidence in these figures is medium.



**Projections of possible development of precipitation and water availability**

**Annual total precipitation**

- Median projection of change in annual total precipitation is for a slight increase of 0.5 mm by 2100.
- Full range of projected changes from 0.0 to 1.0 mm.
- Confidence in these figures is medium.

**Precipitation seasonality**

- Median projection of change in annual total precipitation is for a slight increase of 0.5 mm by 2100.
- Full range of projected changes from 0.0 to 1.0 mm.
- Confidence in these figures is medium.

**Evaporation**

- Median projection of change in annual evaporation is for a slight increase of 0.5 mm by 2100.
- Full range of projected changes from 0.0 to 1.0 mm.
- Confidence in these figures is medium.

**Climatic water balance**

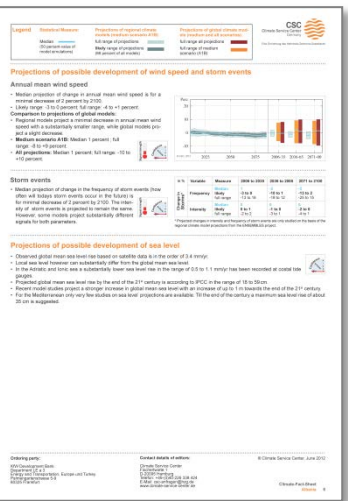
- Median projection of change in annual climatic water balance is for a slight decrease of 10 mm by 2100.
- Full range of projected changes from 0 to 20 mm.
- Confidence in these figures is medium.

**Dry spells**

- Median projection of change in the duration of long-lasting dry spells for a slight increase of 4 days by 2100.
- Full range of projected changes from 2 to 6 days.
- Confidence in these figures is high.

**Wet spells**

- Median projection of change in the duration of long-lasting wet spells for a slight increase of 2 days by 2100.
- Full range of projected changes from 0 to 4 days.
- Confidence in these figures is high.



**Projections of possible development of wind speed and storm events**

**Annual mean wind speed**

- Median projection of change in annual mean wind speed is for a slight increase of 0.1 m/s by 2100.
- Full range of projected changes from 0.0 to 0.2 m/s.
- Confidence in these figures is medium.

**Storm events**

- Median projection of change in the frequency of storm events is for a slight decrease of 2% by 2100.
- Full range of projected changes from 0 to 4%.
- Confidence in these figures is low.

**Projections of possible development of sea level**

- Global mean sea level is projected to increase by 18 to 26 cm by the end of the 21st century.
- Local sea level changes can be substantially different from global mean level projections.

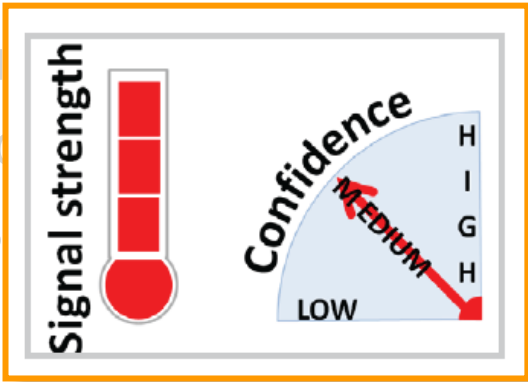
# Concept of the „Climate-Fact-Sheets“

- Concise summary of the major information for the past, current and future development
- Focus of the climate-fact-sheets is on the data and different climate models
- Fact-sheets usually consist of 6 pages
- Information is based on the latest available data and model projections

## Expert judgment on signal strength and confidence

Based on:

- Statistical significance of changes
- magnitude of absolute changes
- Quality of climate model simulations when compared to observed data
- Signal-to-noise ratio of projected changes
- Agreement of model projections in the direction of change



**Climate-Fact-Sheet**

Based on Regional Climate Model Data

**Abstract**  
 The climate service center CSC has developed a series of climate fact sheets. The sheets are intended to provide a concise summary of the major information for the past, current and future development of the climate system. The sheets are based on the latest available data and model projections. The sheets are intended to provide a concise summary of the major information for the past, current and future development of the climate system. The sheets are based on the latest available data and model projections.

