IMPACT2C
“Quantifying projected impacts under 2°C warming”

Robert Vautard[1], Paul Watkiss[2], and IMPACT2C Team

[1] *Institut Pierre – Simon Laplace, Centre National de la Recherche Scientifique, Paris*

[2] *Paul Watkiss Associates*

On the behalf of Daniela Jacob, Helmholtz-Zentrum Geesthacht, Climate Service Center (HZG-CSC)

EU-FP7-co-funded collaborative project

Grant Agreement	**282746**
Duration	**10/2011 – 09/2015**
Co-ordination	**Dr. Daniela Jacob** **Helmholtz-Zentrum Geesthacht** **Climate Service Center**
Project Team	**29 partners from 17 countries**

Concept & objectives

IMPACT2C will analyse the impacts of 2°C global warming for Europe and other vulnerable global regions (Bangladesh, Africa (Nile & Niger basins) and Maldives)

✓ *Provide detailed ensemble based climate change scenarios, plus statistics and derived indices, tailored to the needs of various sectors, for the time slice in which the global temperature is simulated to be 2°C above pre industrial levels*

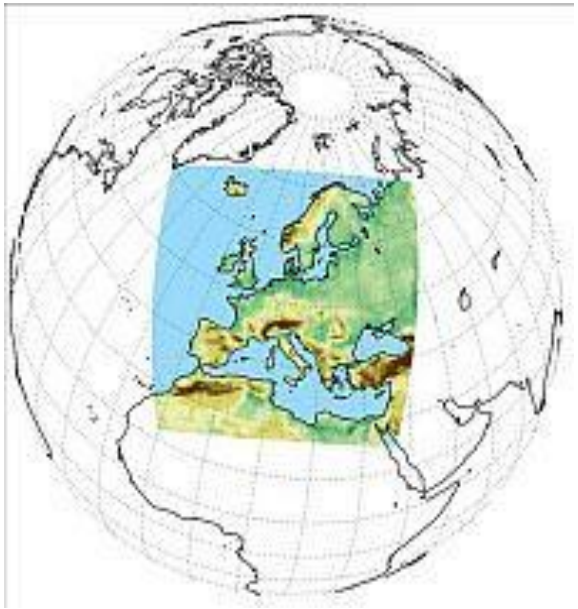
✓ *Provide detailed analysis of risks, vulnerabilities, impacts and costs for range of sectors using consistent RCPs/ and SSPs (Representative Concentration Pathways / Shared Socio-economic Pathways).*

✓ *Provide analysis of adaptation response strategies accounting for the regional differences in adaptive capacity*

Climate Analysis

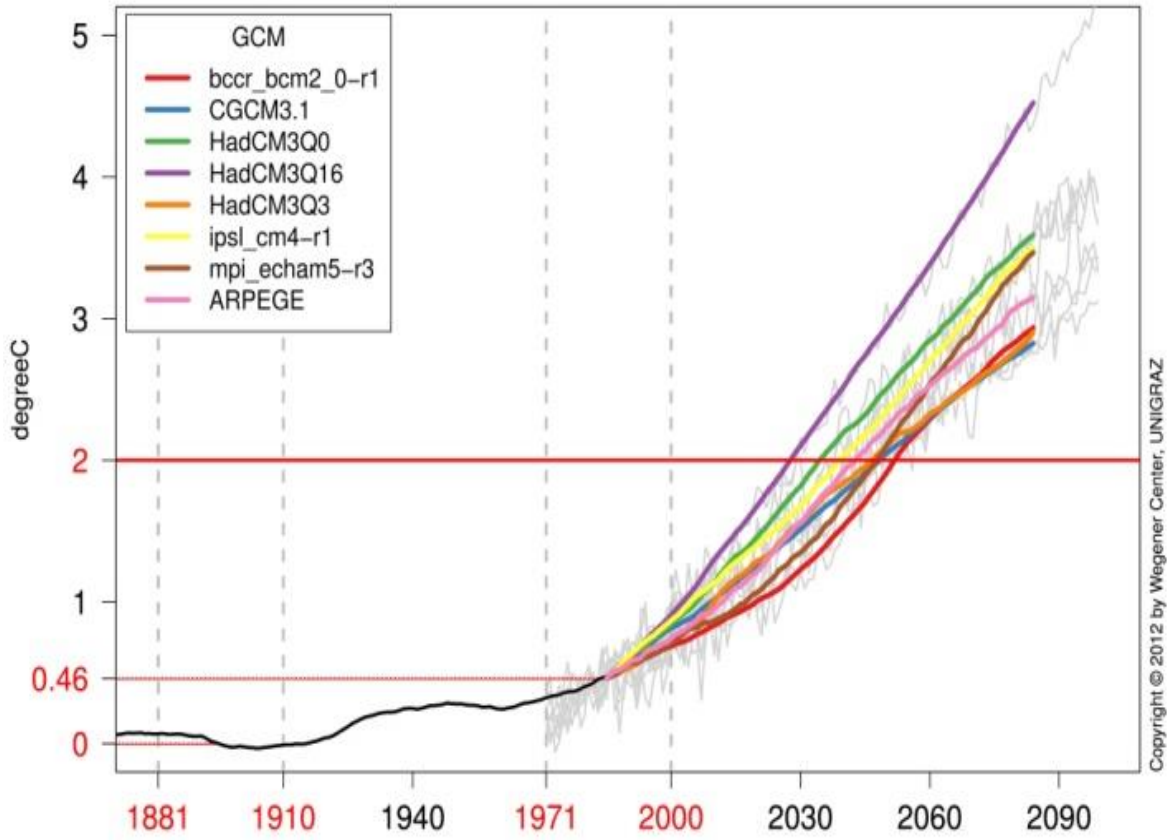
Two streams of climate simulations

- **Fast track**: Regional projections from ENSEMBLES FP7 project
  - Scenario A1B from CMIP3 (AR4) downscaled using regional climate model
- **Slow track**: EURO-CORDEX regional climate models
  - scenarios RCP2.6, RCP4.5 and RCP8.5 (AR5) zoomed over Europe by ~10 models



EURO-CORDEX: Downscaling of CMIP5 projections with unprecedented resolution: 12 km

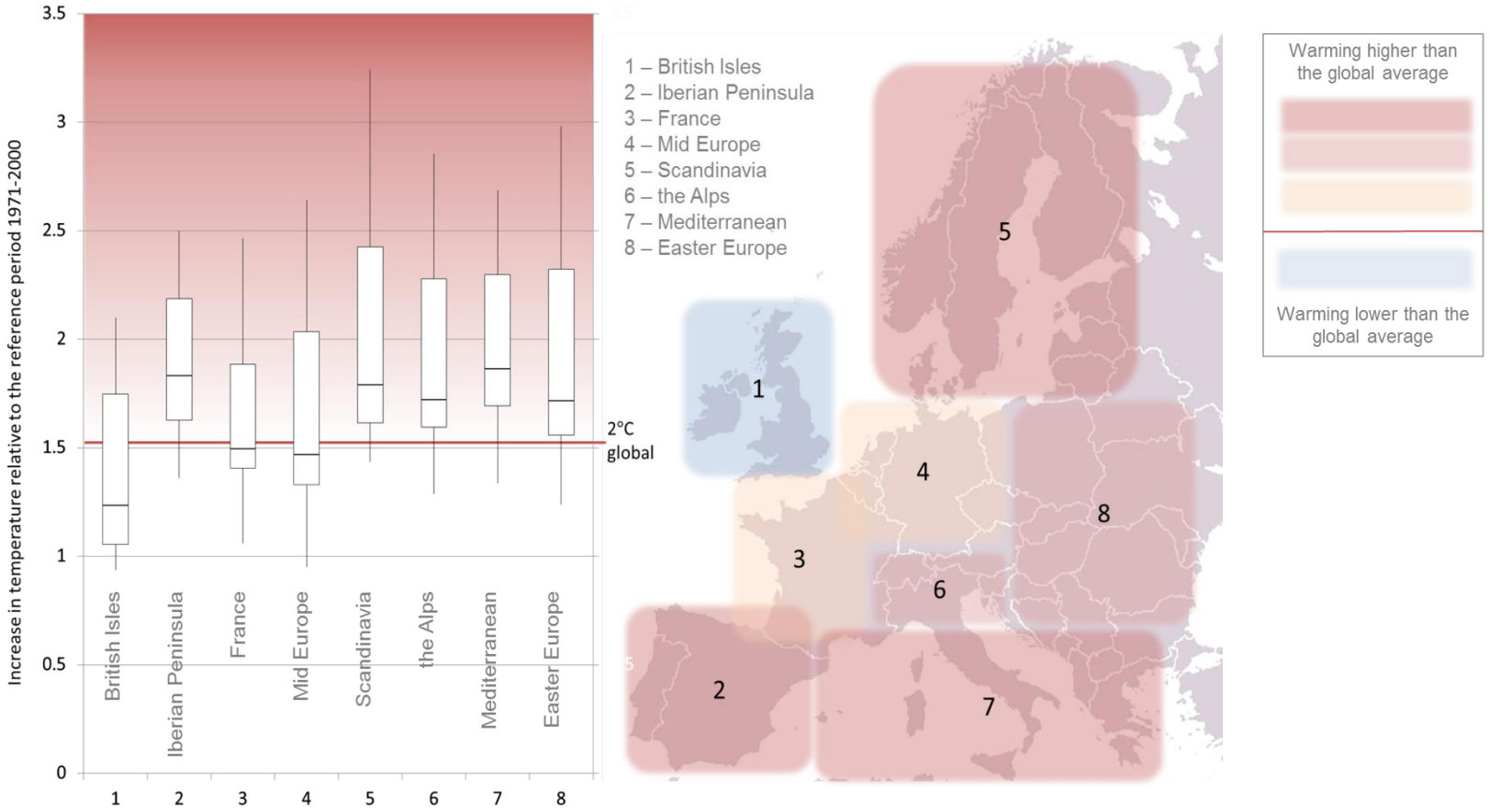
When is +2°C relative to pre-industrial reached?
Scenario SRES A1B : quite soon: 2030 - 2050



Evolution of global temperature. Observed historical (black line) and future projections from different GCMs based on the A1B emission scenario.

