

Available climate simulations and GERICS products for adaptation

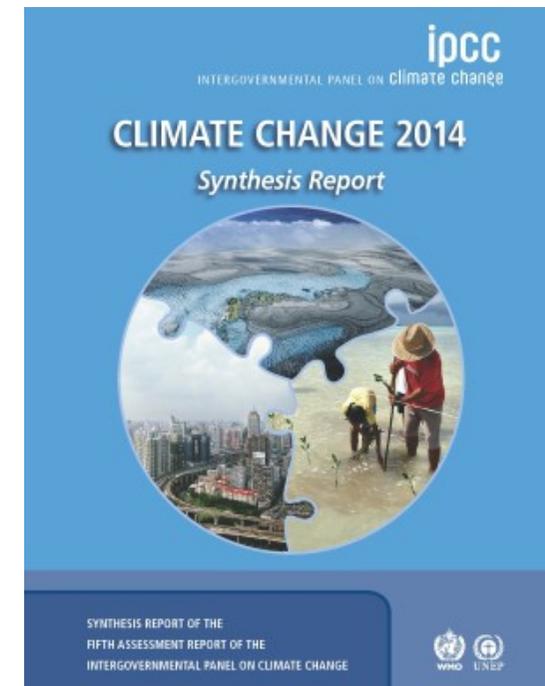
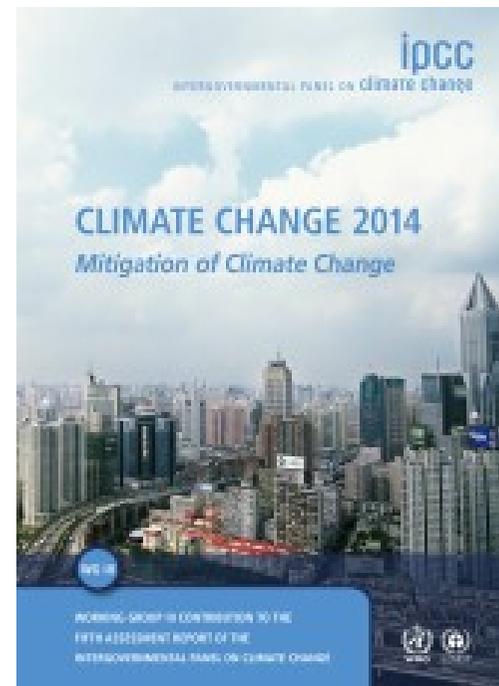
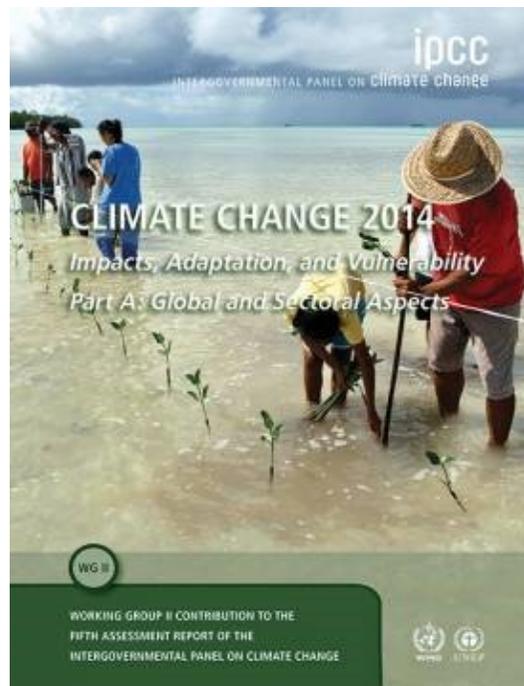
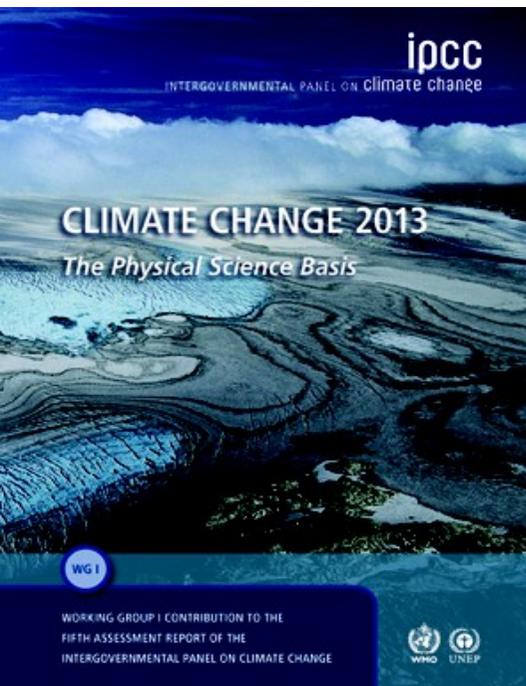
Claas Teichmann and María Máñez
and the GERICS team

Expert meeting to assess progress made in the process to
formulate and implement
National Adaptation Plans (NAPs)

7–9 February 2018, Sao Tome, Sao Tome and Principe

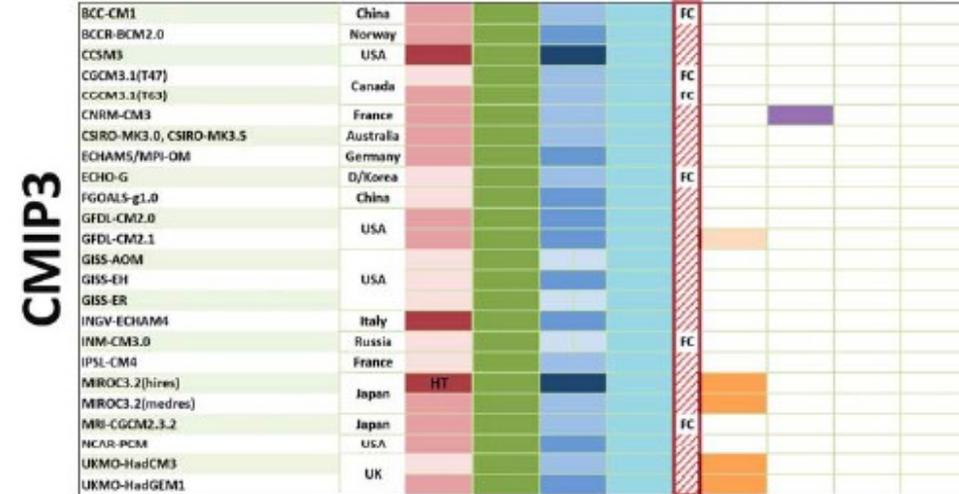
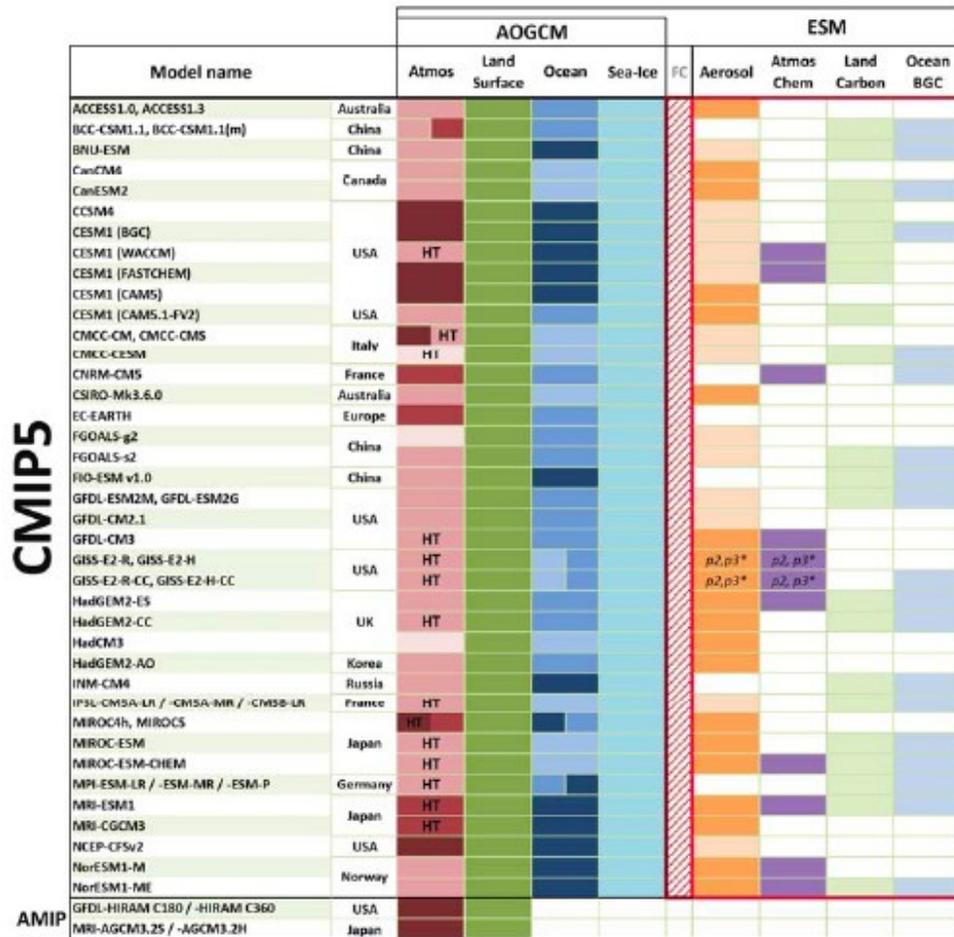
■ IPCC Assessment Report 5