**Zusammenfassung**  
 Das Klimadienstleistungszentrum CSC hat eine Reihe von Klimafaktenblätter entwickelt. Die Faktenblätter sollen einen prägnanten Überblick über die wichtigsten Informationen zum vergangenen, gegenwärtigen und zukünftigen Klimawandel geben. Die Faktenblätter basieren auf den aktuellsten verfügbaren Daten und Modellprojektionen. Die Faktenblätter sollen einen prägnanten Überblick über die wichtigsten Informationen zum vergangenen, gegenwärtigen und zukünftigen Klimawandel geben. Die Faktenblätter basieren auf den aktuellsten verfügbaren Daten und Modellprojektionen.

**Current climate**

Observed mean values are taken from literature and available global datasets and are averaged for the German territory.

- Climate classification: Cfb, Mediterranean
- Annual mean precipitation: 800 mm
- Annual mean actual evaporation: 600 mm
- Annual mean (stream) water balance: 200 mm
- Mean density of heavy rainfall events: 20 mm/day
- Mean duration of heavy rain: 10 min
- Mean duration of wind speed: 5 days
- Annual mean lake evaporation: 400 (WNO) and 500 (WNO+L) mm
- Annual mean lake level: 0.5 m above sea level
- Density of storm events: 10-15 days

**Relevant additional events**

- Drought events: 1975, 1976, 1989, 1992 and 1995-1998
- Flood events: 1992, 1995, 1998 and 1999
- Storm events: 1992, 1995, 1998 and 1999
- Storm events: 1992, 1995, 1998 and 1999

**Historical climate trends**

- Mean annual temperature has increased by approximately 0.3 °C in the period 1960-2000. However, the trend is not statistically significant.
- Precipitation has increased slightly during winter.
- The last 20 years temperature trend assessment.

**Summary of projected future climate**

The median projection of change in annual mean temperature is an increase of 1.7 °C by 2100, with a full range of projected changes from 0.8 to 2.6 °C. Confidence in these figures is medium. The change in precipitation is an increase of 1.7 mm per year by 2100, with a full range of projected changes from 0.8 to 2.6 mm per year. Confidence in these figures is medium. The change in precipitation is an increase of 1.7 mm per year by 2100, with a full range of projected changes from 0.8 to 2.6 mm per year. Confidence in these figures is medium.

**Water balance**

The median projection of change in the annual mean climatic water balance is a decrease of 10 mm per year by 2100, with a full range of projected changes from 0.8 to 2.6 mm per year. Confidence in these figures is medium. The change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium. The change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium.

**Dry spells**

The median projection of change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium. The change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium.

**Heavy rains**

The median projection of change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium. The change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium.

**Wind speed**

The median projection of change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium. The change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium.

**Storm events**

The median projection of change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium. The change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium.

**Sea level**

The median projection of change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium. The change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium.

**Heat stress**

The median projection of change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium. The change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium.

**Heat stress**

The median projection of change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium. The change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium.

**Heat stress**

The median projection of change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium. The change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium.

**Heat stress**

The median projection of change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium. The change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium.

**Evaporation**

The median projection of change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium. The change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium.

**Evaporation**

The median projection of change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium. The change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium.

**Evaporation**

The median projection of change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium. The change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium.

**Evaporation**

The median projection of change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium. The change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium.

**Projections of possible development of sea level**

The median projection of change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium. The change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium.

**Projections of possible development of sea level**

The median projection of change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium. The change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium.

**Projections of possible development of sea level**

The median projection of change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium. The change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium.

**Projections of possible development of sea level**

The median projection of change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium. The change in the duration of long-lasting cold spells is a slight decrease of 2 days by 2100, with a full range of projected changes from 0.8 to 2.6 days. Confidence in these figures is medium.



# Another Example: The Wind Energy Sector

Wind data acquired at meteorological stations are mainly used

1. To scale the data measured at **sites under development** from the on-site observation period (usually one year) to time scales relevant for the financing and operation of the wind farms, i.e. **about 20 years**
2. To **predict the energy production** of wind farms in conjunction with the energy trading and grid operation





# Another Example: The Wind Energy Sector

For the first requirement, homogenous historic wind data are needed covering at least 10 years but preferably more than 20 years.