Time series are smoothed using a 30-year running mean. The 2°C threshold is marked in red.

When does+2°C mean for Europe ? Higher than the global average

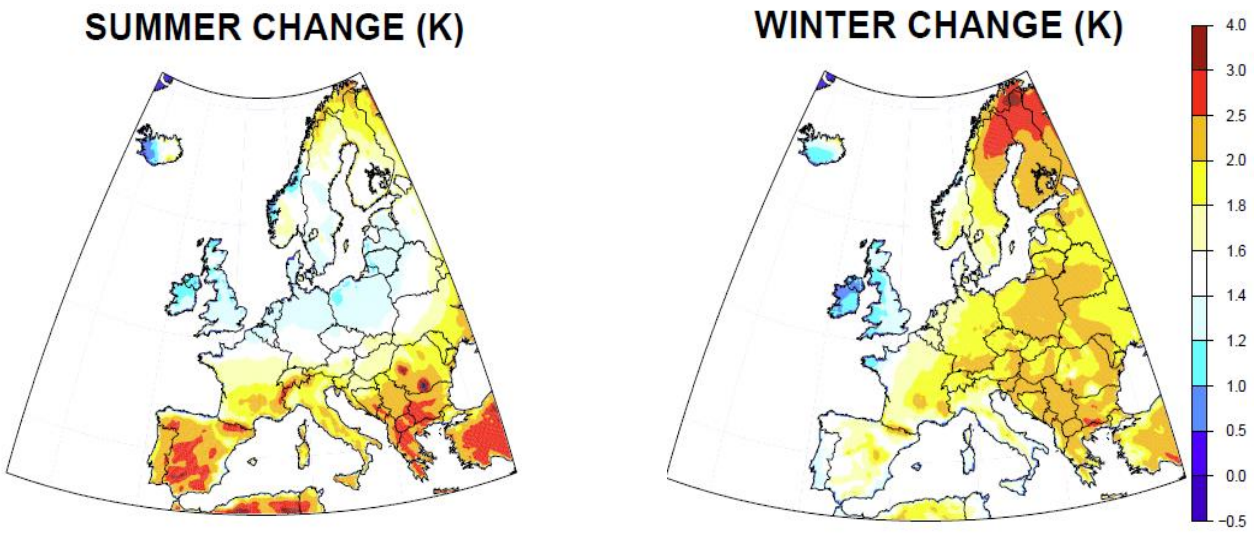


Changes relative to 1971-2000 of a global +2°C warming relative to pre-industrial

19 RCM for A1B for 30-year period when global mean +2 relative to 1881-1910. Landgren et al. 2013.

Temperature changes to expect in Europe for a +2°C warming:

- Enhanced summer heat in Mediterranean regions
- Enhanced winter warming in Northern and Eastern Europe
- Agreement among all models

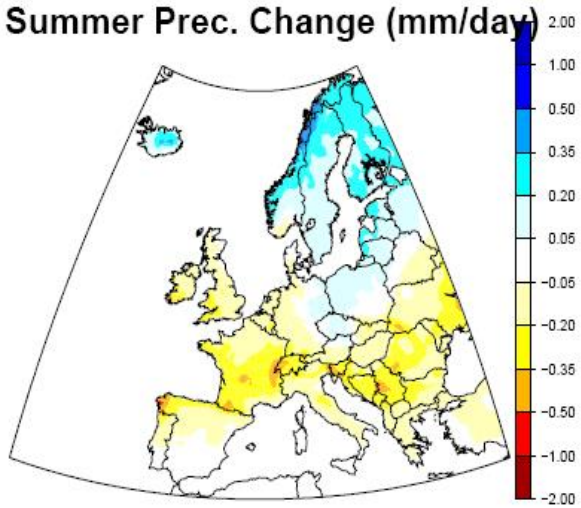


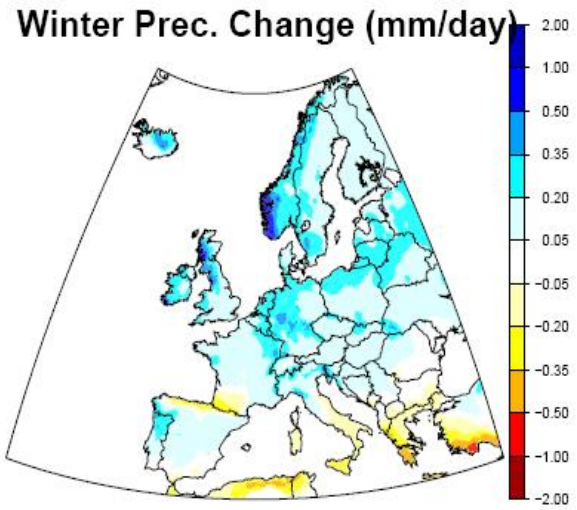
Average RCM (°C) between reference period (1971 – 2000) and period of global 2 degrees. White colour is equivalent to 2 degrees from pre-industrial, i.e. areas yellow or red are warming faster. Results of 15 GCM-RCM.

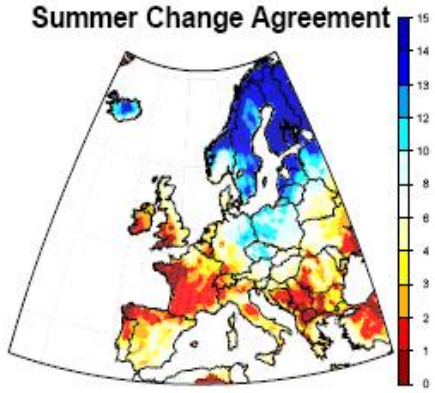
Source: IMPACT2C

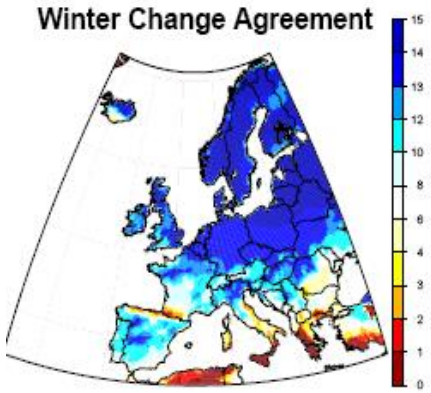
Changes to expect in Europe for a +2°C warming:

- Enhanced summer drought in Central Europe
- Enhanced precipitation in winter in most areas
- Agreement among all models in most regions







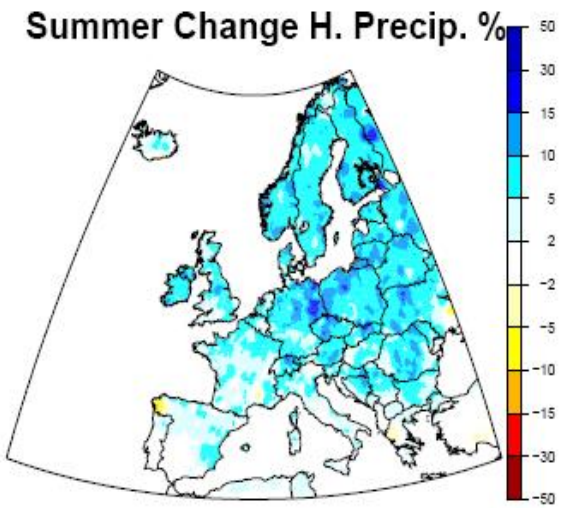


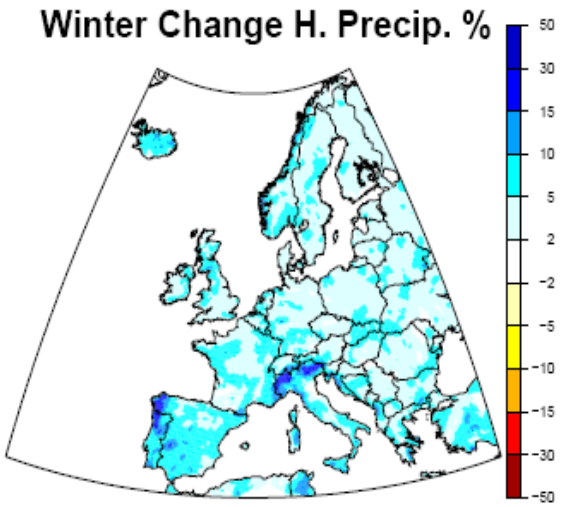
Average RCM between reference period (1971 – 2000) and period of global 2 degrees. Results of 15 GCM-RCM.

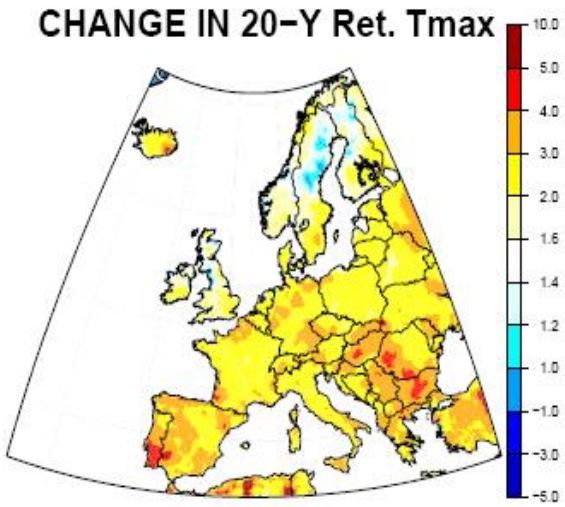
Source: IMPACT2C

Changes to expect in Europe for a +2°C warming

More heavy precipitation everywhere and in all seasons 2-20%
More summer hot extremes almost everywhere +2°C - +4°C
Less winter cold spells







Changes in 20-year return values

Average RCM between reference period (1971 – 2000) and period of global 2 degrees. Results of 15 GCM-RCM.