Current state of scientific knowledge relevant to climate change:
<http://www.ipcc.ch/report/ar5/>



5th Assessment Report of the Intergovernmental Panel on Climate Change:
WGI 2013, WGII, WGIII,SYR 2014

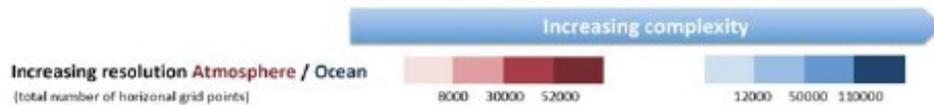
Multi-model ensemble CMIP5 and CMIP3



MIPs Model Intercomparison Projects (since 1990): standard experiment protocol and an world wide community-based infrastructure in support of model simulations, validation, intercomparison, documentation and data access.

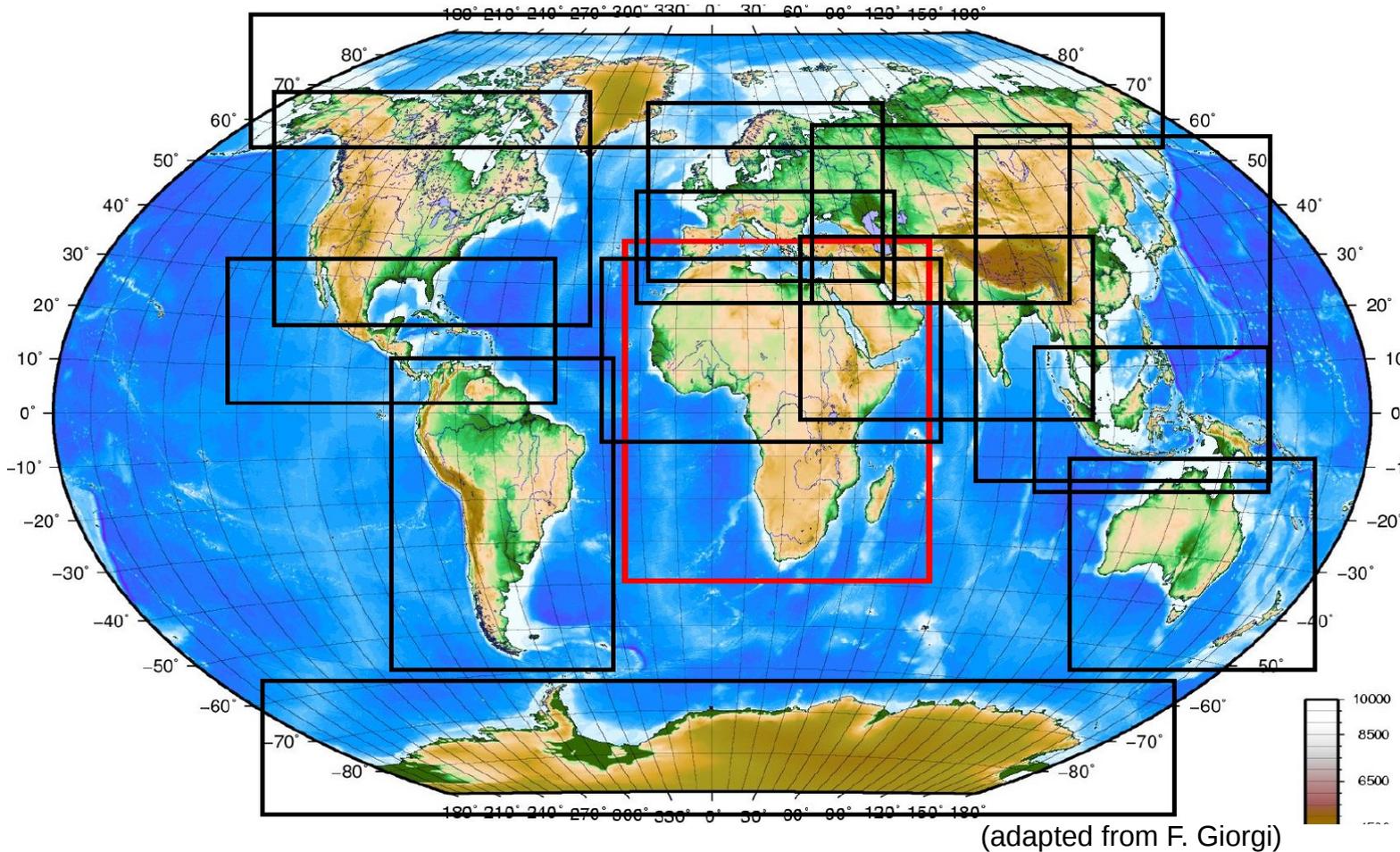
CMIP3: coordinated climate projections, based on emission scenarios from SRES, global model basis for IPCC AR4

CMIP5: a new set of coordinated, based on the new RCPs, global model basis for IPCC AR5



Source: IPCC 2013 AR5 Chapter 9

Regional climate simulations: WCRP CORDEX



14 domains with a resolution of $0.44^\circ \times 0.44^\circ$ (approx. $50 \times 50 \text{ km}^2$)

High resolution simulations with $0.11^\circ \times 0.11^\circ$ (approx. $12 \times 12 \text{ km}^2$) for Europe

CORDEX data available via *Earth System Grid Federation*: <https://esgf-data.dkrz.de/search/cordex-dkrz/>

- CORDEX focus on Africa
- GERICS participates in many CORDEX-regions

■ CORDEX vision and goals

The CORDEX vision is to advance and coordinate the science and application of regional climate downscaling through global partnerships.

