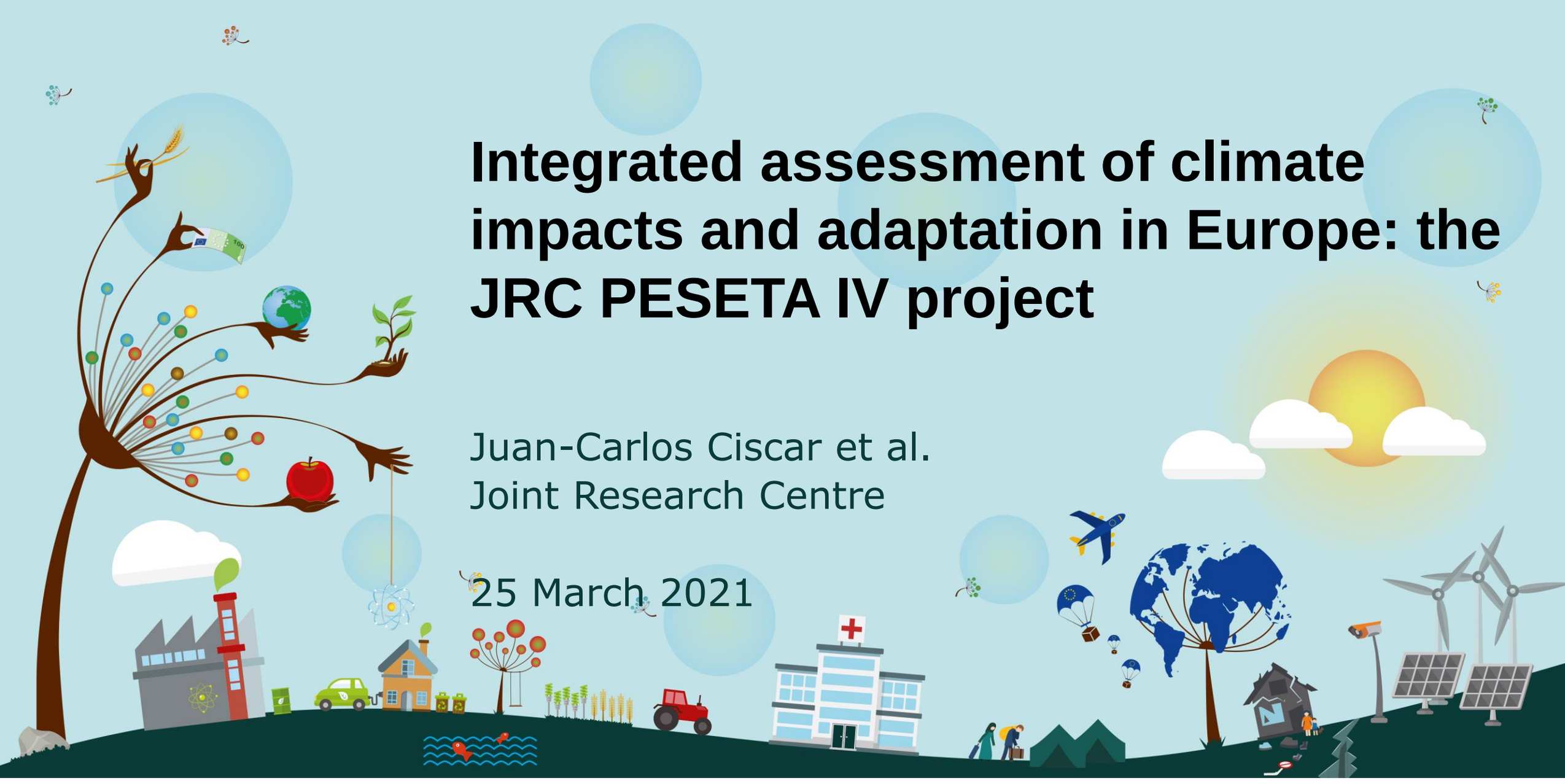
Integrated assessment of climate impacts and adaptation in Europe: the JRC PESETA IV project

Juan-Carlos Ciscar et al.
Joint Research Centre

25 March 2021



ECFIN Webinar on the economics of climate change:
Towards a climate neutral economy - what role for economic policies?

European Commission

Climate change impacts and adaptation in Europe: the JRC **PESETA** studies

Projection of Economic impacts of climate change in Sectors of the European Union based on boTtom-up Analysis

What are the most important climate impacts in Europe?

Is there a regional pattern in impacts?

How much climate impacts are avoided with mitigation?

How much climate impacts are avoided by adaptation?

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Policy context

2007 Green Paper on Adaptation

…

2015 The Paris Agreement

…

2020 The European Green Deal

2021 New EU Strategy on Adaptation

Methodology

Multi-disciplinary, integrative methodology

- Results are mostly based on bottom-up, process-based impact models

- Consistency: common, high-resolution climate scenarios; same socio-economic scenarios (ECFIN Ageing Report)

Focus on **1.5C, 2C and 3C warming levels** (average of RCP4.5 and RCP8.5)

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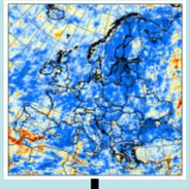
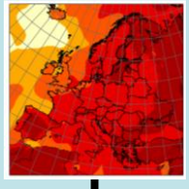
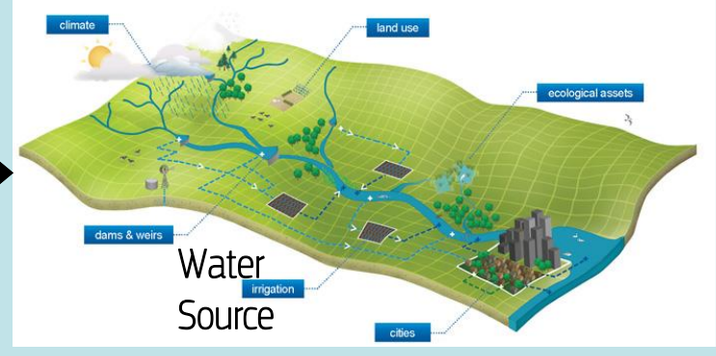
Example impact modelling: river floods

high-resolution climate information

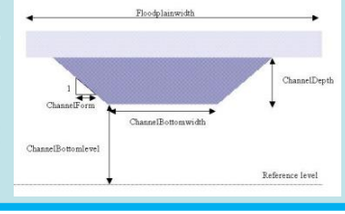






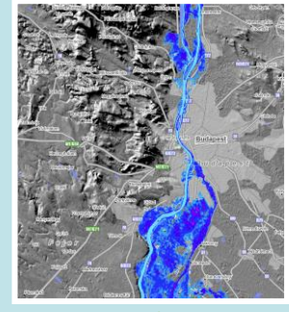
data on soils, land cover, river basins, ...