Source: IMPACT2C

What is the influence of the new RCP runs vs. SRES? When is +2°C relative to pre-industrial reached…..slightly earlier for 1.5/2C runs.

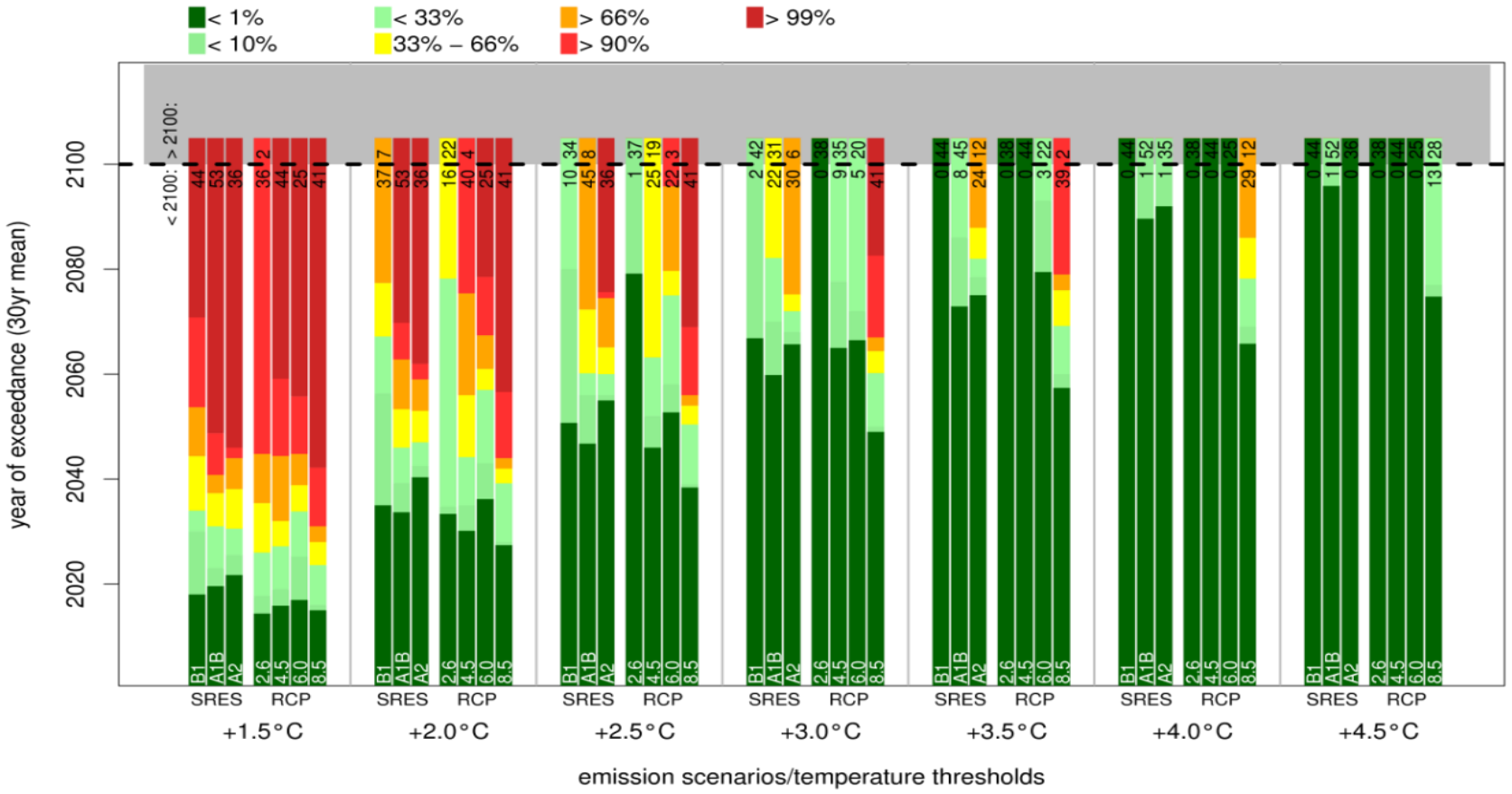


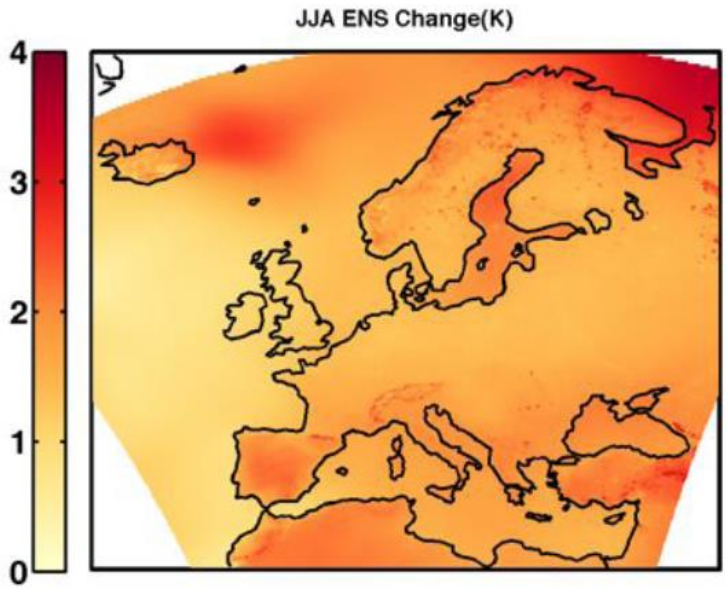
Figure source : Uni-Graz
Courtesy of A Gobiet

EURO-CORDEX : New ensemble of projections with unprecedented resolution (12 km)

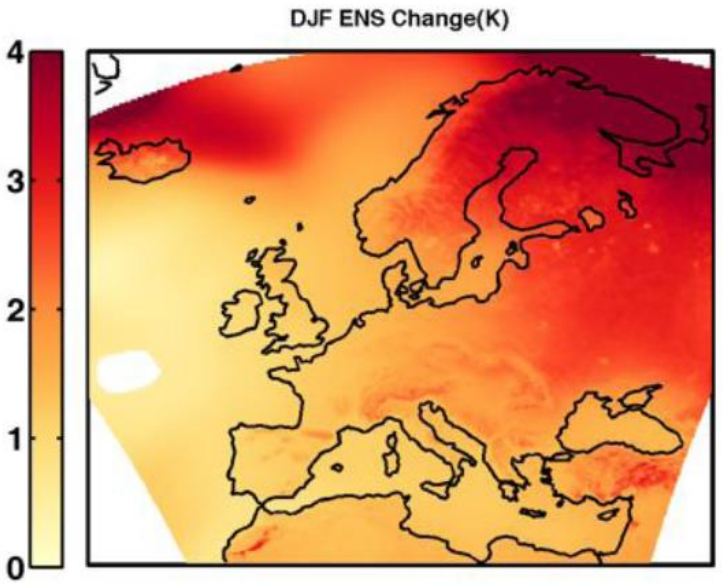
→Improvement in complex terrain (mountain ranges, coasts)

→Improvement of extreme events (heavy precipitations)