- To better understand relevant regional/local climate phenomena, their variability and changes, through downscaling.
- To evaluate and improve regional climate downscaling models and techniques
- To produce coordinated sets of regional downscaled projections worldwide
- To foster communication and knowledge exchange with users of regional climate information

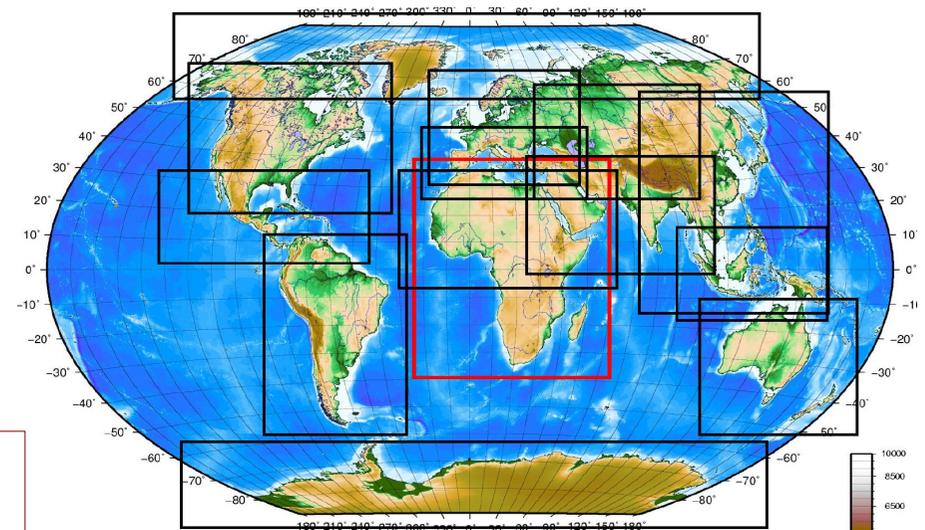
Emerging scientific challenges

- Added value
- Human element
- Coordination of regional coupled modelling
- Precipitation
- Local wind systems



Great parts of the information of climate change is based on CORDEX activities

CORDEX domains



(adapted from F. Giorgi)

CORDEX-CORE



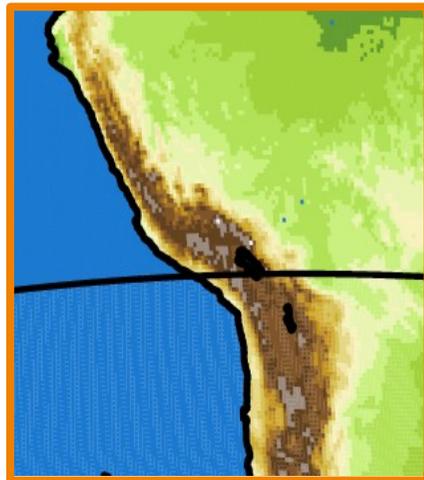
Towards a homogeneous high-resolution simulation dataset for the world

Horizontal resolution: 0.22° (~25km) resolution

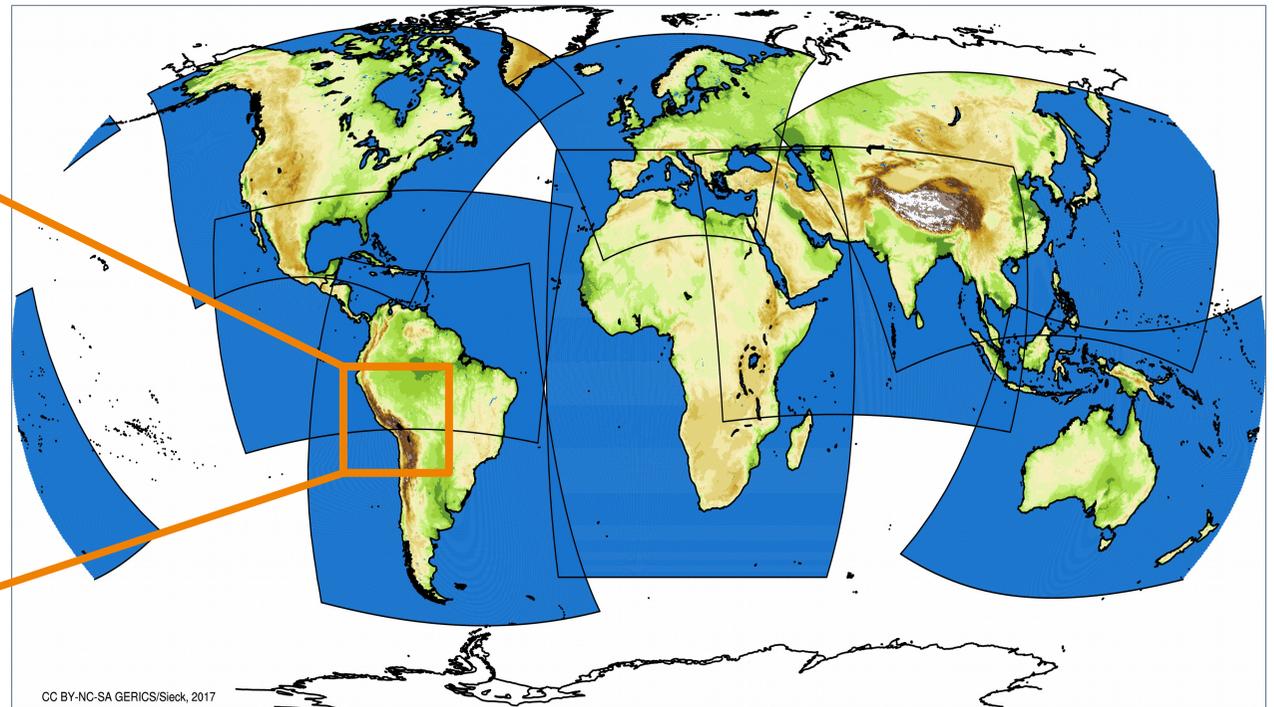
Forcing: re-analysis (ERA-Interim), RPC2.6 and RCP8.5 driven global simulations

GCMs: HadGEM (backup: MIROC5), MPI-ESM (backup: EC-Earth), NorESM (backup: GFDL-ESM)

RCMs: REMO, RegCM, CLM



Orographically structured area.



CORDEX-CORE model domains as setup for simulations by the regional climate model REMO.

Domains from top-left to bottom right: North America, Central America, South America, EURO-CORDEX, Africa, South Asia, East Asia, Australasia.

■ CORDEX-CORE

Towards a homogeneous high-resolution simulation dataset for the world



Horizontal resolution: 0.22° (~25km) resolution

Forcing: re-analysis (ERA-Interim), RPC2.6 and RCP8.5 driven global

sim
GO The main ideas of the CORDEX CORE framework are

- No
RC
- to use a core set of RCMs
 - to downscale a core set of GCMs
 - to cover the major inhabited areas of the world
 - to use different representative concentration pathways (RCPs)
 - to incrementally extend the CORDEX-CORE ensemble with further contributions by additional models/experiments

CORDEX-CORE model domains as setup for simulations by the regional climate model REMO.

Domains from top-left to bottom right: North America, Central America, South America, EURO-CORDEX, Africa, South Asia, East Asia, Australasia.