At sites with relatively ***strong*** wind resource, an **error of 0.1 m/s** in the aggregated wind speed history will lead to an **error in predicted long term energy production of 2 % to 3 %**.

For sites with ***moderate*** wind resource, an **error of 0.1 m/s** in predicted long term mean wind speed will cause an **error of 3 % to 5 %** at such sites.



# Another Example: The Wind Energy Sector

A **0.1 m/s wind speed error** contained in the wind statistics of a meteorological station will basically consume **half of the expected return** of the investor.

For a medium size wind farm of 10 wind turbines, and **error of 5 %** corresponds to a loss (or gain) in the order of 200,000 € to 300,000 € per year at a site with moderate wind resource, i.e. about **5 M€ over the lifetime of the wind farm.**



## Evaluation of Model Data

---

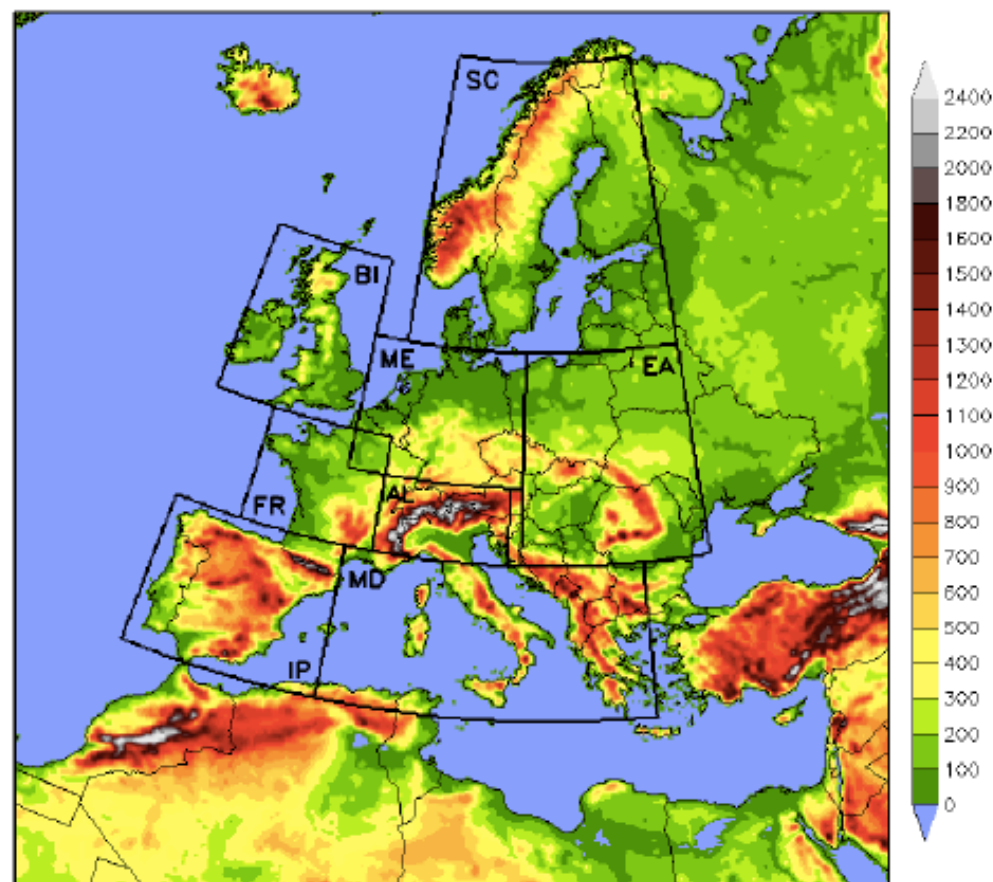
# DATA AND METHODS (2)

## Evaluation Metrics

1. Seasonal mean biases at grid point scale for entire Euro-CORDEX domain (EUR-11)
2. Eight metrics applied to each analysis region, describing different aspects of model performance (EUR-11 and EUR-44)

- Temporal and spatial means
- Spatial variability
- Temporal variability
- Mean annual cycle

**This talk**



**Regional climate modeling on European scales:  
A joint standard evaluation of the  
EURO-CORDEX RCM ensemble**

## Evaluation of Climate Models

---

**Climate change models** (global and regionally downscaled) must be evaluated carefully, before they can be used as a basis for impact models or indicators, which are going into adaptation research/information.