Summer



Winter

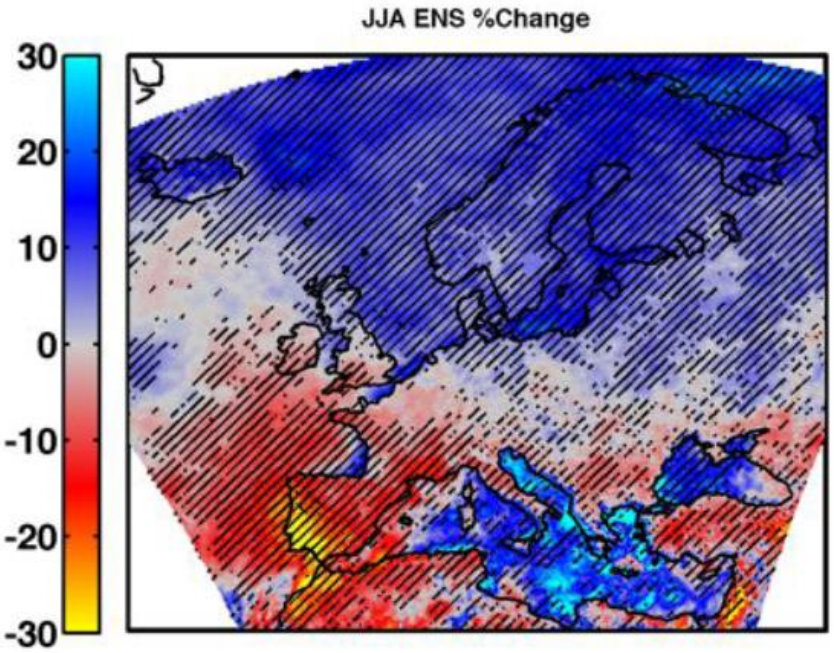


Changes in Temperature

Figure source : BCCR
Courtesy of S Sobolowski

ROBUST CHANGES IN PRECIPITATION

Summer



Winter

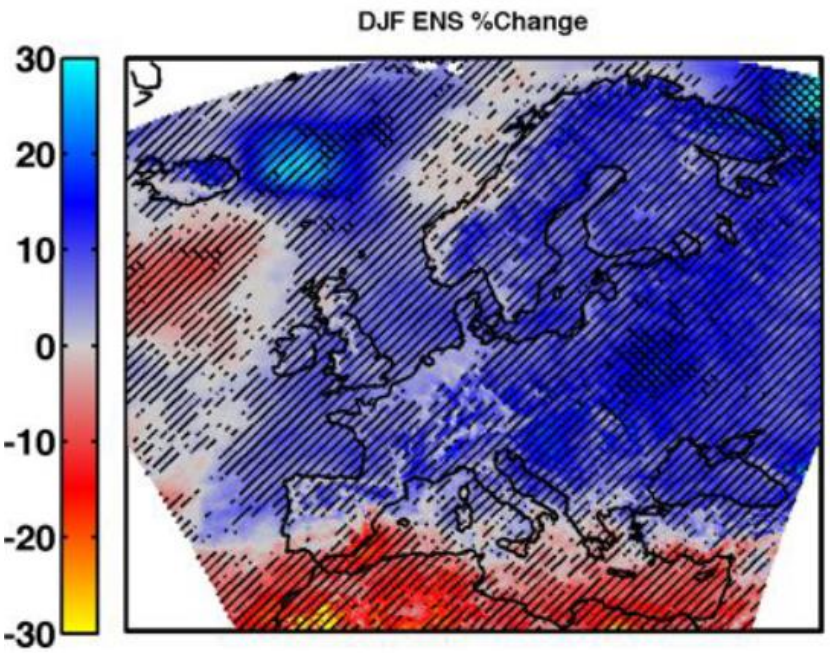
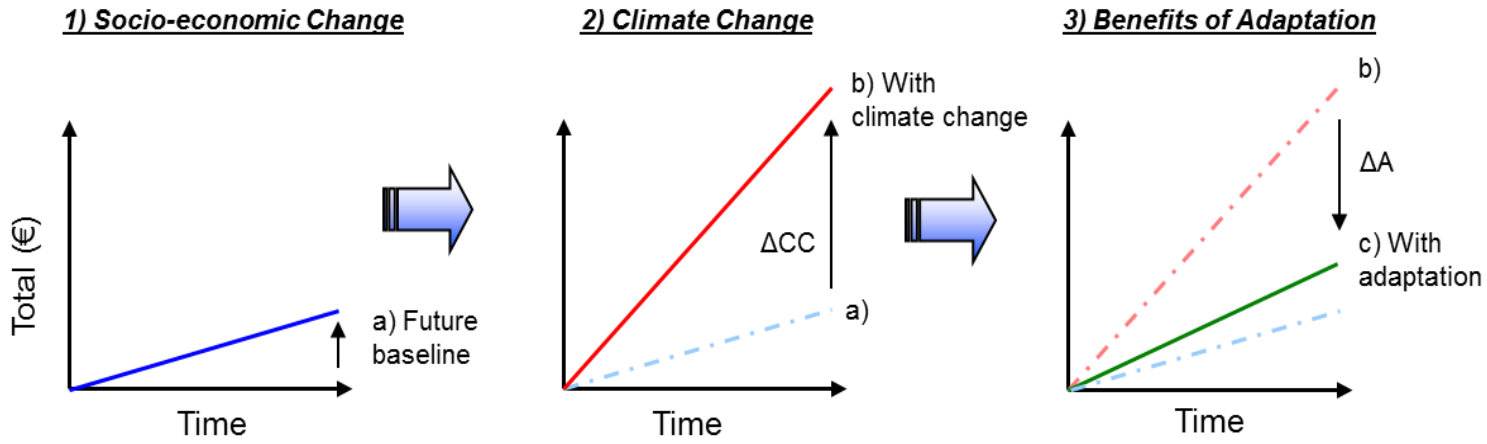


Figure source : BCCR
Courtesy of S Sobolowski

Impacts and Adaptation

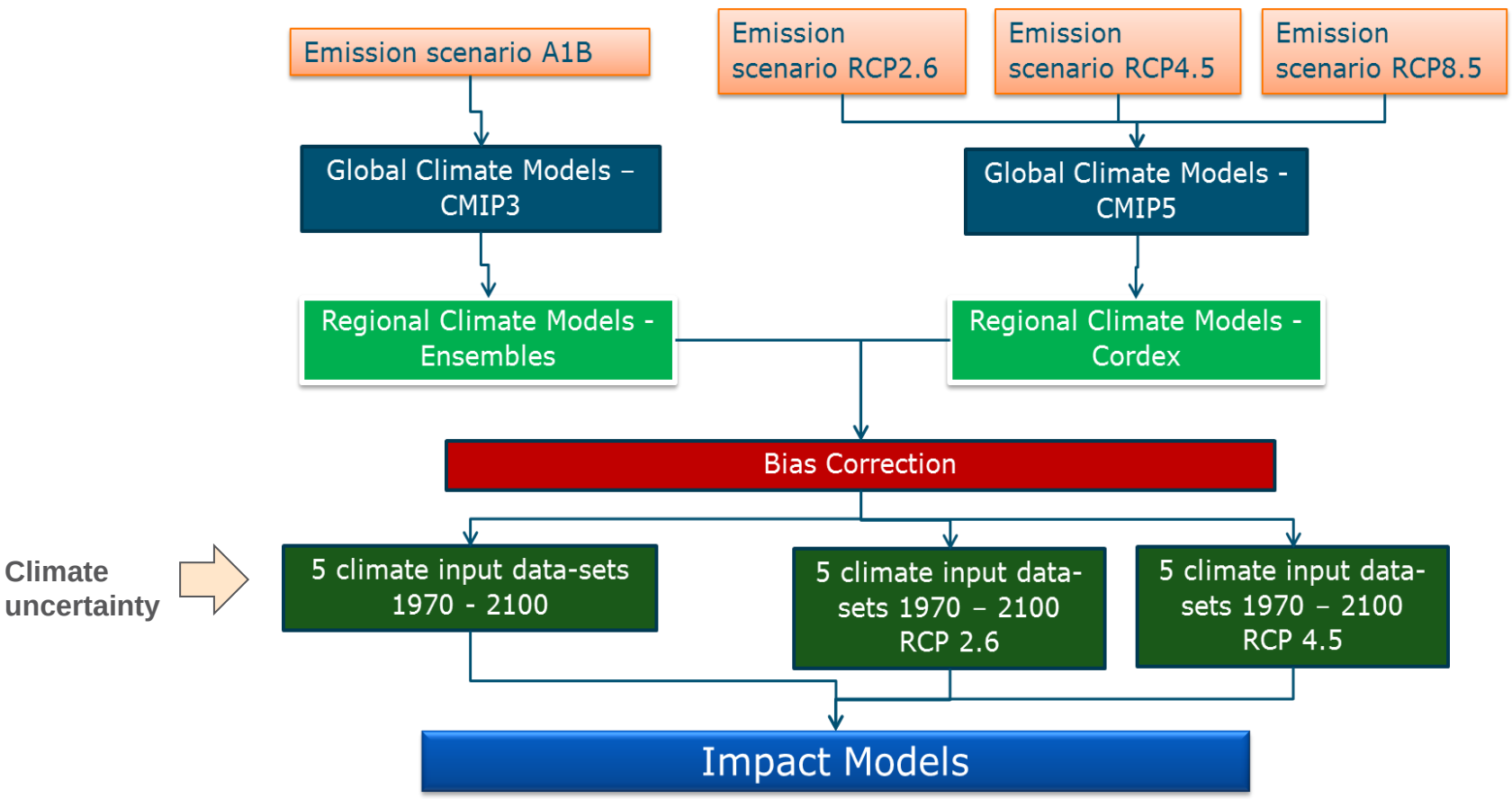
- **IMPACT2C undertakes scenario based impact assessment**



- Impacts and economic costs of climate change
- European wide analysis with new RCP and SSP – 2 degrees and higher scenarios, considering scenario and climate model uncertainty
- Distributional impacts across Europe, e.g. higher summer warming in South
- Analysis of adaptation at European scale with decision making under uncertainty