■ Further information

- Accessing observation data:
 - www.ncdc.noaa.gov
- Accessing simulation data:
 - <https://esgf-data.dkrz.de/projects/esgf-dkrz/>
- Quick visualization of simulation data
 - http://climexp.knmi.nl/plot_atlas_form.py

GERICS products for adaptation

Claas Teichmann and María Máñez
January 25, 2018

■ Interlinking Science and Society

We develop innovative, cutting-edge solutions



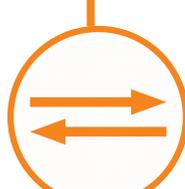
- regional climate modelling
- regional system modelling
- climate change impacts
- economics and politics
- transdisciplinary processes



- prototype product development
- inter- and transdisciplinary approaches
- application of climate service infrastructure
- evaluation of climate services



- climate-fact-sheets and focus papers
- maps and visualisations
- modular toolkits
- training concepts
- books, reports and studies



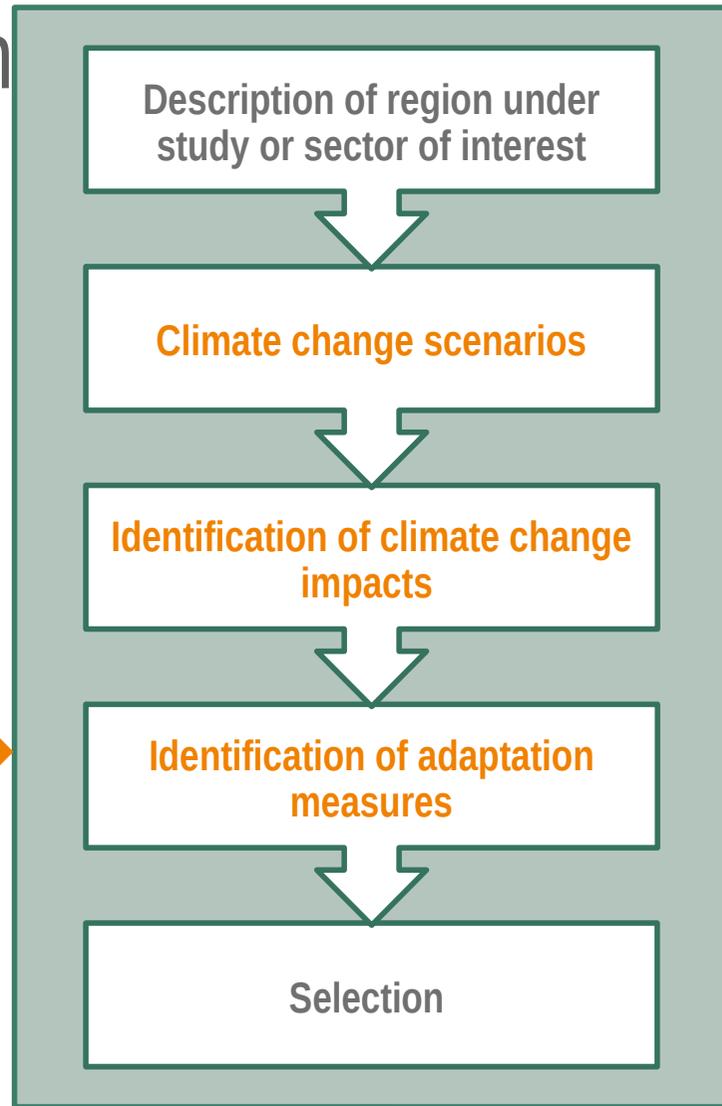
- strategic partnerships and associates
- creating and facilitating networks
- hosting secretariats
- operationalising climate services
- continuous user interaction

Products for adaptation

SOCIETAL NEEDS



Adaptation



- Toolkit for cities
- Toolkit for companies
- Regional modelling toolkit

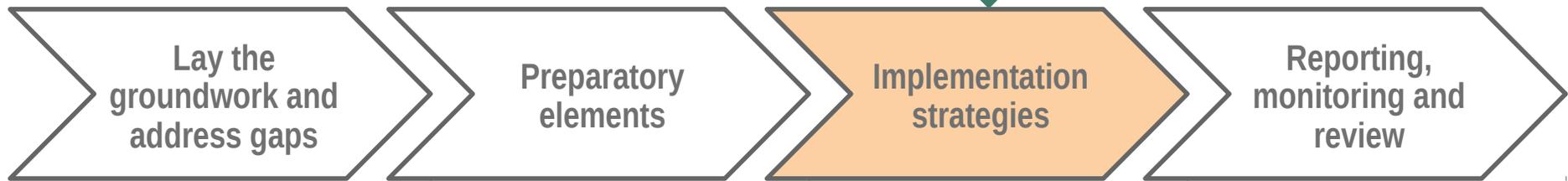
Adaptation Toolkits

- Climate Fact Sheets
- Site-characteristic Climate-Fact-Sheets

Fact Sheets

- Climate signal maps
- Rain maps

Maps & visualizations



GERICS Adaptation Toolkit for Cities



GERICS Climate-Fact-Sheets

Concise climate characteristics of individual countries or regions



Example-pages from CFS: Burkina Faso – Togo – Ghana

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Current climate
Observed mean values are taken from literature and available global data sets (averaged over the whole region):

- Major climate zones (see also climate diagrams - CD1-3):
Tropical wet and dry (Aw)
- Annual mean temperature: 27°C
- Annual total precipitation: 1100 mm/yr
- Annual mean actual evaporation: 882 mm/yr
- Annual mean climatic water balance*: 122 mm/yr
- Intensity of heavy rain events*: 122 mm/day
- Mean duration of dry spells*: 12 days
- Mean duration of heat waves*: 7 days
- Mean duration of cold spells*: 7 days
- Annual mean solar irradiance (surface): 1460 kWh/m² yr
- Annual mean wind speed (10 m above surface): 2.1 m/s

Reported recent extreme events:

- In Benin, flood-events in 2010 affected 831,000 people

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% confidence level. The description of the climate zones is based on the Köppen-Geiger climate classification.
**The climatic water balance is derived from a different data set than precipitation and evaporation, therefore it is possible that the values do not sum up.

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

Observations from globally available data (CRU) show:

- A significant temperature increase of 0.04°C per decade was observed between 1901 and 2013, whereas over the last thirty years the observed increase was slightly stronger, but not significantly.
- Over the same period of 113 years almost no change has been observed in annual total precipitation amounts.

Additional information from literature:

- Over Benin, the annual maximum 30-day total rainfall was 1160 mm between 1960 and 2000.
- No clear trend has been observed in extreme rainfall events.

Summary of projected future climate (for a 30-year period centred around 2085)

Temperature The likely range of projected change in annual mean temperature is from +1.4 to +5.1°C. Confidence in these figures is medium. The change in temperature from 1960 to 2085 is projected to be +1.5 to +4.8°C.

Heat waves The likely range of projected change in the duration of long-lasting heat waves is from +6 to +141 days. Confidence in these figures is medium. The change in the duration of long-lasting heat waves can be considered to be strong.

Cold spells The likely range of projected change in the duration of long-lasting cold spells is from -11 to +1 days, with only a few projections showing an increase. Confidence in the duration of long-lasting cold spells can be considered to be strong.

Precipitation The likely range of projected change in annual total precipitation is from -3 to +7% by 2085. The very likely range is from -8 to +12% by 2085. The projected change in precipitation shows a large relative change for the dry season (November to February). During the rainy season a tendency for a drying in the first half of the rainy season from March to June, whereas in the second half from July to October a slight increase is projected (likely range from -25 to +25%). Confidence in these figures is medium. The change in annual total precipitation can be considered to be weak.

Dry spells The likely range of projected change in the duration of long-lasting dry spells is from -10 to 0 days by 2085 and the very likely range is from -24 to +4 days, with only a few projections showing an increase. Confidence in these figures is low. The change in the duration of long-lasting dry spells can be considered to be weak.

Climate-Fact-Sheet
Benin - Ghana - Togo 2

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Projections of possible development of precipitation and water availability

Annual total precipitation

- Likely range of projected change in annual total precipitation is from -1 to +5% by 2030, from -2 to +6% by 2050 and from -3 to +7% by 2085.
- Very likely range: -4 to +10% by 2030; -6 to +12% by 2050; -8 to +12% by 2085.

Separate scenario examination (by 2085):

- Low-Scenario: Median +1%
- High-Scenario: Median +4%

Comparison to projections of IPCC AR4:

- Latest ARS projections show the same outcome of no clear trend but with a smaller bandwidth.