data on river dimensions, discharges, etc



Hazard analysis

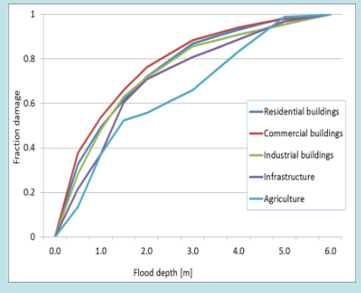
Hazard



Impact

Exposure

Vulnerability



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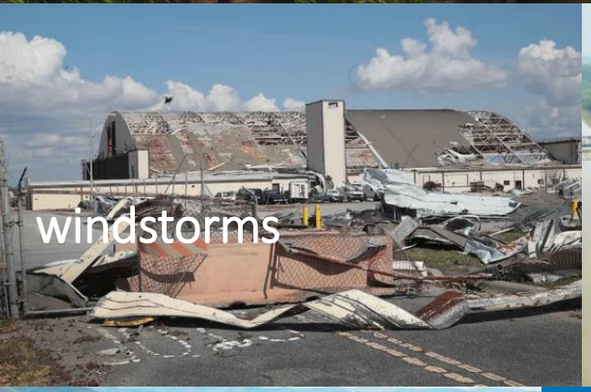
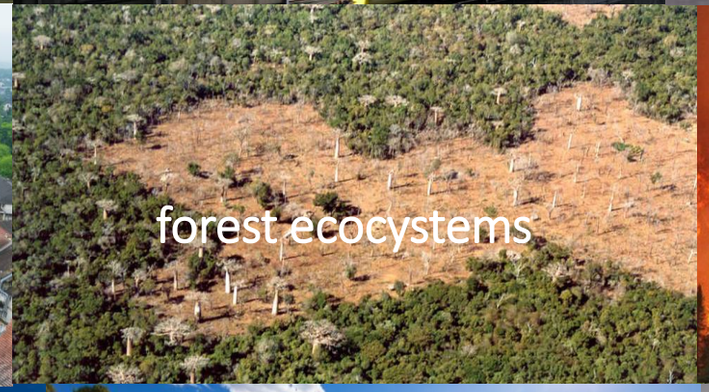
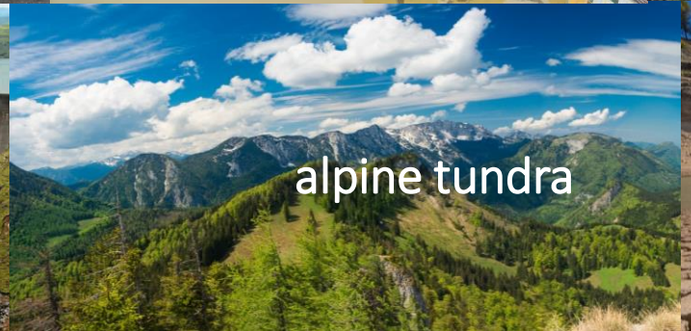
PESETA climate impact categories

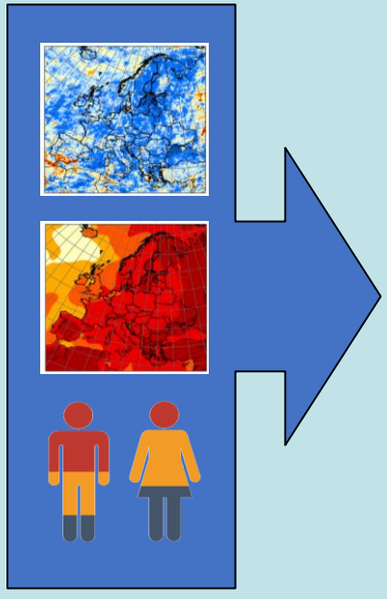






JRC PESETA IV project

Climate change and socioeconomic data



Bio-physical modelling

Agriculture

River floods

Human health

Energy

Droughts

Coasts

Windstorms

Habitat loss

Forest fires

Forest Ecosystems

Water

Ecosystem services

Tipping points

6th mass extinction

Economic results

Bio-physical results

Impacts not considered

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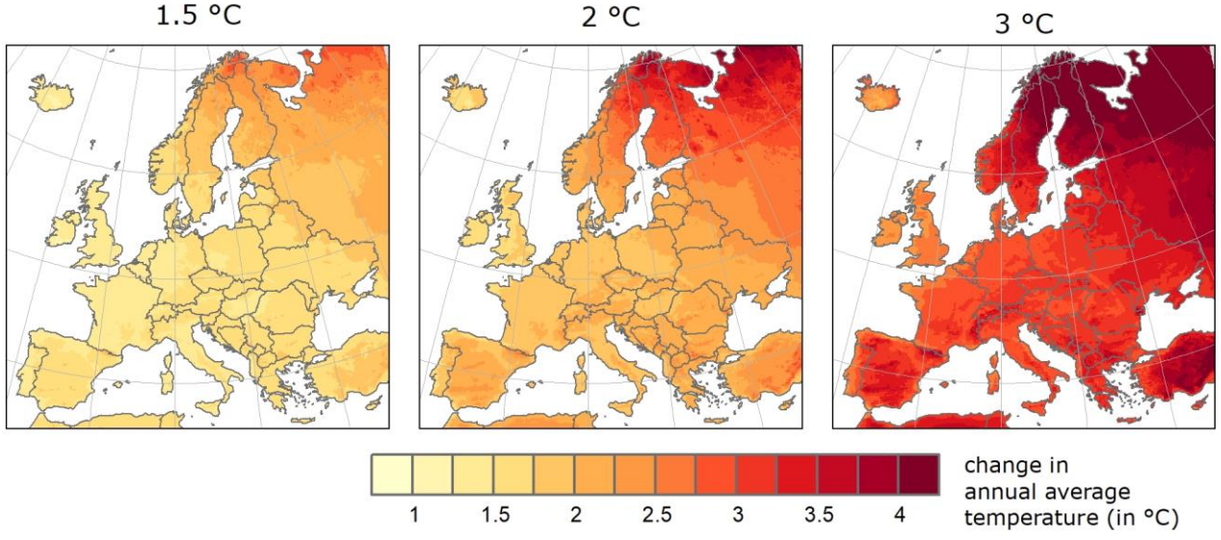
Stage 1. Climate change scenarios

RCP4.5 and 8.5

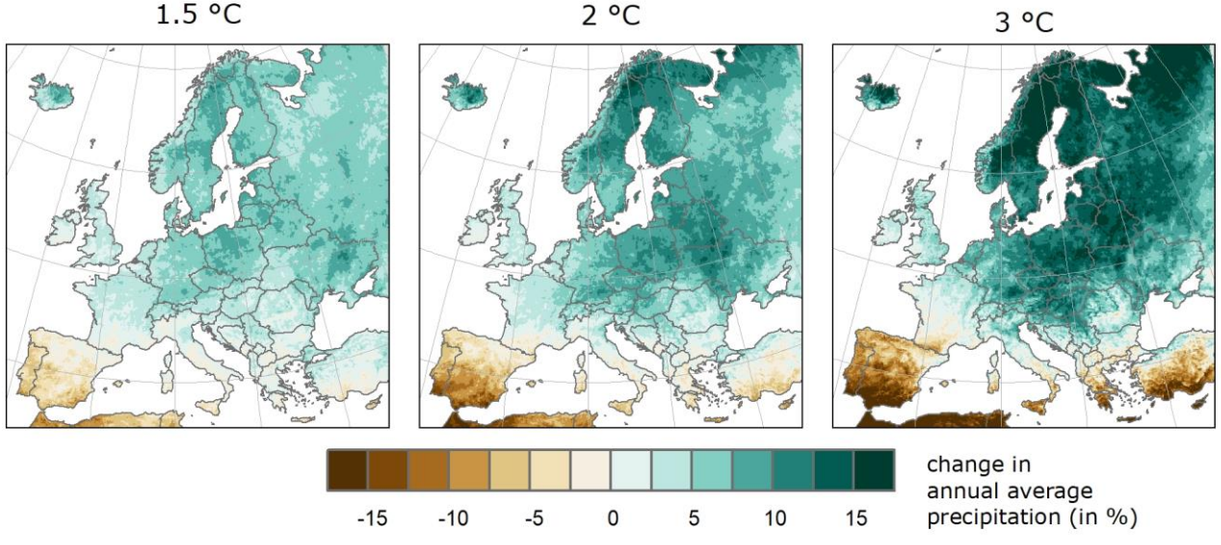
11 climate runs for each RCP (EUROCORDEX, 11km)

Focus on 1.5C, 2C and 3C global warming levels

Climate change in Europe with global warming



Projected change (˚C) in annual average temperature compared to pre-industrial times