Figure source : UNFCCC, 2009 Based on Hunt and Boyd, 2006

Climate Inputs for Impact models

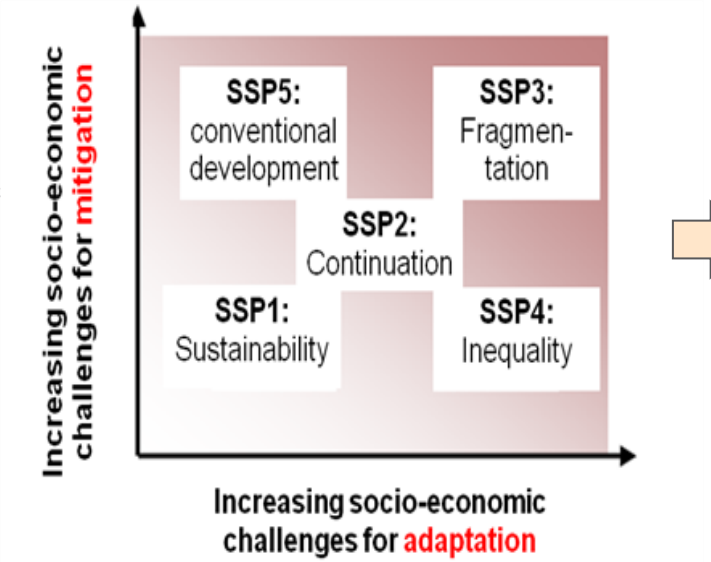


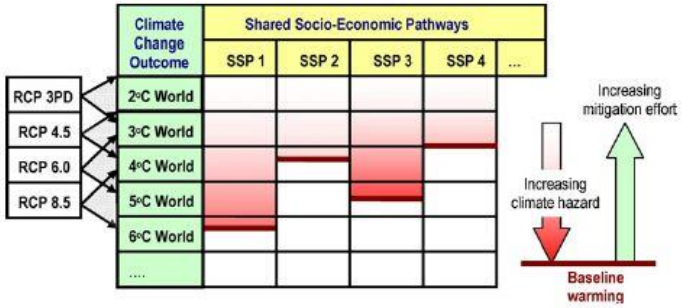
Socio-economic scenarios

Future socio-economics is as important as future climate signal

New Shared Socio-economic Pathways

Socio-economic uncertainty





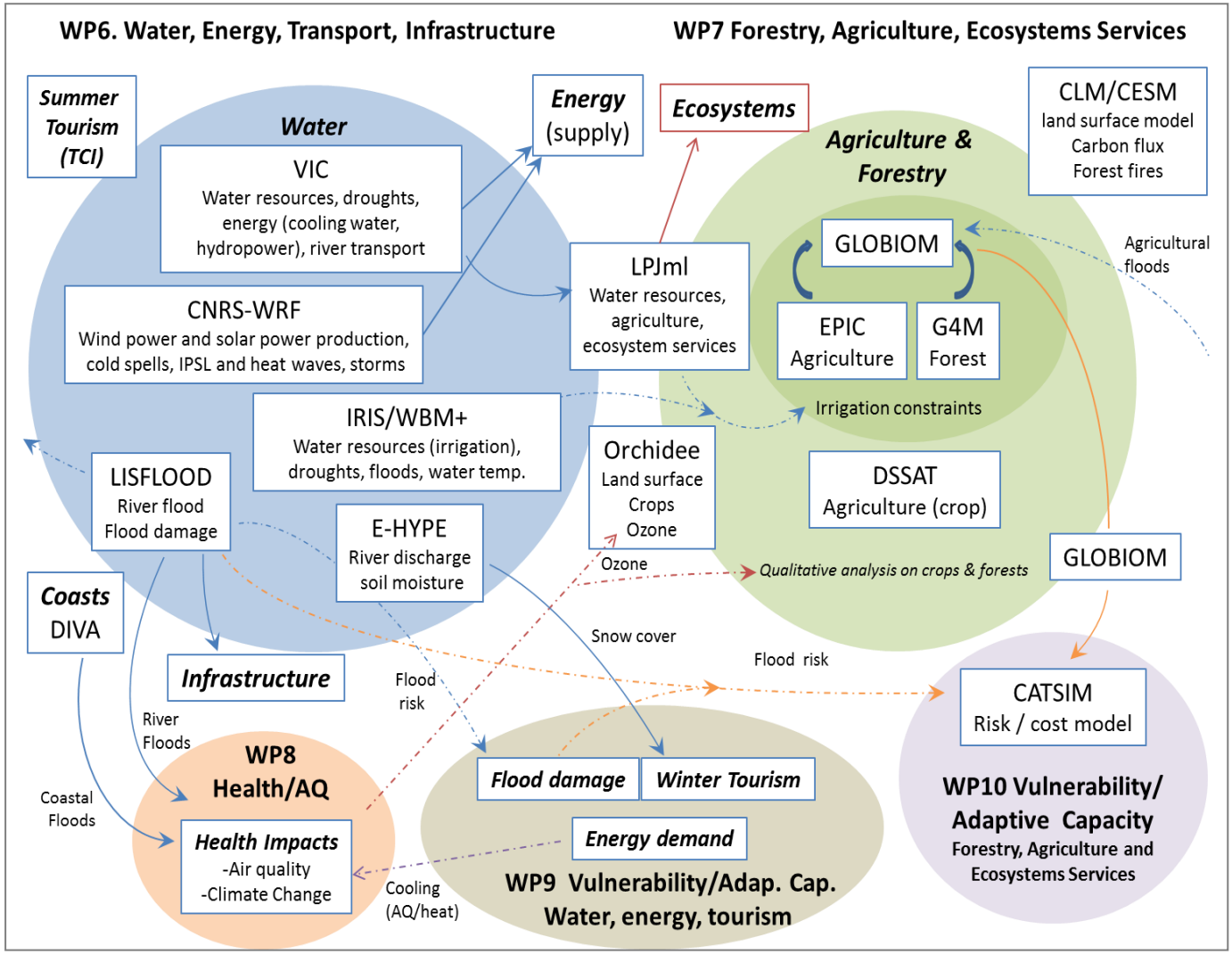
Linking RCP and SSP combinations together

Figure source : Moss et al, 2011; van Vuuren 2012

IMPACT2C Model Environment

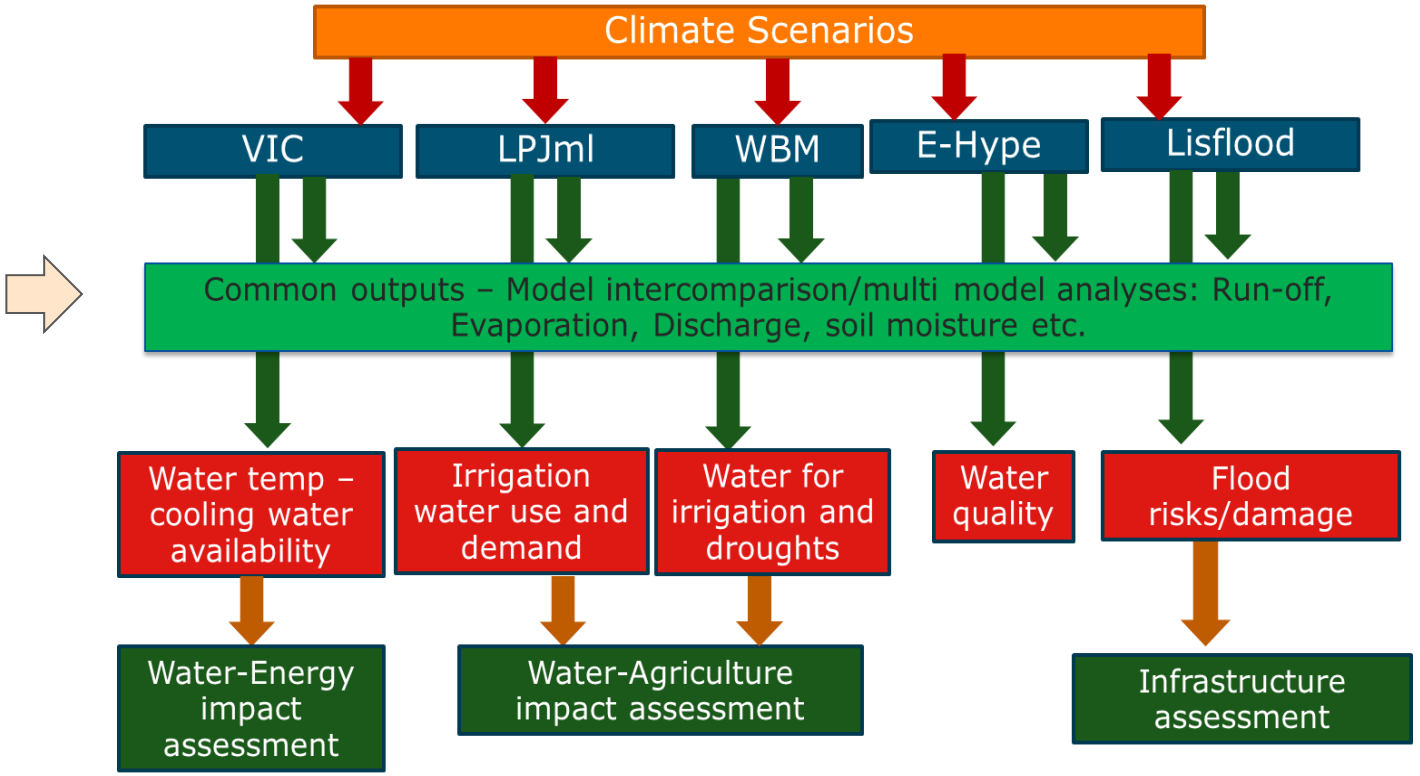
-Water (x-sectoral)
-Coastal zones
-Agriculture & forestry
-Health (inc. CC+ AQ)
-Energy
-Tourism

Hard and soft links



Example – water sector – inter-model comparison and multiple impacts

Impact model uncertainty



Impact of two degree global warming on changes in run-off in Europe using four different hydrological models.