Range of projected changes for all simulations with global mean warming below 2°C or above 4°C (by 2085):

- below 2°C-target: -3 to +8%
- above 4°C-threshold: -8 to +16%

Precipitation seasonality (by 2085)

- A large relative change is projected for the dry season (November to February). During the rainy season, there is a tendency for a drying in the first half of the rainy season from March to June, whereas in the second half from July to October a slight increase is projected.
- Likely range (rainy season): -25 to +25%
- Very likely range (rainy season): -30 to +30%

During the rainy season, there is almost no difference between the changes in precipitation projected under the low and high scenario.

Signal strength

Confidence

Signal strength

Confidence

Climate-Fact-Sheet
Benin - Ghana - Togo 6

Available on request:

www.climate-service-center.de/climate-fact-sheets

Jointly developed with



Climate-Fact-Sheets in a nutshell

- Climate-Fact-Sheets usually have some 4 to 6 pages with short text passages, tables and different diagrams
- Focus of the Climate-Fact-Sheets is on the projected future changes. Short information on current climate and past extremes is also included.
- Information is based on primary data (e.g. projections from global and regional climate models or continental wide observational datasets) and literature review

Climate parameters included in the Climate-Fact-Sheets

Temperature (Annual mean, min, max)

Heat waves and cold spells

Precipitation (Annual total, Seasonal cycle), Evaporation, climatological water balance

Dry spells and heavy rainfall events

solar Irradiance, Wind speed, Sea level rise

The image displays six pages of a Climate-Fact-Sheet for Pakistan, organized into a grid. Each page contains a mix of text, tables, and charts. The pages cover the following topics:

- Page 1 (Top Left):** Overview of the Climate-Fact-Sheet, including a title, location (Pakistan), and a summary of the document's purpose and structure.
- Page 2 (Top Middle):** 'Current climate' section, detailing current climate conditions and trends, supported by various charts and maps.
- Page 3 (Top Right):** 'Historical climate trends' section, comparing current trends with historical data and projections.
- Page 4 (Middle Left):** 'Projections of possible development of temperature, heatwaves and cold spells', including sections for 'Annual mean temperature', 'Maximum and minimum temperature', 'Heatwaves', and 'Cold spells'.
- Page 5 (Middle Right):** 'Projections of possible development of precipitation and water availability', including sections for 'Annual total precipitation', 'Precipitation seasonality', 'Climate water balance', and 'Evaporation'.
- Page 6 (Bottom):** 'Projections of possible development of wind speed' and 'Projections of possible development of sea level', including sections for 'Dry spells' and 'Heavy rain'.

Each page features the logo of the Climate Service Center (CSC) and the German Research Aerospace Establishment (DLR). The charts and tables use color-coded data to represent different climate scenarios and trends.

■ Main elements of a Climate-Fact-Sheets

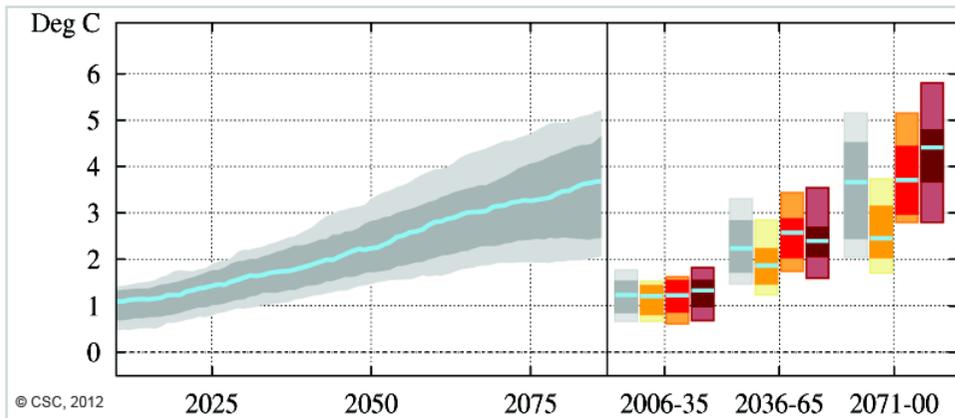
Detailed description of temporal development projected changes

Annual mean temperature

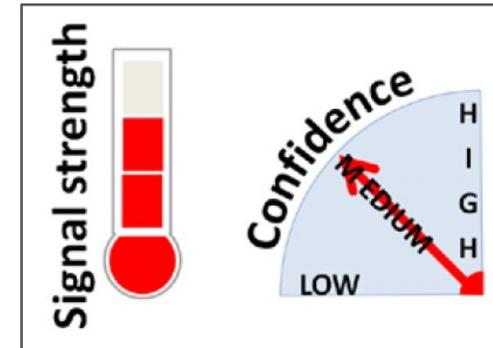
- Median projection of change in annual mean temperature is for an increase of 3.7 °C by 2100.
- Likely range: 2.5 to 4.5 °C; very likely range: 2.0 to 5.2 °C

Separate scenario examination:

- **Low-Scenario B1:** Median +2.5 °C
- **High-Scenario A2:** Median +4.4 °C



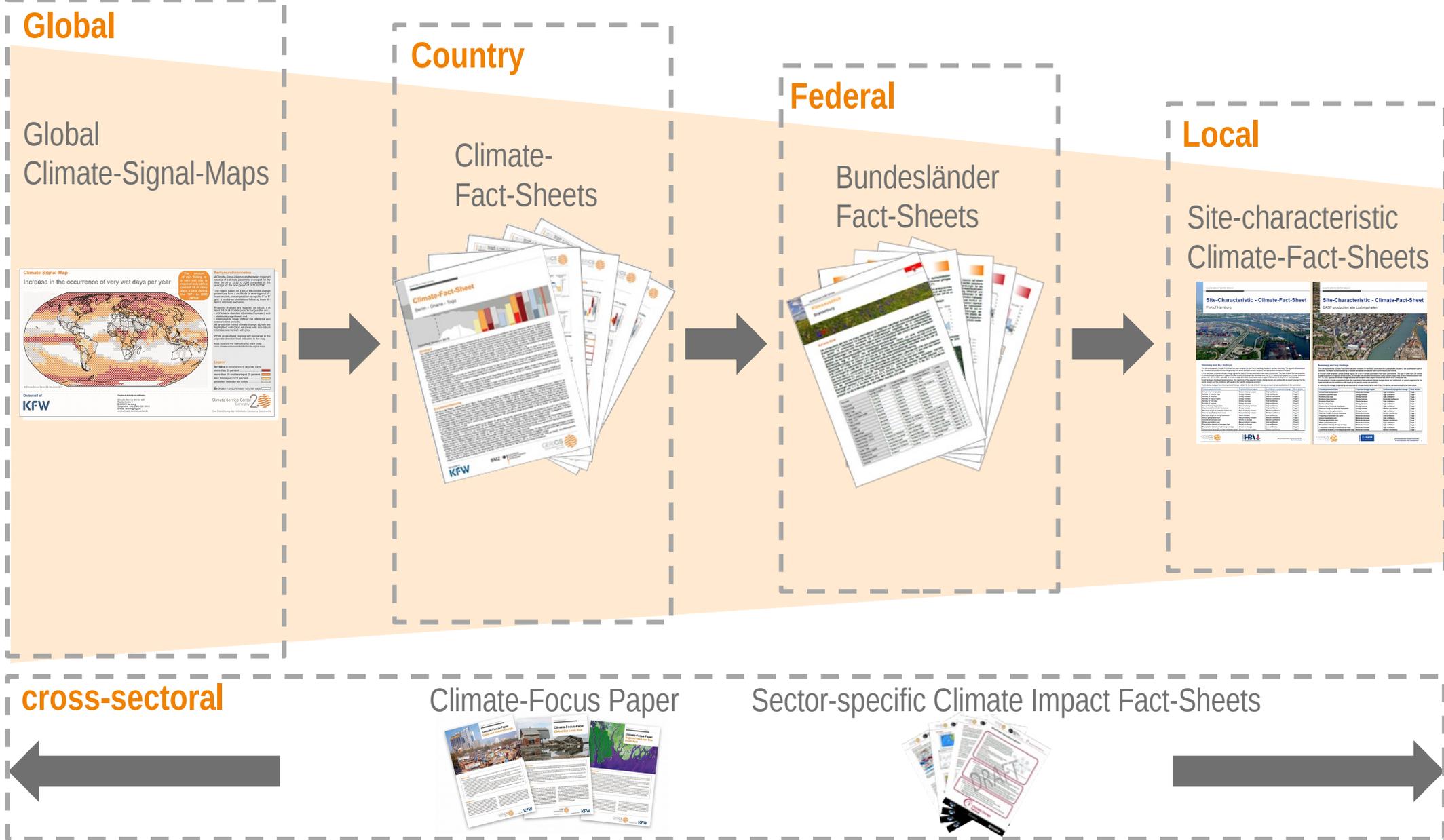
Expert Judgement on signal strength and confidence



based on

- statistical significance & magnitude of absolute change
- quality of simulations in comparison to observations
- signal-to-noise ratio of projected changes
- agreement of model simulations