If **bias-correction** (or any other model output statistics) is used to modify the climate model data, then we have to know how much the method is changing the result (signal).

A **comparison** of bias-correction methods is therefore needed.

---



# Evaluation of Climate Models

---

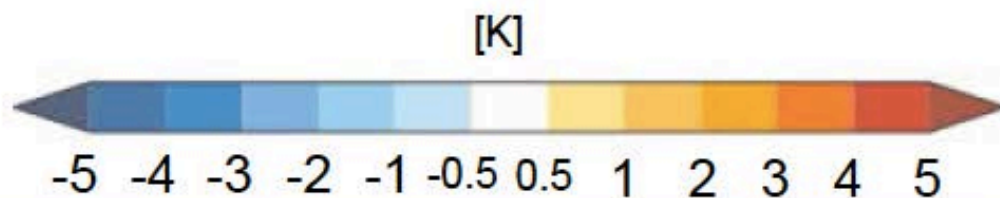
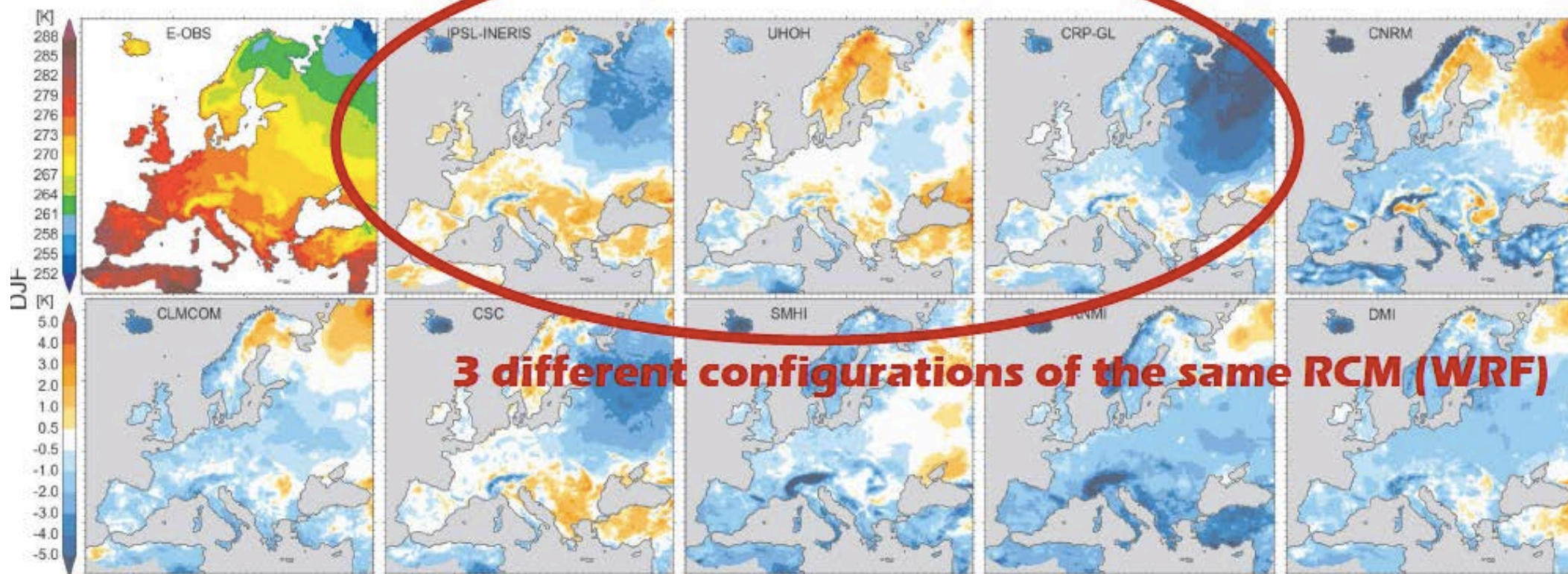
The evaluation should **not focus only on standard variables**; it should consider parameters required by the users.

Examples: **hours of sunshine** or **humidity-driven parameters** important for the construction sector, **soil parameters** for the agricultural sector.

Observations such such parameters (e.g., soil parameters) are often missing.