Impact model uncertainty

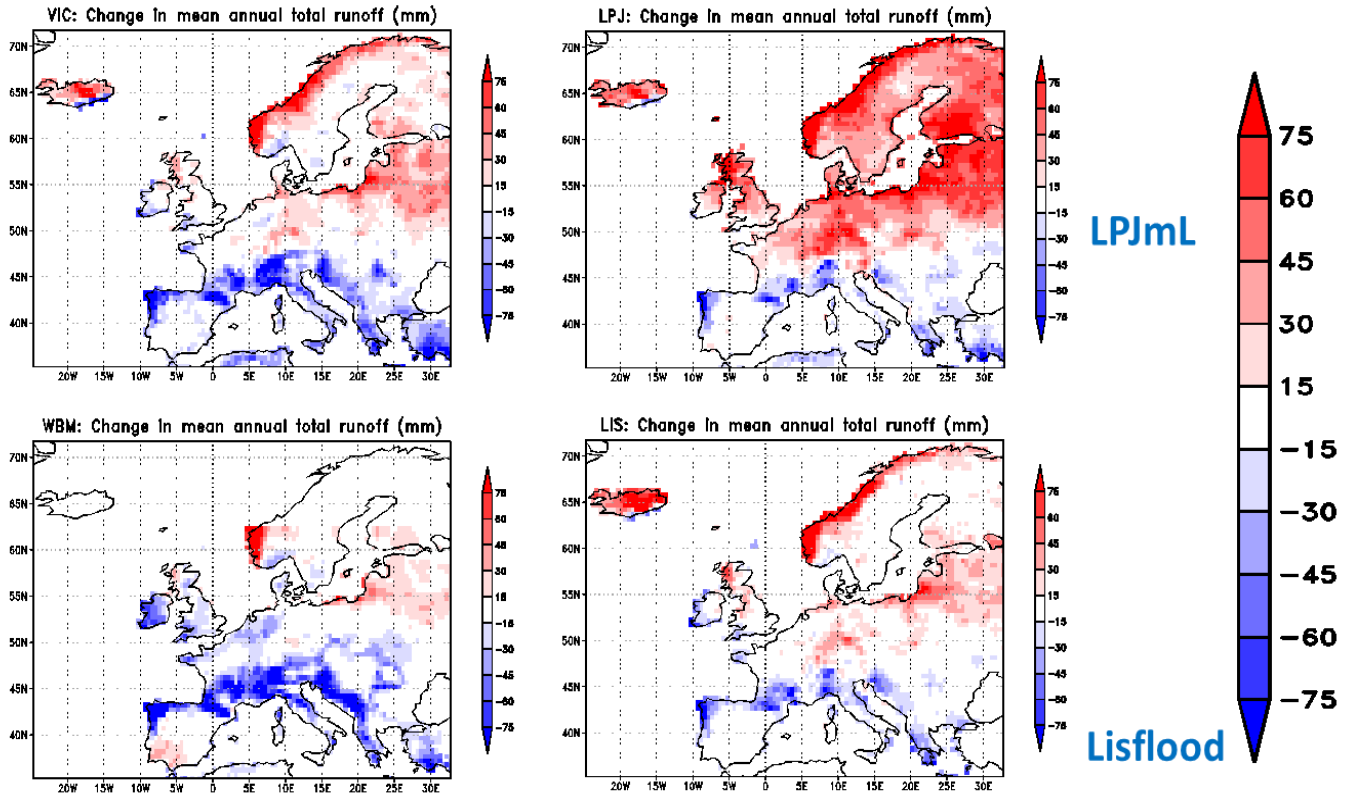
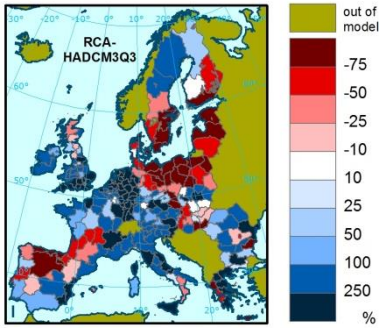


Figure source : IMPACT2C

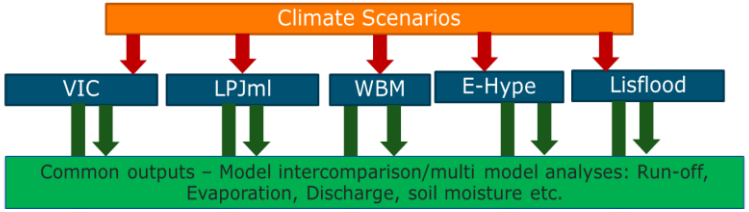
Linking to Impacts

Snow cover (winter tourism)

River flood damage



Health and well-being from flooding



Hydro-electric Power

Power station cooling

Water availability for irrigated agriculture

Figure source : i-stock

Linking to global systems where relevant

Global demand and supply

GLOBIOM framework

Inputs from sector models

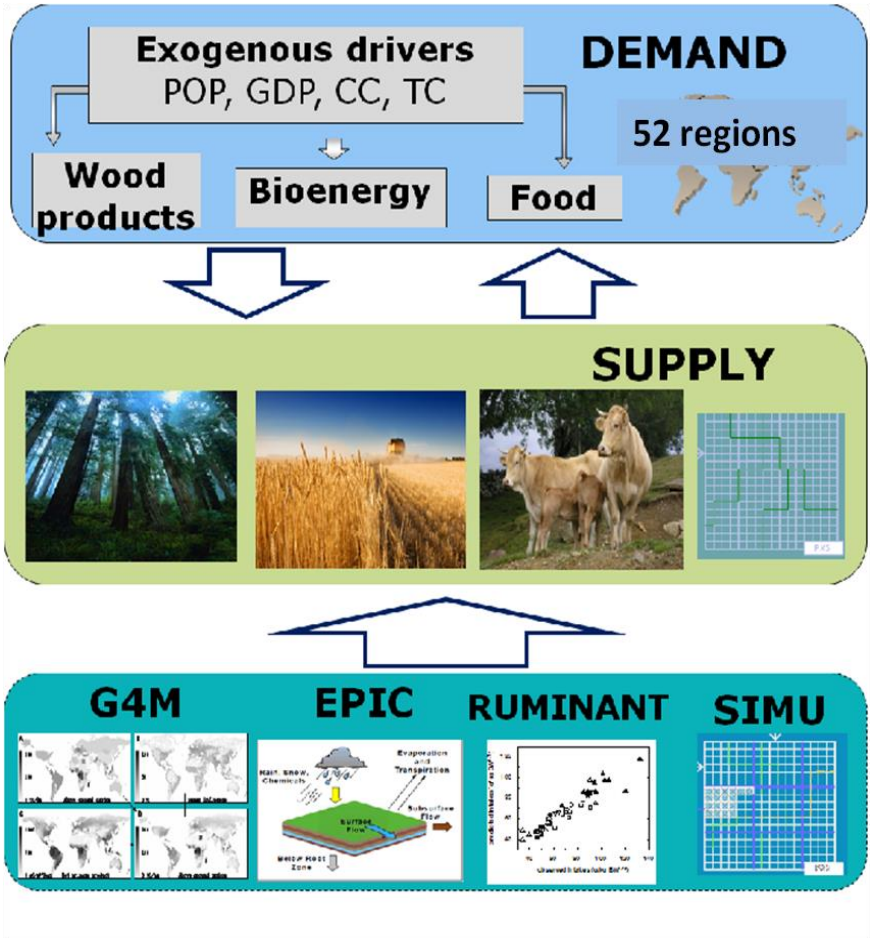
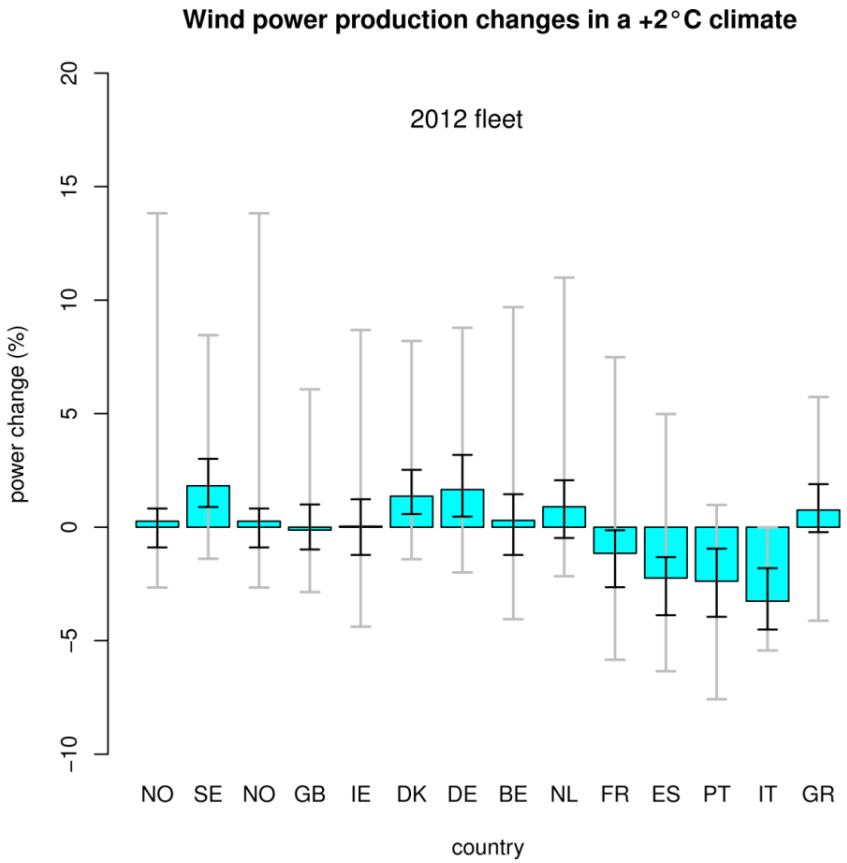