Fact-Sheet concept covers global scales and issues



■ Use of GERICS Climate-Fact-Sheets (CFS)

Criteria: use

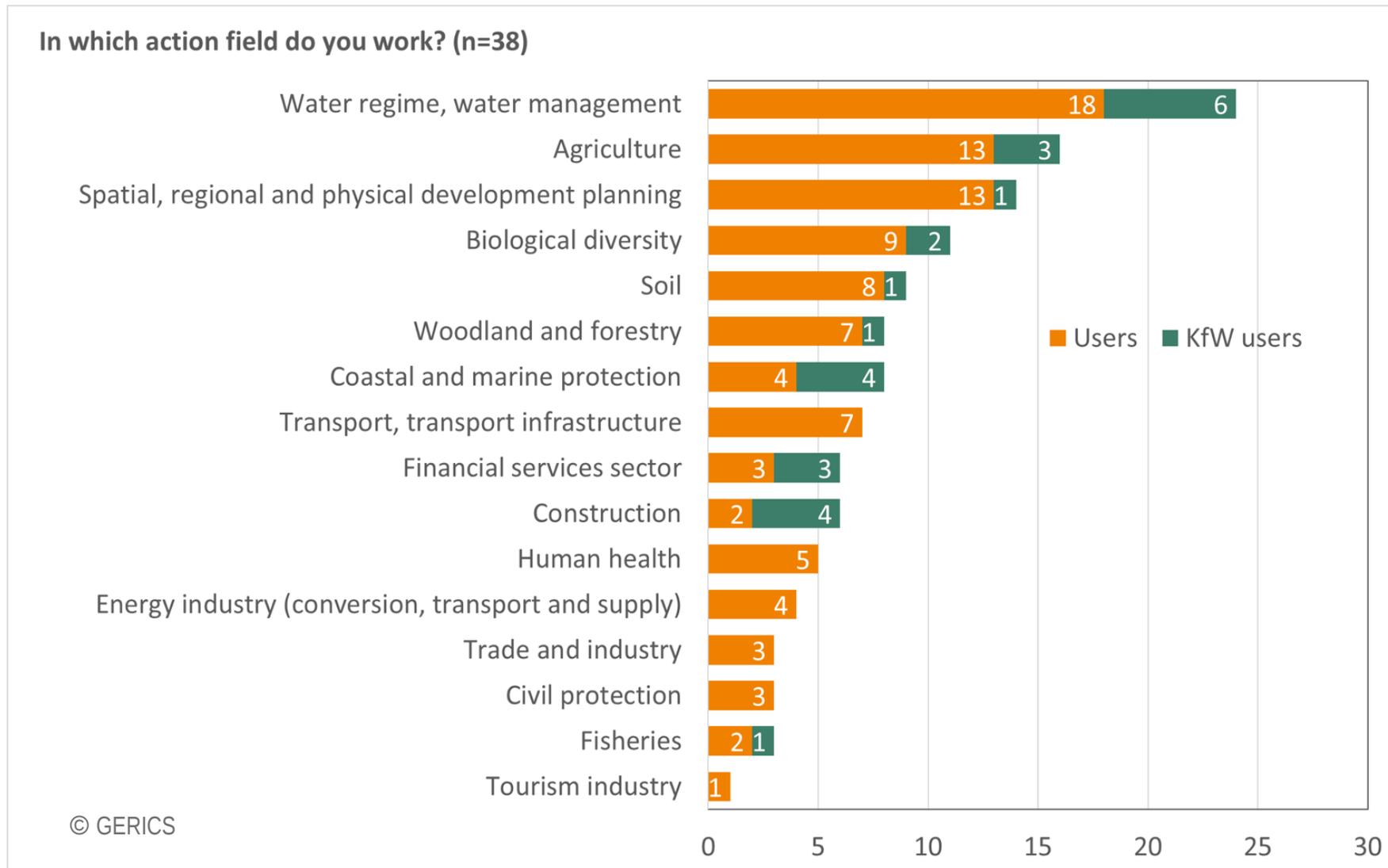
Indicator: breadth of use

> 284 users worldwide
(except for KfW)

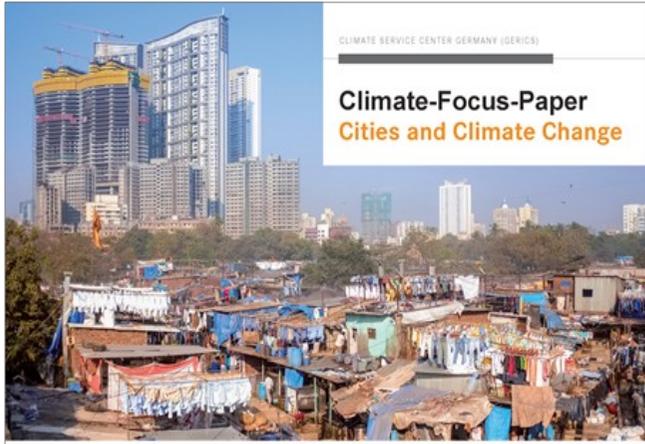


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Use of GERICS Climate-Fact-Sheets (CFS)



GERICS Climate-Focus-Papers



CLIMATE SERVICE CENTER GERMANY (GERICS)

Climate-Focus-Paper Cities and Climate Change

Speed read

- The majority of the world's population already lives in urban areas, and this trend will increase, with global urban population projected to have increased to 66% by 2050.
- Cities consume up to 80% of total global energy production, and account for 71 to 76% of global CO₂ emissions. Accordingly, cities have a major role to play in achieving the global climate policy goal of limiting global warming to no more than 2°C.
- Cities are highly vulnerable to climate change, and as such, require coherent, carefully considered mitigation and adaptation strategies, where potential co-benefits between the two, are included.
- With carbon emissions still rising, and the threat posed by climate impacts becoming ever clearer, there is an urgent need for action.
- Existing infrastructure in developing cities is often of substandard quality, and thus fails to provide adequate protection from extreme weather events and changing climatic conditions. The urban poor are particularly vulnerable towards extreme weather events.
- Many of the world's cities are situated along the coast, and as such are exposed to flooding from storm surges and sea level rise. The risk of coastal flooding is further increased in cities affected by subsidence.
- Financing for mitigation and adaptation actions exist, but are difficult to access for cities. Innovative solutions are needed now to close the finance gap.