Projected change (%) in annual average precipitation compared to 1981-2010

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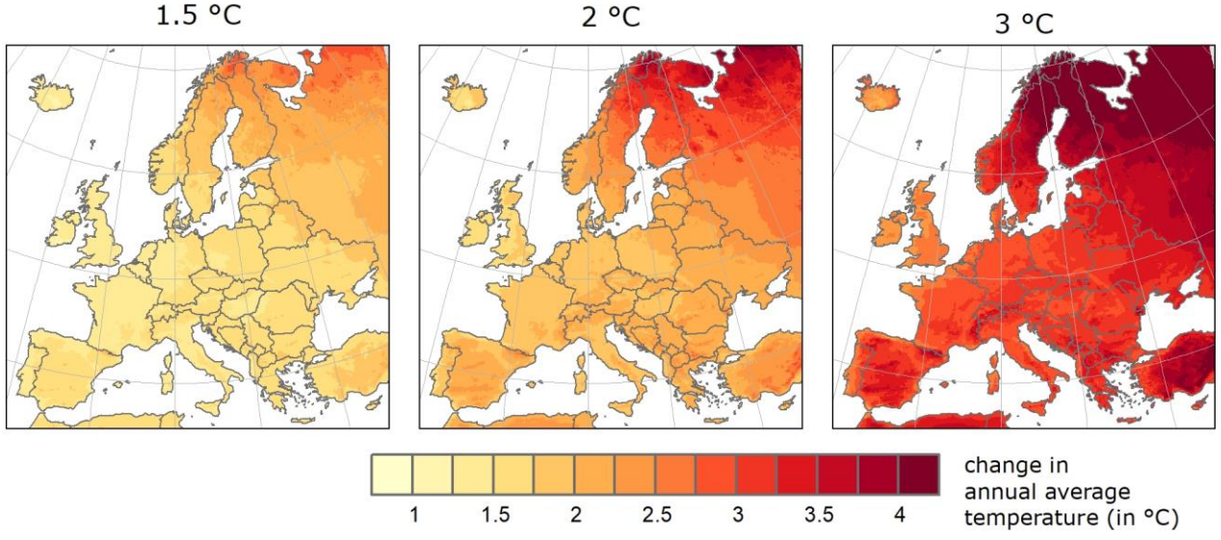
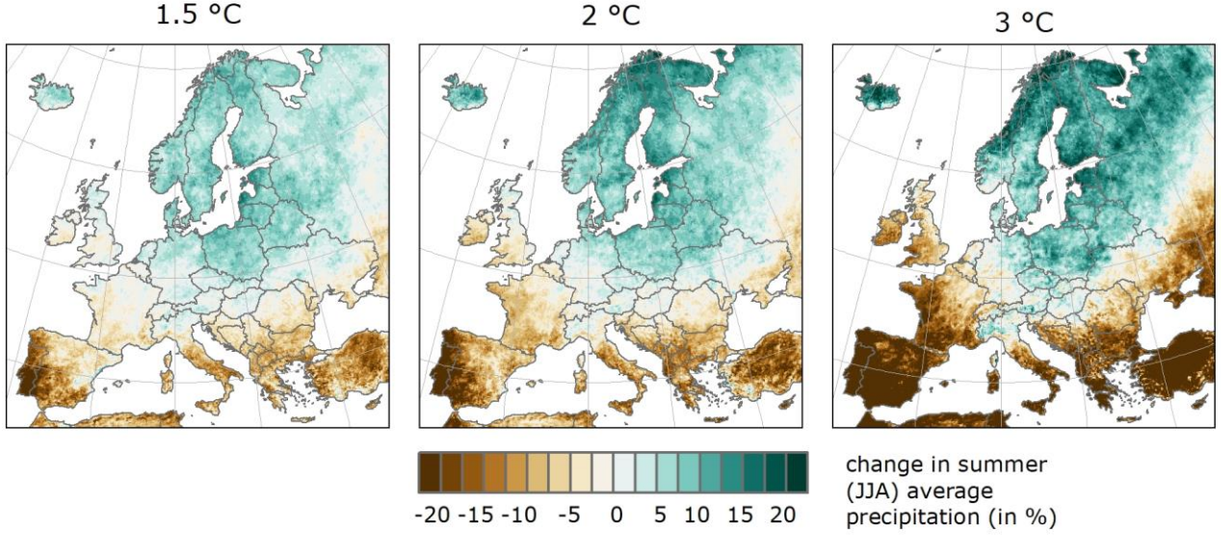
Climate change in Europe with global warming



Projected change (˚C) in annual average temperature compared to pre-industrial times



Projected change (%) in summer average precipitation compared to 1981-2010

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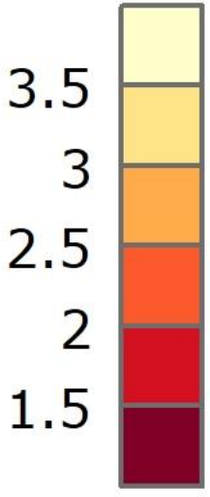
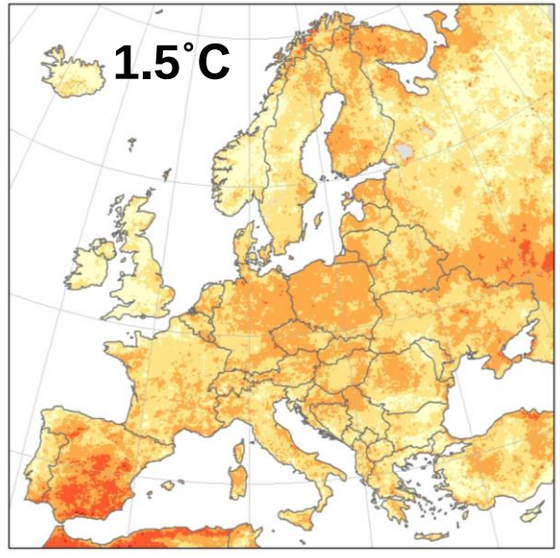
Stage 2. Biophysical impact modelling

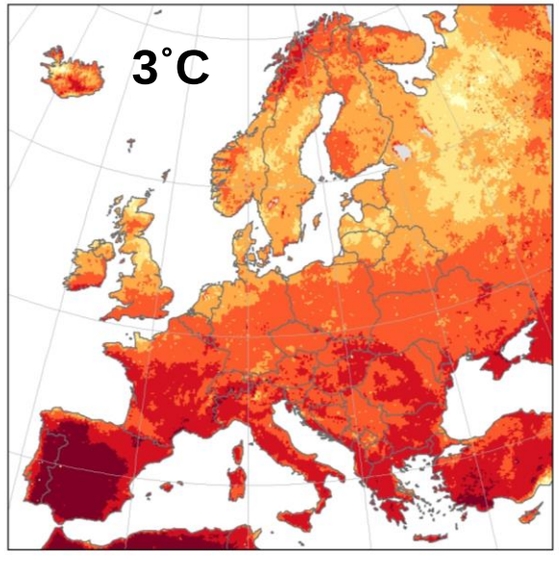
Direct damage results (dynamic)

Expected annual losses

Impact on EU population of extreme heat







Occurrence frequency in years of heat waves that now happen once every 20 years

. Human exposure to and fatalities from heat waves in Europe

base	1.5˚C	2.0˚C	3.0˚C
People annually exposed to a 50-year heat wave (million)			
9.6	103	168	288
Annual fatalities from heat waves (x1000)			
2.7	28.8	49.4	89.0