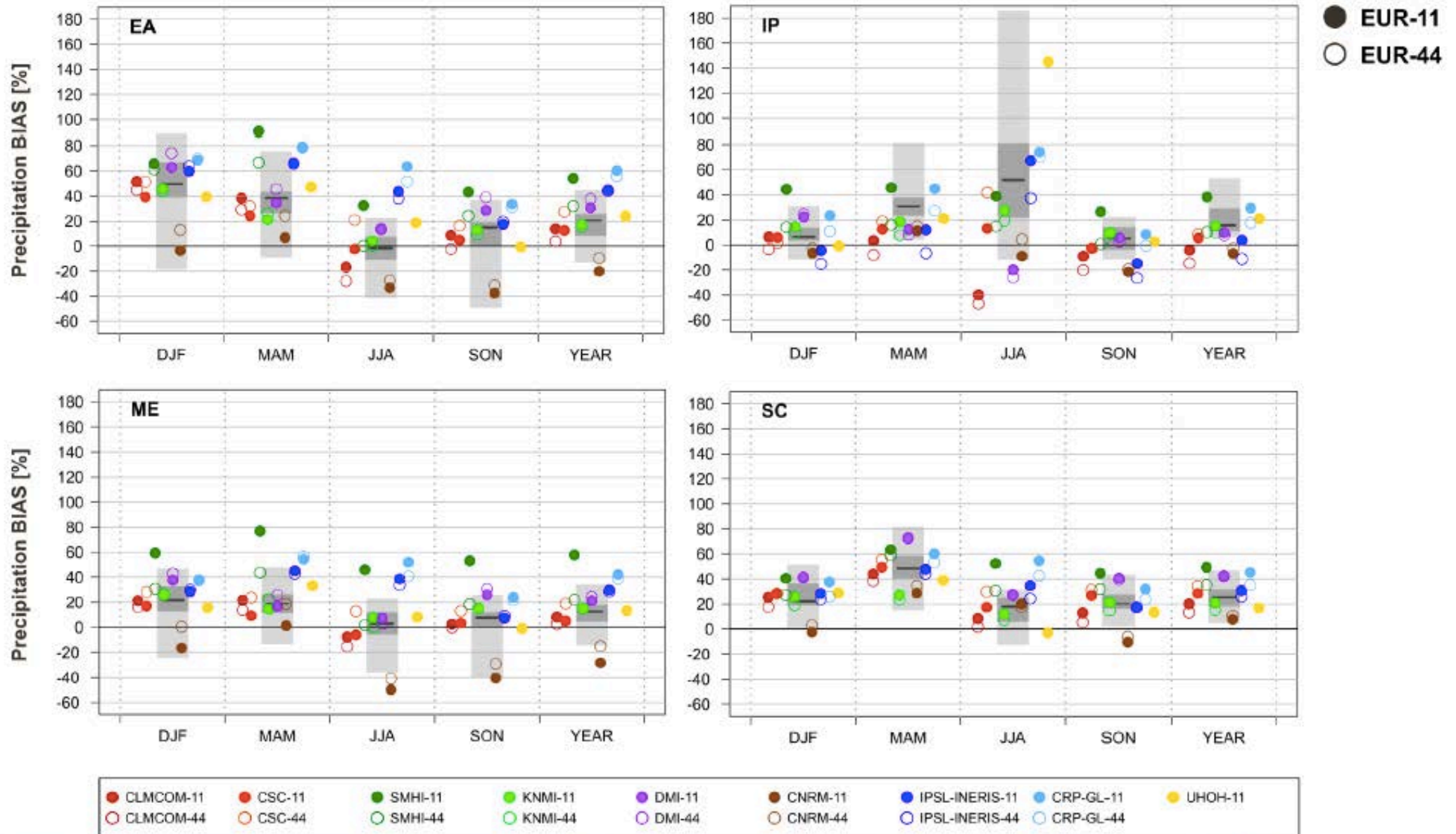
---

# DJF TEMPERATURE BIAS (mean 1989-2008) [K]

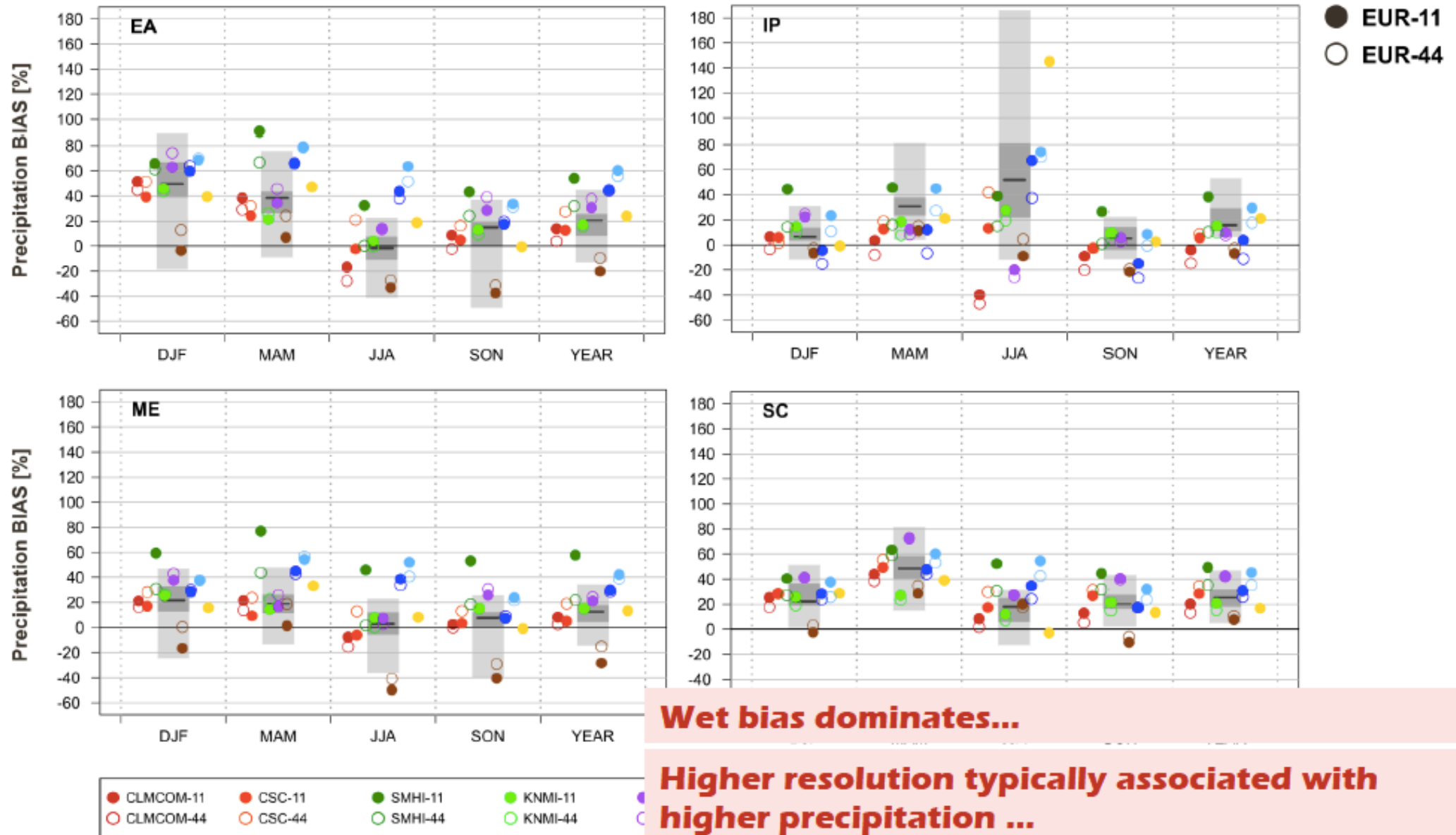




# PRECIPITATION: Regional and temporal mean bias [%]



# PRECIPITATION: Regional and temporal mean bias [%]



**Wet bias dominates...**

**Higher resolution typically associated with higher precipitation ...**

**Individual outliers beyond ENSEMBLES range...**

# Requirements from the users

**QC is needed in all steps of the creation of the data** for climate change adaptation: observations and the associated techniques, modeling, model output statistics, analyses methods, visualization

The **standards for non meteorological data** (e.g., soil data, socio-economic data, model output, etc.) should be the same as for climate data.