Figure source : IIASA

Early Results: Linking pathways with impacts – e.g. Renewables

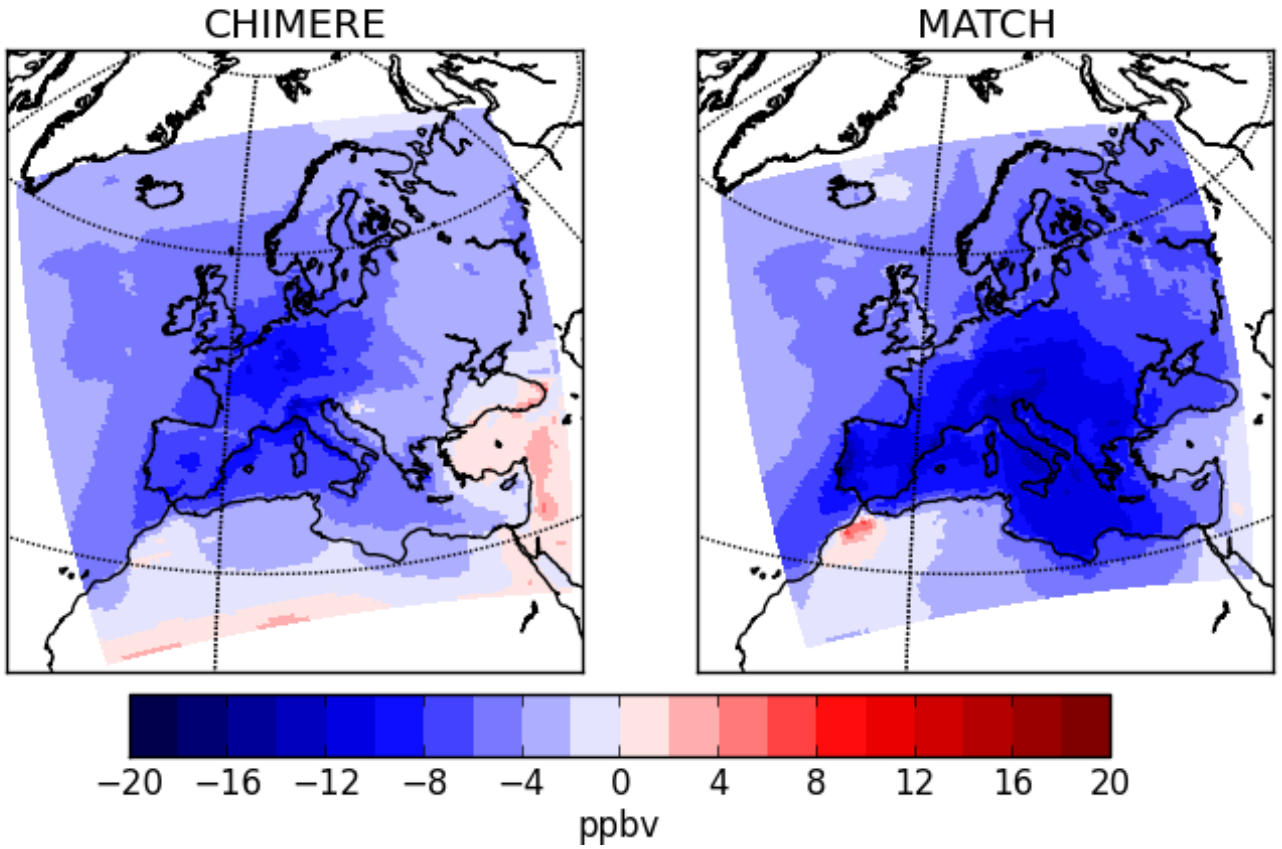


Changes expected in wind power production in European fleet for a +2°C warming

Figure source : IPSL
Courtesy of I Tobin

Early Results: Assessing Impacts of 2° across Europe:

Impacts of Climate Change and Emission Changes on Air Quality and Health In Europe



Ozone Daily Maximum in Baseline Scenario (IIASA), difference between +2°C and current periods for 2 IMPACT2C models

Figure source : IPSL and SMHI
Courtesy of G Lacressonniere and E Magnuz

Moving to adaptation pathways

Updated headline adaptation costs and benefits for European and MS

- E.g. coastal impacts (Diva), river floods (Lisflood), agriculture (EPIC/GBM)
- Looking across range of uncertainty from climate projections to impacts

- Building on existing FP7 research on methods for addressing uncertainty
- Consideration of adaptation pathways
  - Moving beyond technical only perspective at European scale
  - Applying iterative concepts to EU scale

Iterative adaptation pathways

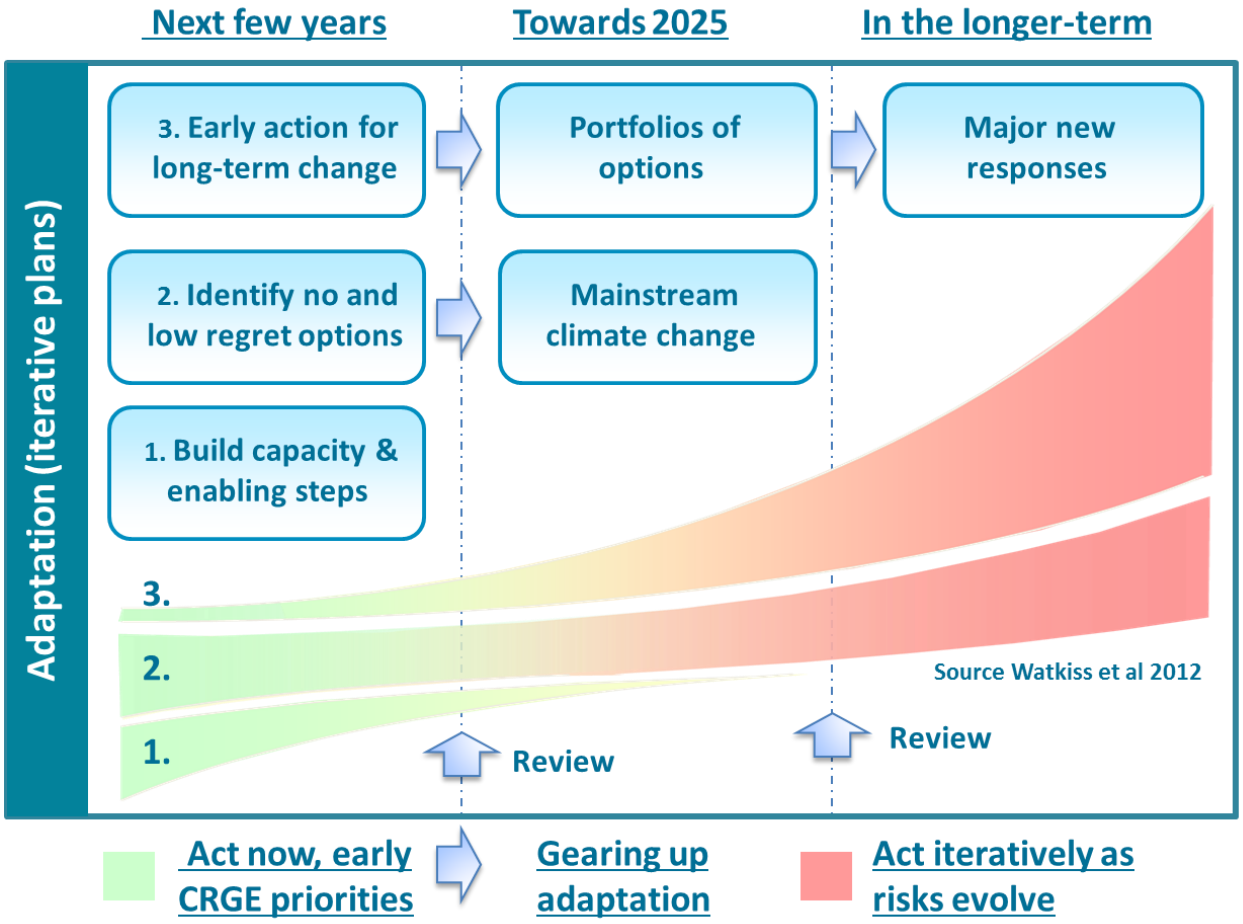


Figure source : Watkiss et al 2012

Taking account of cross-sectoral effects

Increasing recognition of cross sectoral and cross cutting effects

- Where impacts in one sector cascade through to indirect effects in another.
  e.g. flooding damages property, but also leads to health effects.

- Where risk of amplification or cumulative effects where sectors are linked,
  e.g. impacts greater than if sectoral alone (convergence)

- Where cross-sectoral demand that require wider analysis
  e.g. water resource availability where multiple sources of demand.

- At the wider economic level, where economic impacts in one sector ripple through other sectors and across whole economy.

Adaptation often needs to be cross-sectoral in response – synergistic

IMPACT2C looking at these hotspots, adaptation case studies (IWM, Coast, Adapt Policy)