Source: JRC PESETA IV

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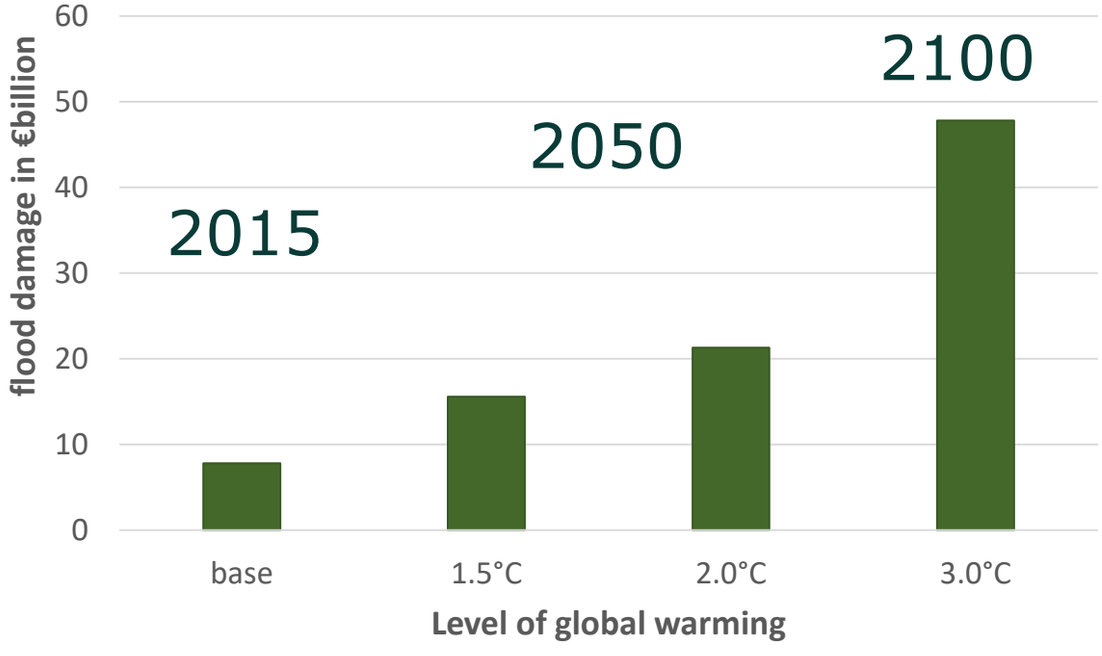
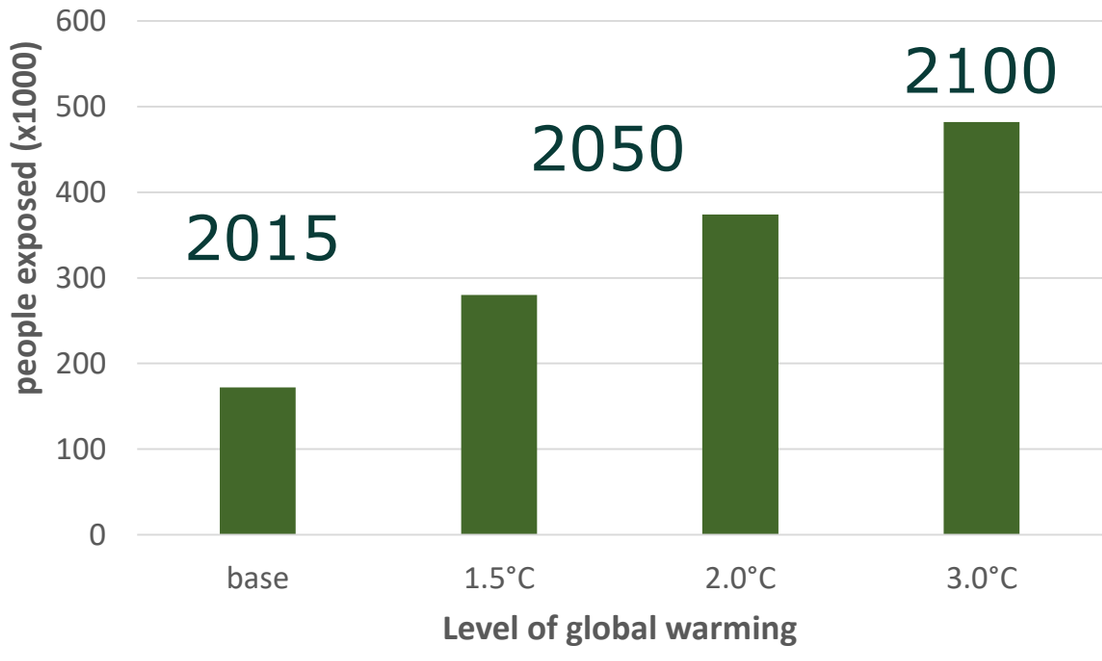
River flood risk in Europe

Annual flood losses in EU + UK



Population annually exposed in EU + UK



River risk in Europe will increase with global warming

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Drought in a changing climate

A **first-ever** pan-European quantitative assessment of the economic impacts of drought in Europe.

EU & UK DROUGHT LOSSES PER YEAR

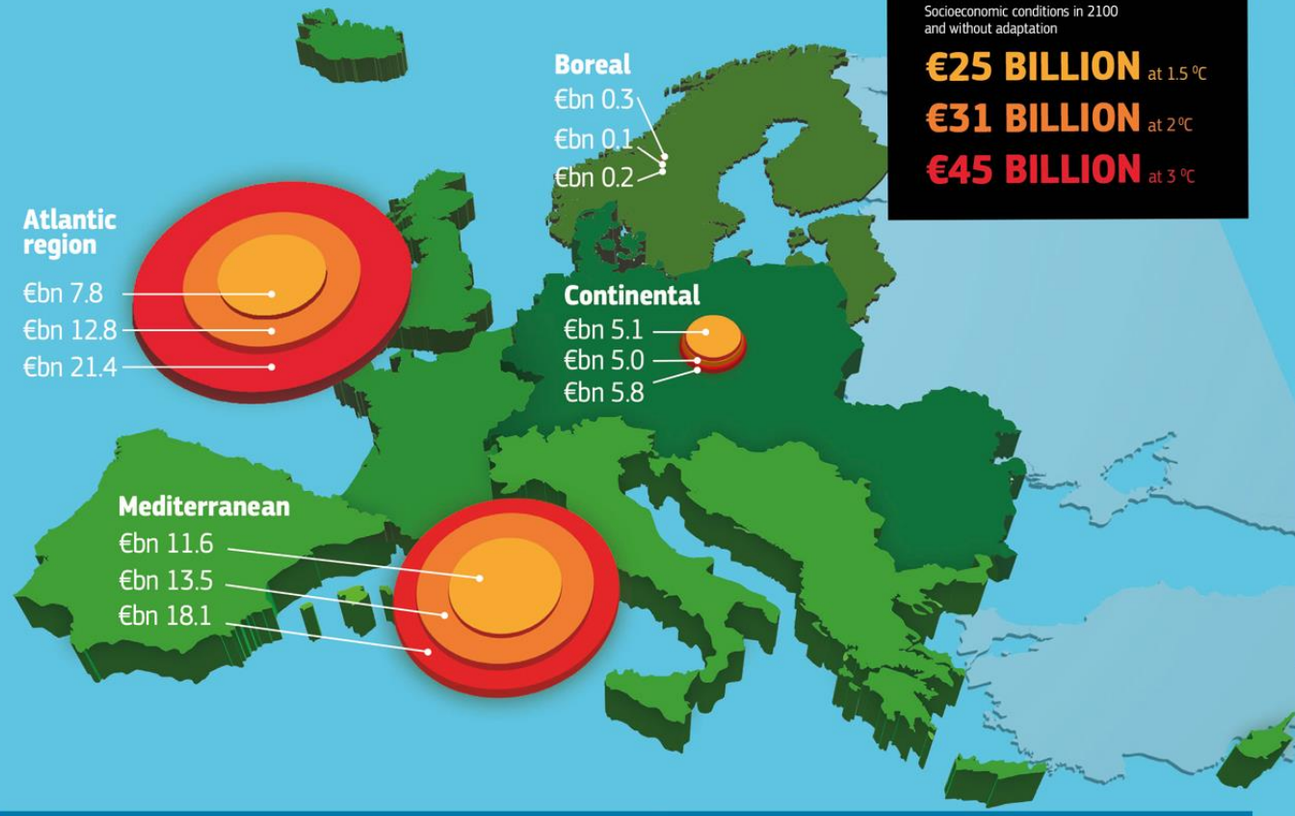
€9 BILLION present (1981 - 2010)

Socioeconomic conditions in 2100 and without adaptation

€25 BILLION at 1.5 °C

€31 BILLION at 2 °C

€45 BILLION at 3 °C



Modelled expected annual losses (billion €) for the present (1981 - 2010)

Mediterranean	Atlantic region	Continental	Boreal
3.6	2.5	2.6	0.3

Projected expected annual damages (billion €) based on socioeconomic conditions in 2100 and without adaptation, at:

1.5 °C 2 °C 3 °C

For more information, including assumptions of the modelling framework used, see: JRC PESETA IV project https://ec.europa.eu/jrc/en/peseta-iv

IMPACT ON SECTORS CONSIDERED

Agriculture
- Damages to crops and livestock losses
- Irrigation restrictions due to water scarcity

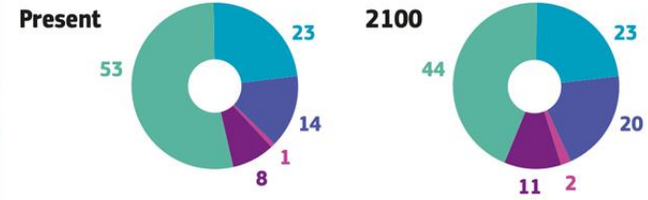
Power generation
- Reduction in hydroelectricity production
- Reduced capacity of cooling systems
- Possible shutdown of thermal and nuclear power plants

Public water supply
- Decreasing water availability
- Increasing competition amongst different sectors

Commercial shipping
- Interruption of navigation
- Reduction in cargo maximum capacity
- Transfer to other means of transportation

Buildings and infrastructure
- Damages due to soil subsidence
- Aquifer over-exploitation may aggravate damage to buildings from subsidence

Share of drought losses per socioeconomic sector (%)



KEY SUMMARY

- Drought will be more severe and persistant in southern and western Europe, whereas it will become less intense in northern and eastern Europe.
- Mediterranean and Atlantic regions are already contributing to about 68% of present losses, and this share will become 87% at 3 °C.
- Agriculture sector is most affected now and in the future, even if its economic importance is reduced in future European economies.

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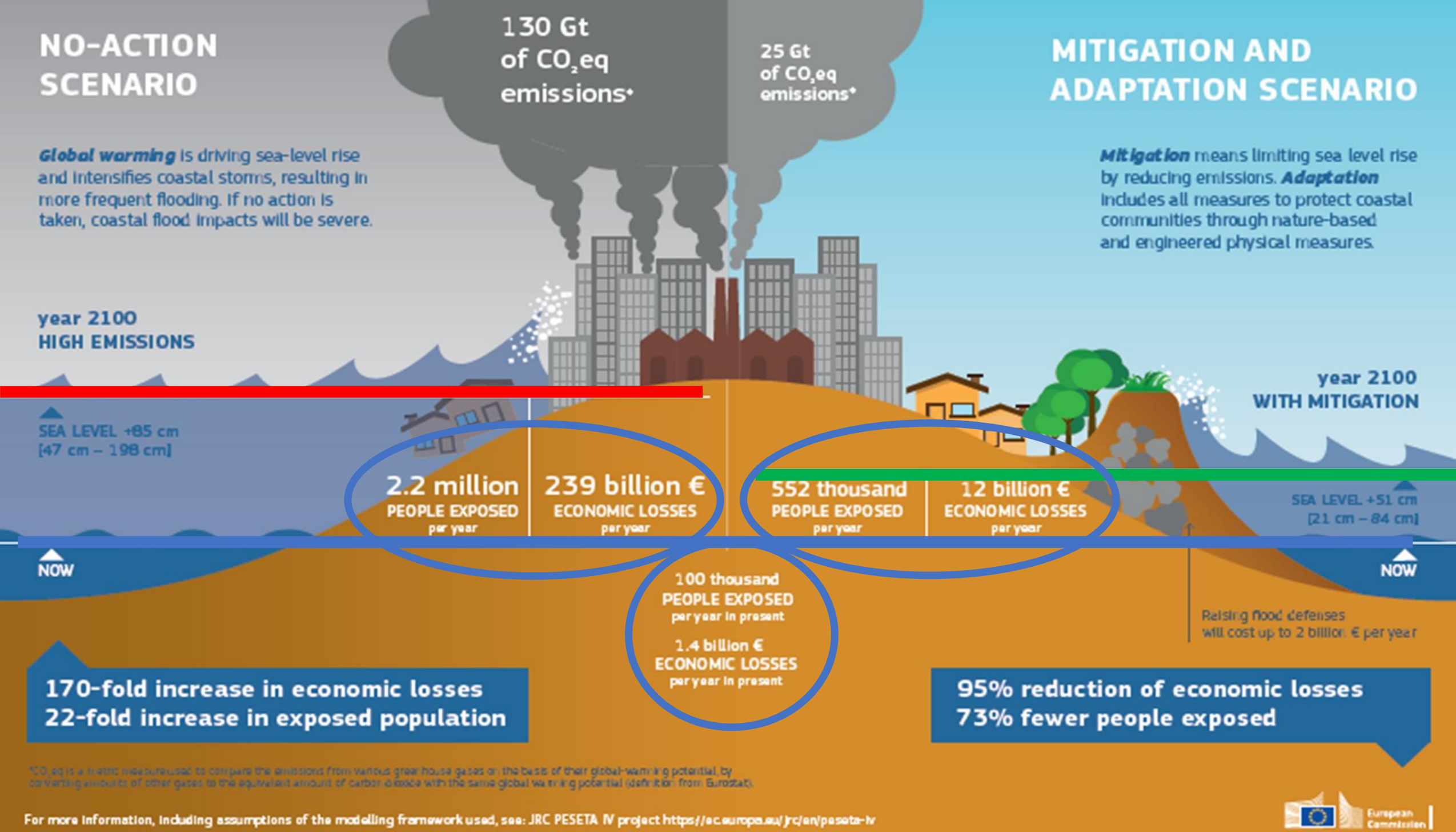

*CO_2eq is a metric measure used to compare the emissions from various greenhouse gases on the basis of their global-warming potential, by converting amounts of other gases to the equivalent amount of carbon dioxide with the same global warming potential (definition from Eurostat).

For more information, including assumptions of the modelling framework used, see: JRC PESETA IV project https://ec.europa.eu/jrc/en/peseta-iv

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Alpine tundra in Europe in a changing climate

Present

Future

The treeline is projected to move vertically upwards by up to 8m every year in a 3 °C warming scenario.

Tundra area loss

Region	Global temperature increase 1.5 °C	2 °C	3 °C
Alps	-36%	-50%	-75%
Scandes	-50%	-61%	-87%
Pyrenees	-74%	-91%	-99%

98% of Europe's alpine tundra domain is in the Pyrenees, the Alps and the Scandes.

The domain is projected to shrink by **84%** across Europe in a 3 °C warming scenario.

The projected changes affect vital ecosystem services, such as the provision and regulation of freshwater from melting snow. They also diminish valuable habitats, biodiversity, and recreational uses such as skiing.

For more information, including assumptions of the modelling framework used, see: JRC PESETA IV project https://ec.europa.eu/jrc/en/peseta-iv

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Stage 3. Economic integration

Welfare results

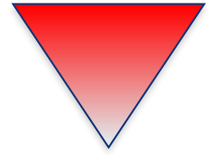
Static (economy as of today)

Approach to integration with economics

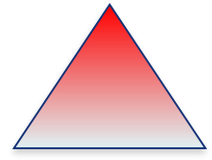
- Economic model to integrate the biophysical impacts (making them *comparable*)
- *Model*: Multi-sector, multi-country Computable General Equilibrium (CGE) (CAGE-GEME3 with 19 sectors and 25 regions)
- CGE as an accounting framework: direct and indirect effects; includes cross-sectoral and cross-country effects
- *Comparative static* framework: impact of future climate change on today's economy.