Introduction

This paper outlines the role of cities as being drivers of global climate change and at the same time being affected by climate change. In addition to climate change, cities are confronted by challenges in relation to urbanization, natural hazards, and their interaction. The paper highlights the need to reduce greenhouse gas (GHG) emissions through climate mitigation policies, as well as the need for adaptation action to combat existing and potential climate impacts. Moreover, the paper underlines the challenges in finding synergies between adaptation and mitigation measures, suggests possible adaptation responses to inevitable climate change, and points out the financial barriers. The main focus lies on rapidly growing cities in developing countries and emerging economies. Given the complexity and unique characteristics of individual cities, it is not possible to provide an in-depth analysis of existing and projected climate risks, and possible mitigation and adaptation policies, for one particular city. Rather, this Focus-Paper provides a brief overview of various aspects, topics, and sectors of relevance to cities in general.

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CLIMATE SERVICE CENTER GERMANY (GERICS)

Climate-Focus-Paper Regional Sea Level Rise South Asia

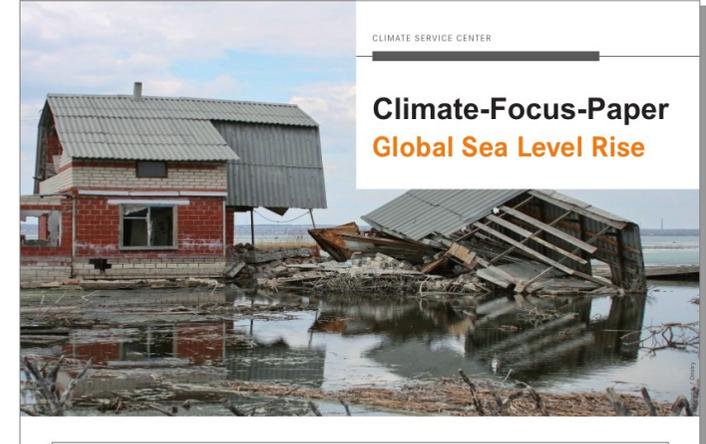
Speed read

- South Asian countries bordering the Bay of Bengal are subject to a number of climate related hazards, chief among which is rising sea levels. Rising sea levels lead to impacts in many different economic sectors, including agriculture, water resources, and human health. As such, many economic sectors will need to adapt to the threat posed by rising sea levels.
- Successful adaptation to rising sea levels requires an understanding of the relative importance of the various drivers of change, whether these be climatic, or non-climatic factors. Understanding changes in sea level in the highly populated and low-lying south Asian region is of major importance, but is challenging because of inadequate tide-gauge, and subsidence time-series, data.
- Tide gauge observations of changes in sea level in the region show a large range of variation in linear rates of relative sea level rise (RSLR), ranging from 0.7 mm yr⁻¹ at Chennai, to 8.2 mm yr⁻¹ at Charchanga, in the Ganges delta.
- Projections of future changes in RSLR across the region, in 2080-2099, are fairly similar, with mean increases in the range 0.32 m to 0.38 m under a stringent mitigation scenario (RCP2.6), and 0.53 m to 0.58 m under a business-as-usual scenario (RCP8.5). These projections do not take account of local subsidence, however, which in some areas is a more important driver of changes in RSLR than climatic factors.
- Coastal flooding is one of the most important impacts associated with rising sea levels, and a major study shows the avoided damage costs by investing in infrastructure adaptation, i.e. dikes and sea walls, to maintain present day standards, may be as high as 1800%.

Introduction

Changes in mean sea level are the result of the complex interplay of a number of climatic and non-climatic factors. Regional and local mean sea level may differ significantly from global mean sea level because of variation in the relative importance of the different factors across the world'. A Focus Paper on Global Sea Level Rise is also available which discusses these issues'. Particularly at the regional and local level, the importance of non-climatic factors, e.g. subsidence or uplift, may be more important drivers of sea level change, than climatic ones. As such, when developing projects and considering investment decisions that may be sensitive to changes in sea level, it is important that adequate consideration of all relevant factors has been taken, and the implications this may have for projects well understood. This Focus Paper highlights the challenge of understanding changes in sea level, and the associated impacts, for a region in south Asia, focused on the Bay of Bengal.

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CLIMATE SERVICE CENTER

Climate-Focus-Paper Global Sea Level Rise

Speed read

- Global mean sea level (GMSL) rise is one of the main indicators of climate change, and is of major concern for policy and decision makers, as it can have wide ranging impacts including on freshwater resources, agriculture, the incidence of flooding events, and loss of land in coastal areas.
- Adapting to these impacts is essential but challenging, as there is large uncertainty around how high sea levels may rise, and how fast.
- GMSL has increased by 0.19 m over the period 1901-2010, and the rate of increase has accelerated during the 20th century, with current rates estimated at 3.2 mm yr⁻¹.
- GMSL is projected to increase over the 21st century by between 0.28 m and 0.98 m by the year 2100 (IPCC AR5), and the future rate of increase is very likely to exceed the rate observed over the period 1971-2000.
- Using the IPCC AR5 estimates, it is possible to suggest an upper limit for GMSL of between 1.4 m and 1.6 m by the year 2100.
- This Climate-Focus-Paper is intended to provide information on various issues associated with GMSL rise, in order to support investment decisions in coastal and low-lying areas.

Background

When planning projects and investments in coastal and low-lying areas the potential impact of sea level rise (SLR) is highly relevant, particularly in the context of feasibility studies. Planners and decision makers may wish to know what a plausible upper limit for sea level rise may be. Establishing an upper limit for sea level rise is extremely challenging, as changes in sea level are the result of a range of different physical processes. At the global scale the chief processes are through thermal expansion as the oceans warm, and through the addition of water from land ice i.e. from melting glaciers and ice sheets. It is estimated that since the early 1970s these two processes account for around 75% of the observed global mean sea level rise'. Adapting to the impacts of SLR however, will take place at the local to regional scale, where additional processes related to vertical land movement e.g. subsidence or uplift, sedimentation rates, ocean currents, gravity, and regional variation in temperature and salinity, will also need to be considered in deriving local estimates of sea level change'. These factors will be discussed in more detail in a supplementary regional sea level focus paper. Here, the focus is on understanding past and future changes in global mean sea level, and the impacts that SLR has in a range of different economic sectors, illustrated with a detailed analysis of the impacts associated with flooding events. The work presented in this paper draws heavily on the results reported in the recent IPCC Fifth Assessment Report (AR5).

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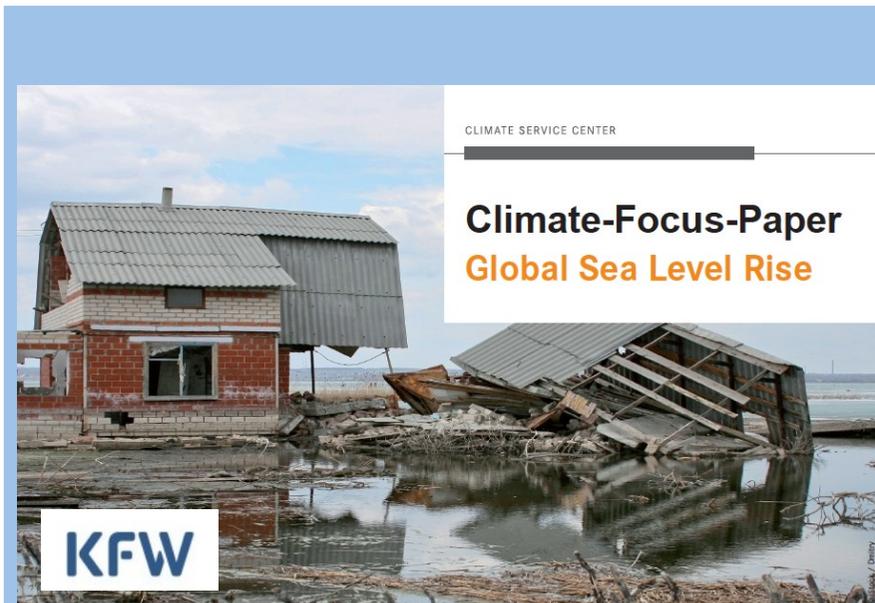
■ Climate-Focus-Paper