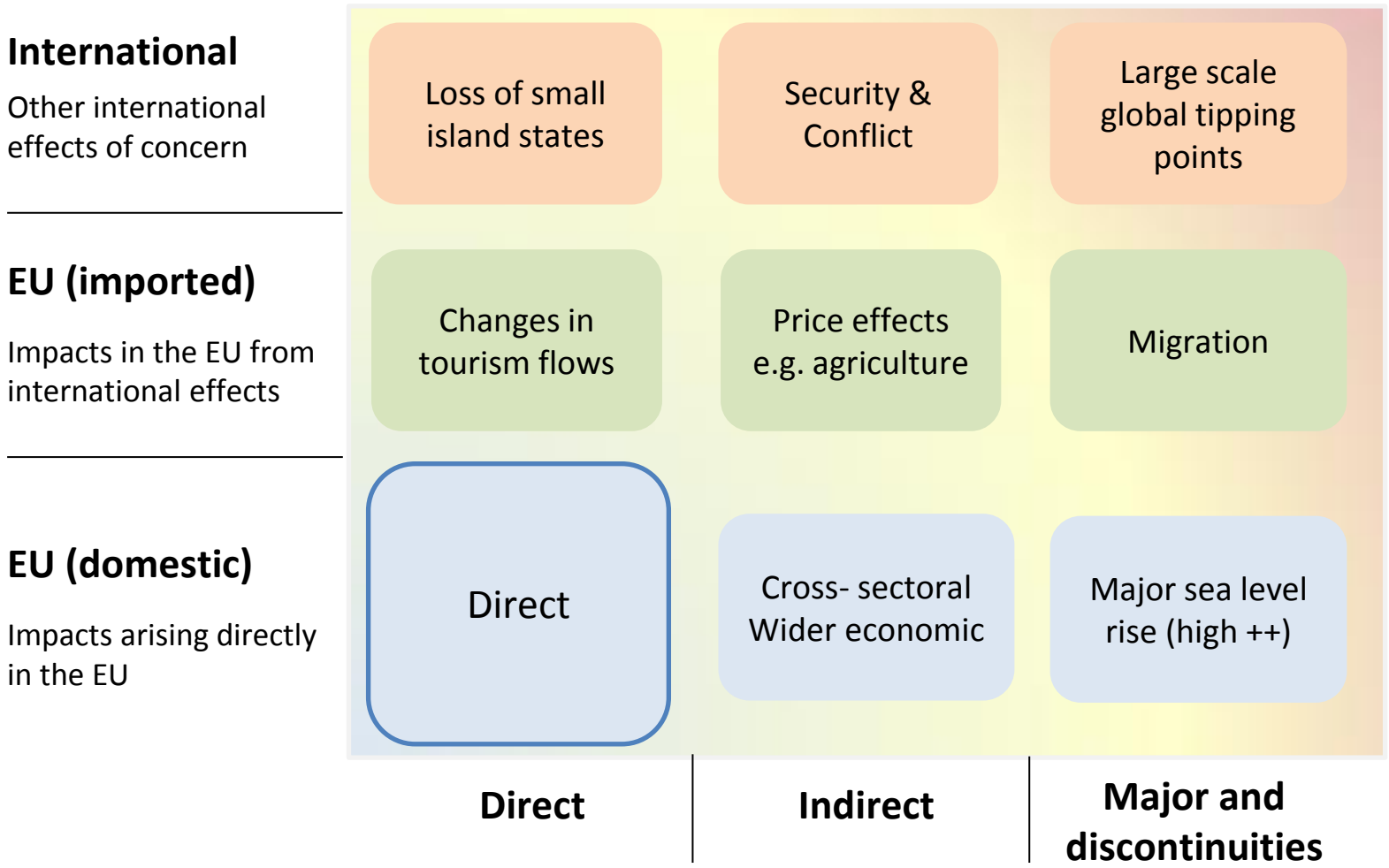


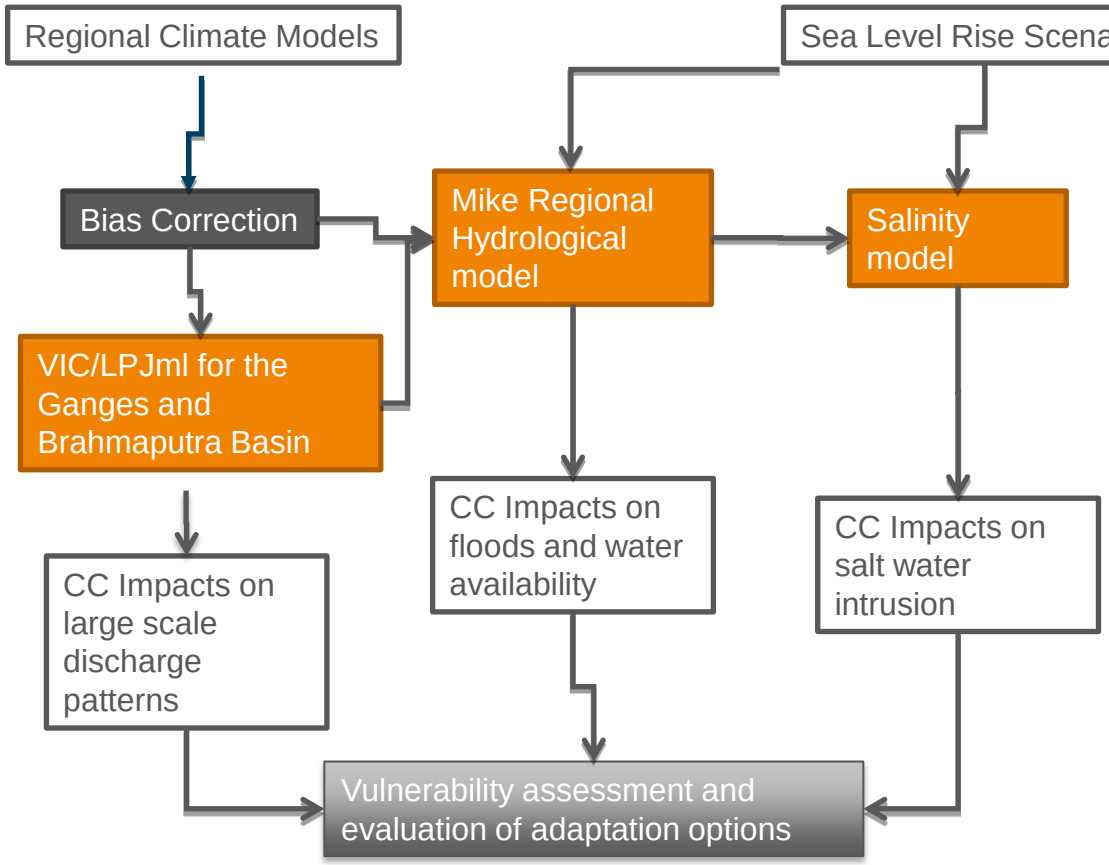
Figure source : Watkiss and Hunt, 2011

Analysis of Key vulnerable global regions

- Bangladesh
- Maldives (SIDS)
- Africa (Nile & Niger basins)

All likely to suffer disproportionately under 2° or 1.5°C of change

Bangladesh



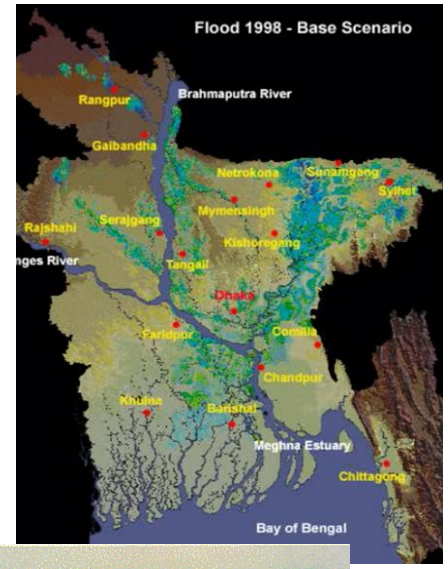


Figure source : WU, Bangladesh Centre For Advanced Studies Association, institute of water modelling (Bangladesh)

Maldives

1. Analysing sea-level impacts using a climate impacts model (DIVA), with a focus on small islands.

2. Understanding today's problems and adaptation solutions for the Maldives, using (four) case studies.

3. For the case studies, analyse impacts (e.g., flooding and submergence) through GIS and possible adaptation options – feedback to 1.

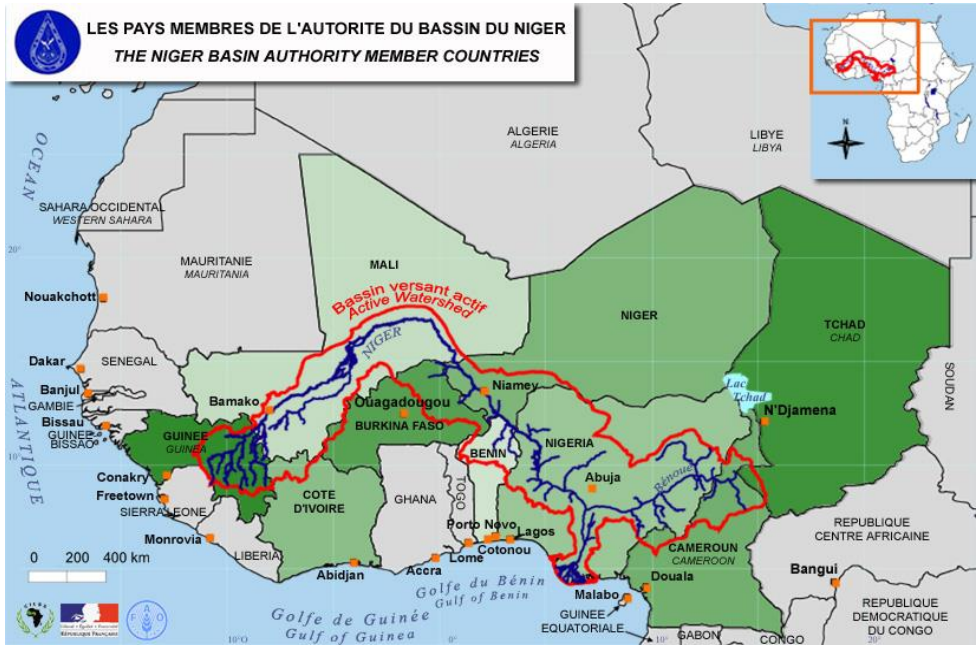
4. Qualitative investigation of other climate aspects of coastal change.

Figure source : UoS, ECF, CSC, Ministry Of Housing And Environment Maldives

Africa case study (Niger & Nile)

Focus on vulnerability assessment in African regions due to a global 2 °C:

1. *River economies*
2. *Demographic pressure*
3. *Vulnerability*
4. *Adaptation*



9 countries and 9th longest river in the world// 1.5M KM2//110 M people with 70% rural// life expectancy 50yrs// 7 out of 9 countries among 20 poorest// underexploitation of water resources

the Niger Basin

Figure source : ENEA, African centre of meteorological application Development

Outputs

- Current phase undertaking analysis of impacts
- Series of policy briefs to present the results
- Linking together in European atlas

Please visit www.impact2c.eu

for more information