Climate impacts interpretation

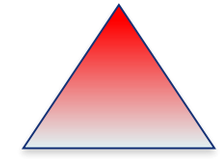
Productivity shocks



Supply = Demand

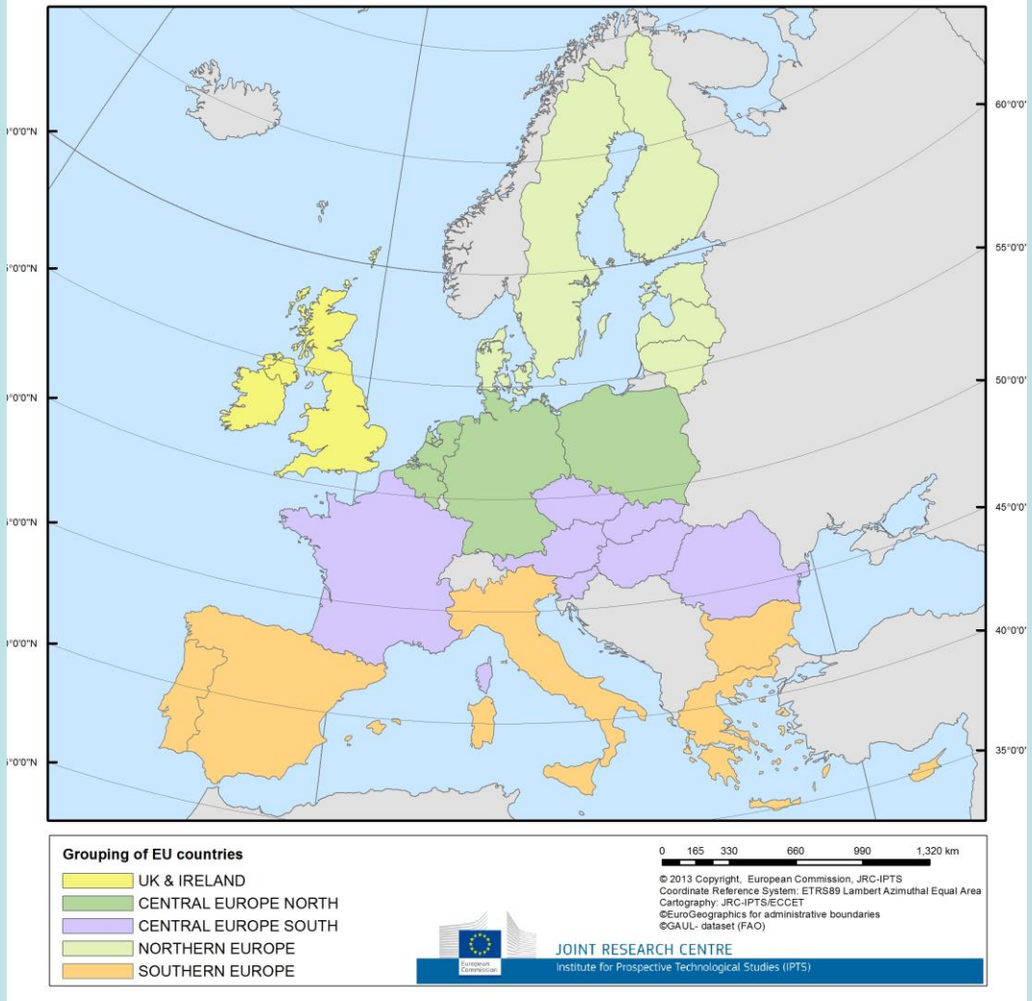


Capital losses



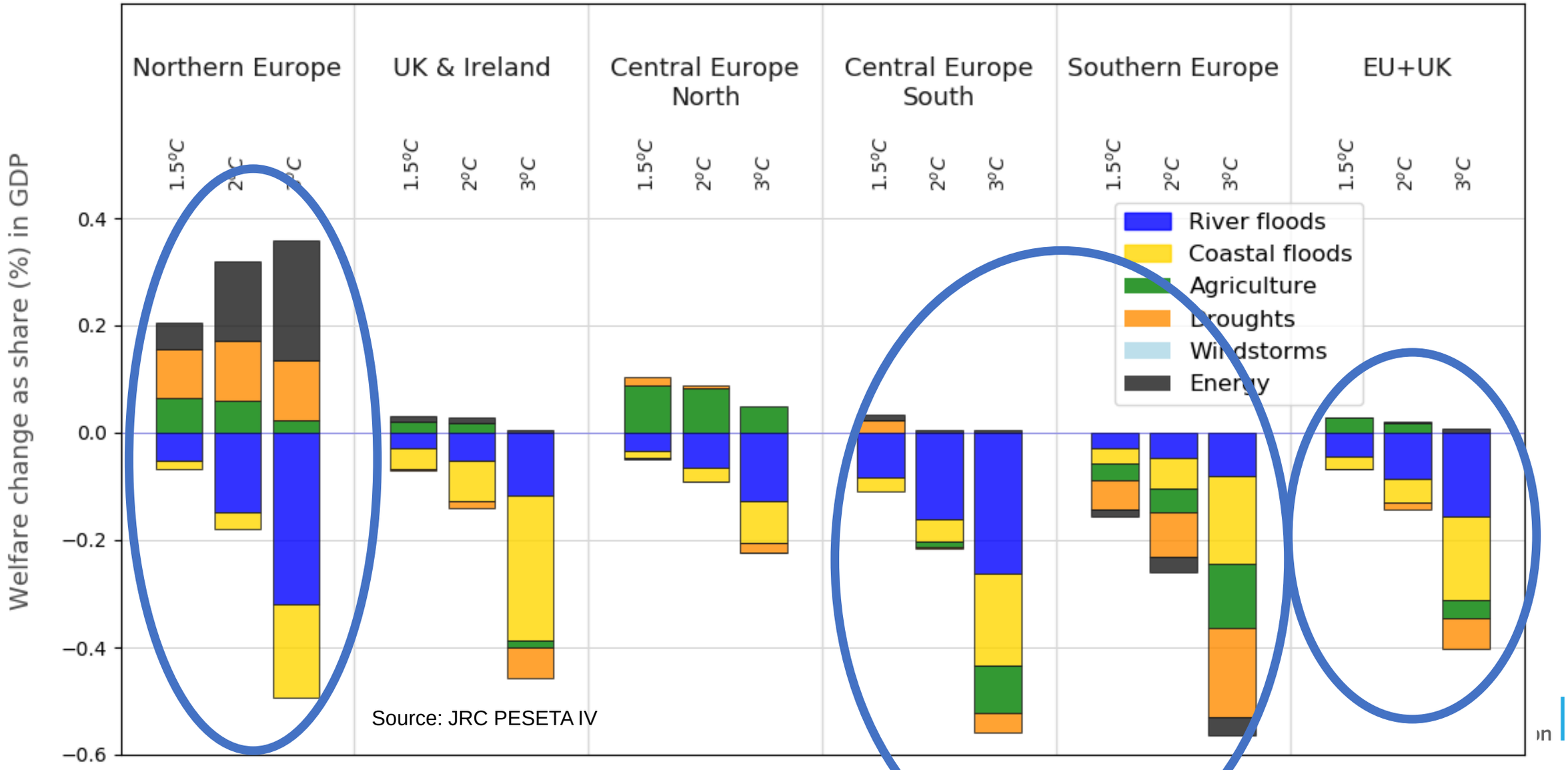
Forced consumption for residential repair