It makes no sense to have a very robust CC information, but less good data on e.g. sectorial data, which are of equal importance to the user for adaptation options.

Data output formats, availability in the archives of values at all time steps, no missing values, easily accessible, transparent data, documentation, **same standards across the EU.**

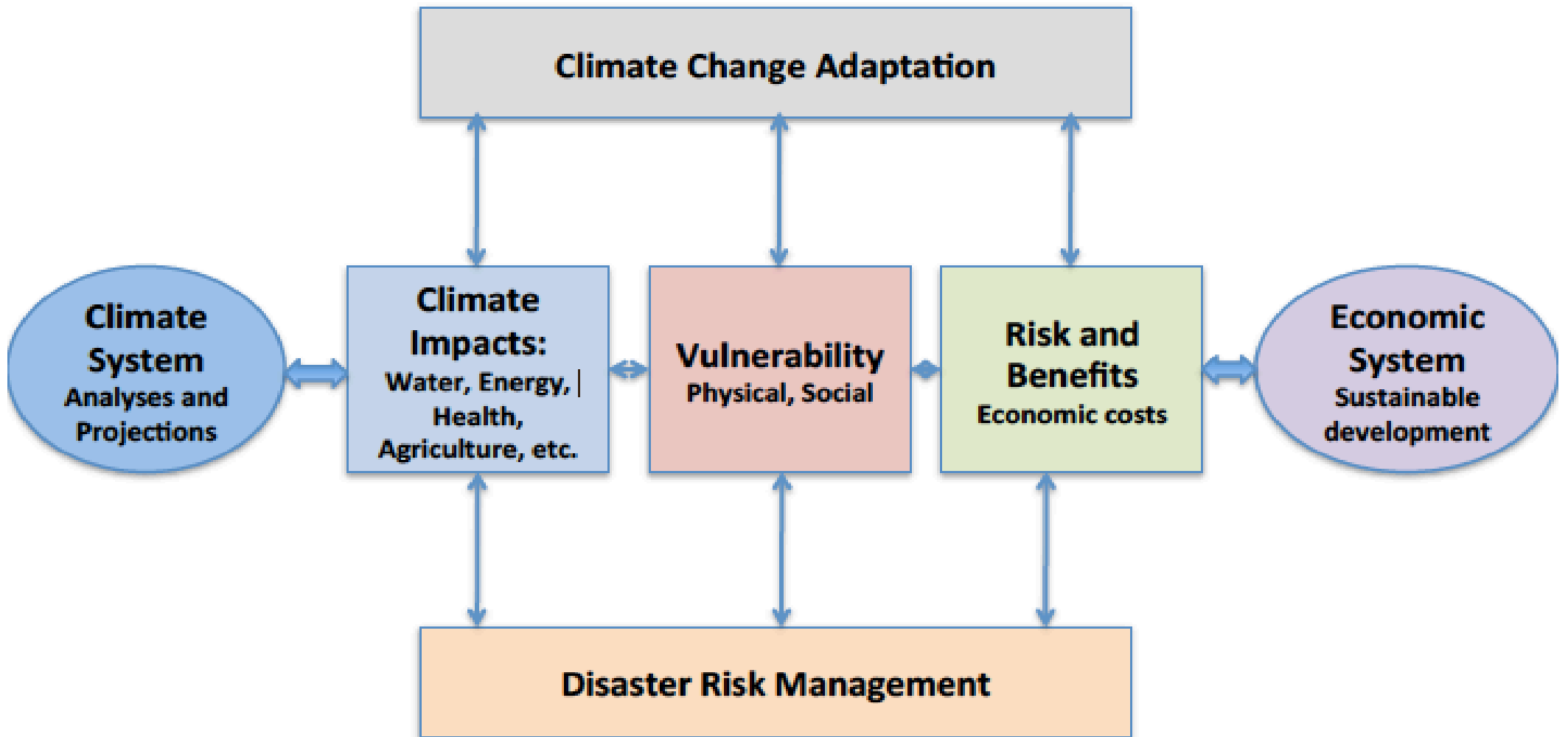
The **archives MUST be open** for everyone - not only NMSs.

---



## Conclusions

---



**The Framework for Climate Services**



Thank You

*Enhancing adaptive capacity for society  
in the context of changing weather and climate*