Value

Climate-Focus-Paper provide an **accessible but wide-ranging introduction** to a topic of major relevance to the work of development cooperation. The paper helps project managers and technical experts **to better incorporate and consider** the importance of the specific topic, when carrying out climate feasibility studies

Topics included in the Climate-Focus-Paper on Global Sea Level Rise

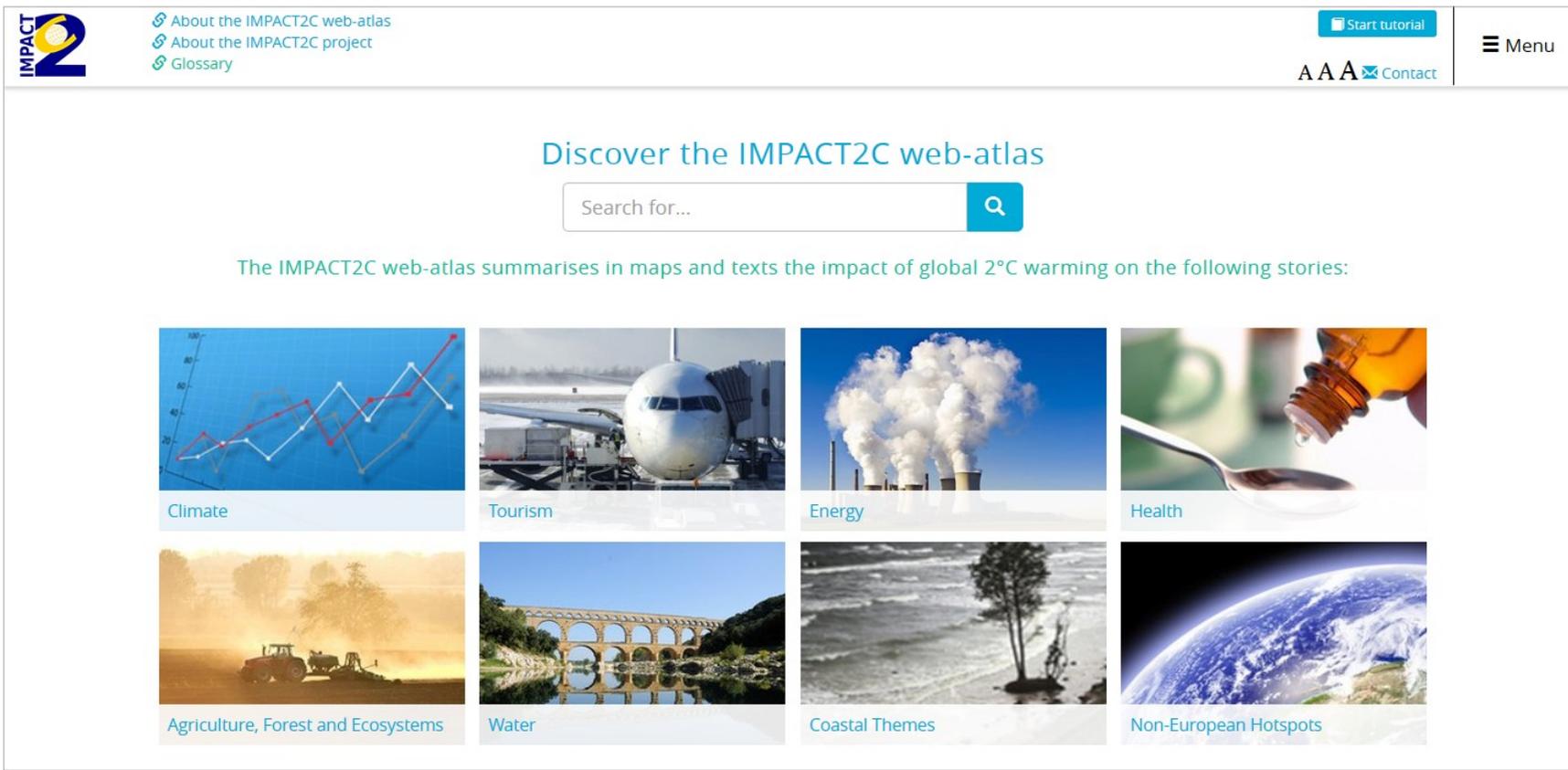
- "Speed Read" und Background
- Past and present sea level rise
- Differences between global and regional sea level change
- Future sea level change; potential limits of global mean sea level rise
- Impacts and Costing global mean sea level rise
- References and Weblinks



IMPACT2C web-atlas

GERICS coordinated the EU Project IMPACT2C: Estimating the key impacts of a +2°C climate change signal for different regions and sectors of the world. The IMPACT2C web-atlas provides climate change information for the development of possible adaptation strategies.

www.atlas.impact2c.eu



IMPACT2C

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About the IMPACT2C project
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Discover the IMPACT2C web-atlas

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The IMPACT2C web-atlas summarises in maps and texts the impact of global 2°C warming on the following stories:

Climate

Tourism

Energy

Health

Agriculture, Forest and Ecosystems

Water

Coastal Themes

Non-European Hotspots



GERICS products in a nutshell

Fact Sheets

- Climate Fact Sheets
- Site-characteristic Climate-Fact-Sheets
- GERICS Climate-Focus-Paper



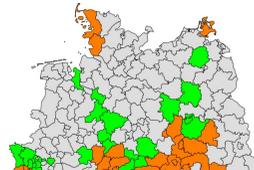
Toolkits

- Adaptation toolkit for Cities (*Stadtbaukasten*)
- Adaptation toolkit for Companies (*Unternehmensbaukasten*)
- Regional modeling toolkit (*Regionaler Modellierbaukasten*)



Maps and Visualizations

- GERICS Climate Signal Maps
- GERICS Climate Signal Maps (global)
- GERICS Rain Map



Trainings

- Customer specific training
- Sector specific training
- Capacity building programmes for countries in Africa, Asia and Latin-America
- Publications and tools supporting our capacity building measures



Publications

- National Assessment on Climate Change
- GERICS Reports
- Studies, Brochures and Documentations
- Klima konkret
- Newsletter
- Books
- GERICS articles at Earth System Knowledge Platform (ESKP) of Helmholtz-Association
- Publications in scientific journals



Webportals

- IMPACT2C Web-Atlas
- Klimanavigator
- Document Server Climate Change (Dokumentenserver Klimawandel)



For further information: Visit GERICS online

www.gerics.de

Key interfaces to users and practitioners are the GERICS web-services. The main gateway is the homepage, which is available in German, English, and in Arabic (only main pages).

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Climate Services for Adaptation

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Prototypical product development

Developing Climate Service Prototypes for Products and Services

Both the commercial and the public sectors have recognised the growing importance of climate-relevant questions, particularly in regards to reducing greenhouse gas emissions (mitigation). The need, however, for adapting to climate change is often neither sufficiently understood nor taken into consideration in long-term planning. One reason is because strategic planning in business, for example, might normally only cover a time period of a few years. It can also be attributed to the fact that decision makers often lack the necessary knowledge on this topic. GERICS is dedicated to this issue by developing application-oriented knowledge in close cooperation with partners and customers so that the climate perspective can be adequately integrated into the respective decision process. This concerns Climate Service product and service prototypes that precisely correspond to the particular user's needs. The practicability of the prototypes is then tested after development. The emphasis, however, lies in the development of prototypes. Operational creation of products is handed over to third parties where appropriate.

■ Contact

Contact:

Claas Teichmann
María Máñez
Climate Service Center Germany
Fischertwiete 1
20095 Hamburg

claas.teichmann@hzg.de
maria.manez@hzg.de
www.climate-service-center.de