Grouping of EU countries

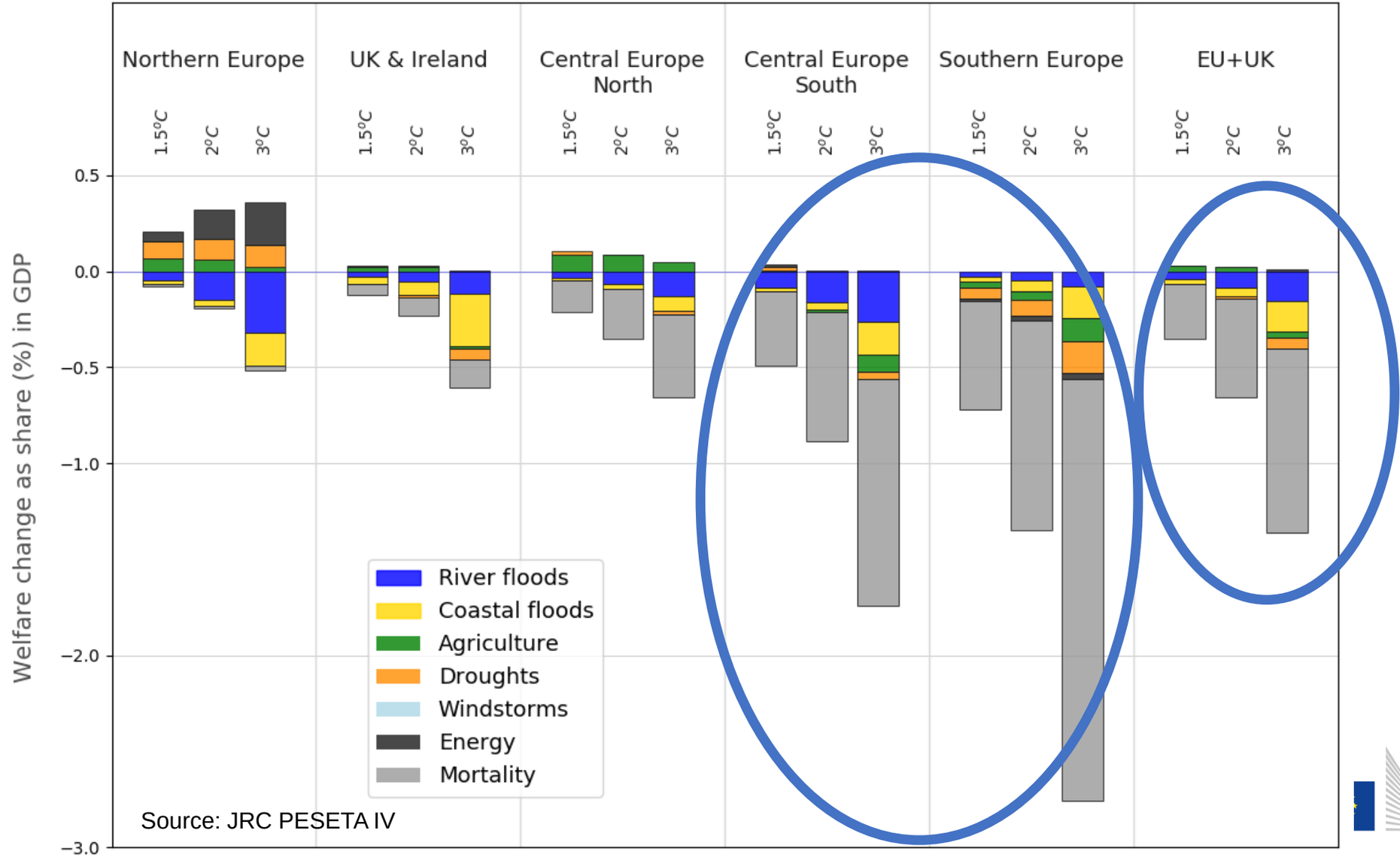


- **Northern Europe:** Sweden, Finland, Estonia, Lithuania, Latvia and Denmark
- **UK & Ireland:** UK and Ireland
- **Central Europe North:** Belgium, Netherlands, Luxemburg, Germany and Poland
- **Central Europe South:** France, Austria, Czech Republic, Slovakia, Hungary, Slovenia and Romania
- **Southern Europe:** Croatia, Portugal, Spain, Italy, Greece, Malta, Cyprus and Bulgaria

Distribution of Welfare damages, without mortality



Distribution of Welfare damages, with mortality



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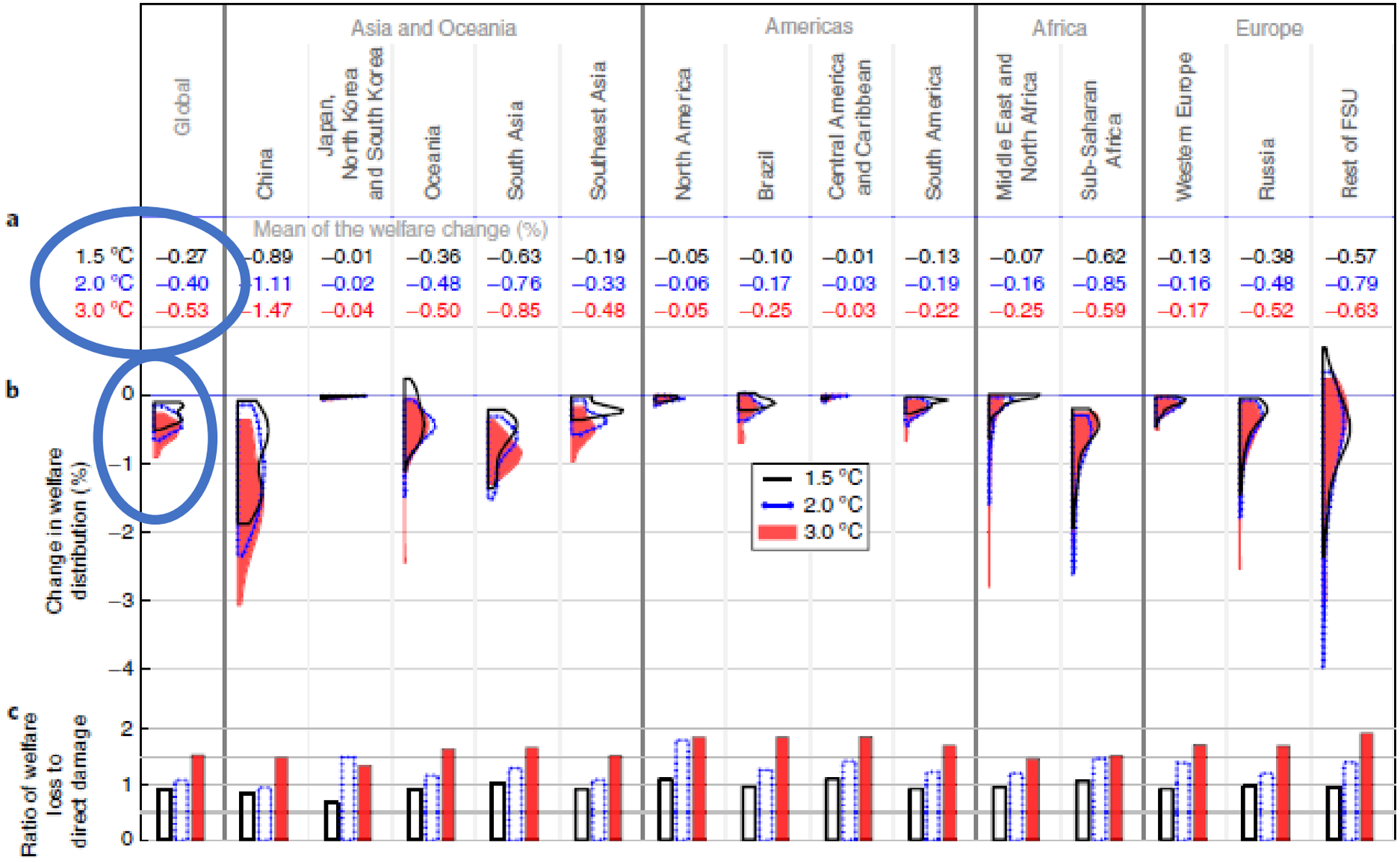
Global analysis of river floods, Welfare effects



Dottori et al (2018), Nature Climate Change

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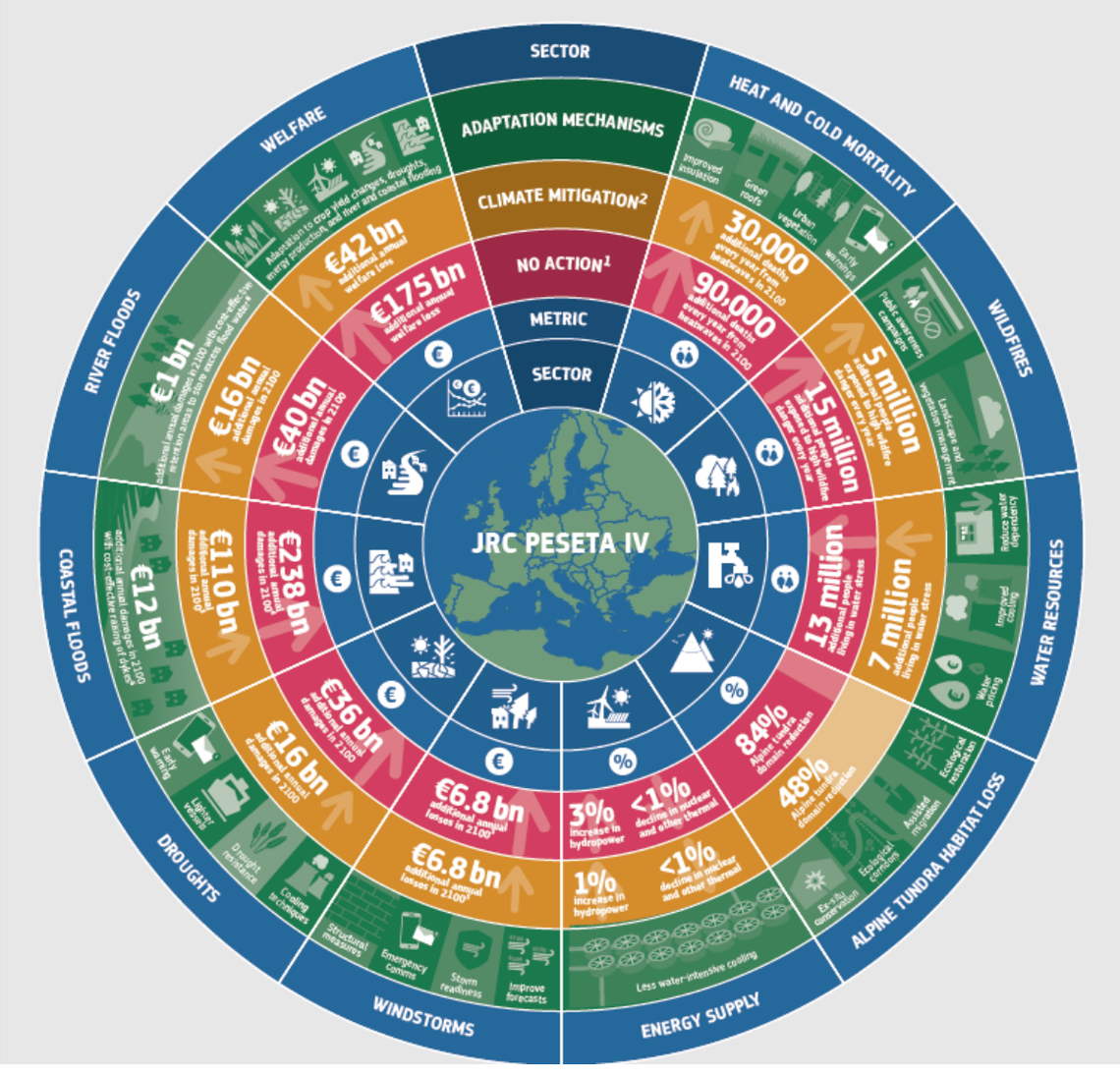
Dissemination



- Technical reports
- Scientific reports

- Infographics
- Summary cards
- *Video*

https://ec.europa.eu/jrc/en/peseta-iv

Dissemination

LETTERS
https://doi.org/10.1038/s41558-018-0260-4
nature climate change

Climatic and socioeconomic controls of future coastal flood risk in Europe

Michalis I. Vousdoukas[1,2*], Lorenzo Mentaschi[1], Evangelos Voukouvalas[3], Alessandra Bianchi[4], Francesco Dottori[1] and Luc Feyen[1]

Environmental Research Letters

LETTER

Assessing future climate change impacts in the EU and the USA: insights and lessons from two continental-scale projects*

Juan-Carlos Ciscar[1], James Rising[2], Robert E Kopp[3] and Luc Feyen[4]

[1] Joint Research Centre, European Commission, Spain
[2] The Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science, United Kingdom
[3] Institute of Earth, Ocean, and Atmospheric Sciences and Department of Earth and Planetary Sciences, Rutgers University, New Brunswick, NJ, United States of America
[4] Joint Research Centre, European Commission, Italy

Earth's Future

RESEARCH ARTICLE
10.1029/2019EF001170

Key Points:
- Unique concurrent spring and summer climatic anomalies affected Europe in 2018
- 2018-like droughts could become a common occurrence as early as 2043
- Climate change adaptation strategies for agriculture in Europe cannot count on recurrent water seesaws

Supporting Information:
- Supporting Information S1

The Exceptional 2018 European Water Seesaw Calls for Action on Adaptation

Andrea Toreti[1], Alan Belward[1], Ignacio Perez-Dominguez[2], Gustavo Naumann[1], Jürg Luterbacher[3], Ottmar Cronie[4], Lorenzo Seguini[1], Giacinto Manfron[1], Raul Lopez-Lozano[1], Bettina Baruth[1], Maurits van den Berg[1], Frank Dentener[1], Andrej Ceglar[1], Thomas Chatzopoulos[2], and Matteo Zampieri[1]

[1]European Commission, Joint Research Centre (JRC), Ispra, Italy, [2]European Commission, Joint Research Centre (JRC), Seville, Spain, [3]Department of Geography, Climatology, Climate Dynamics and Climate Change, Centre for International Development and Environmental Research, Justus-Liebig University of Giessen, Giessen, Germany, [4]Department of Mathematics and Mathematical Statistics, Umeå University, Umeå, Sweden

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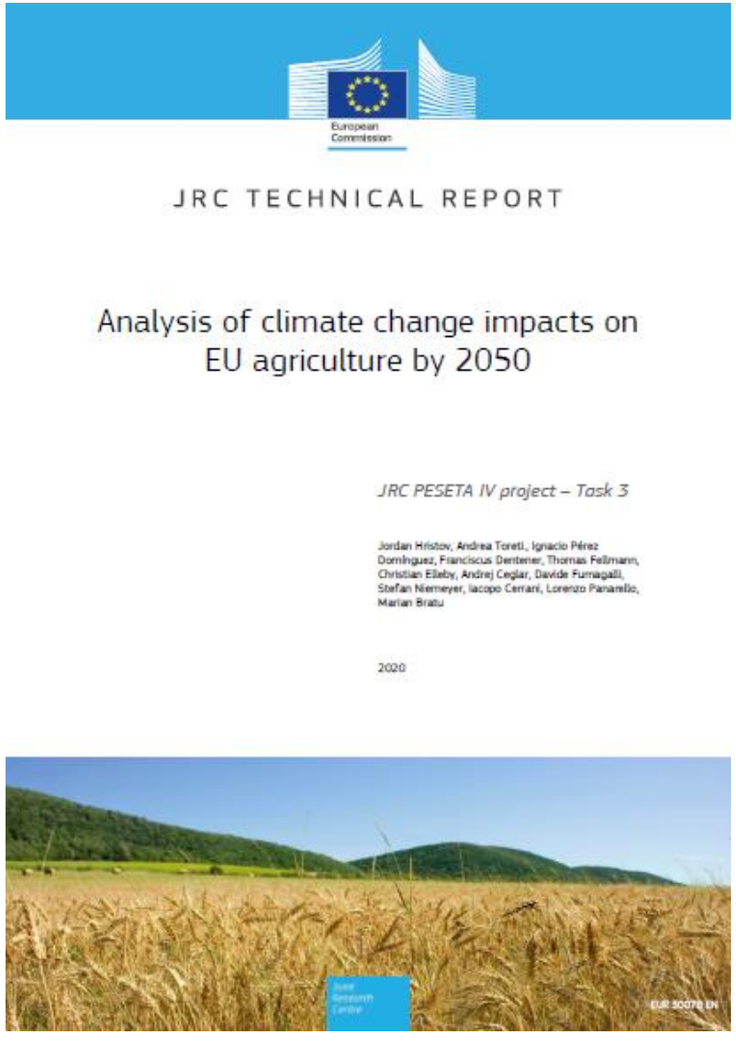
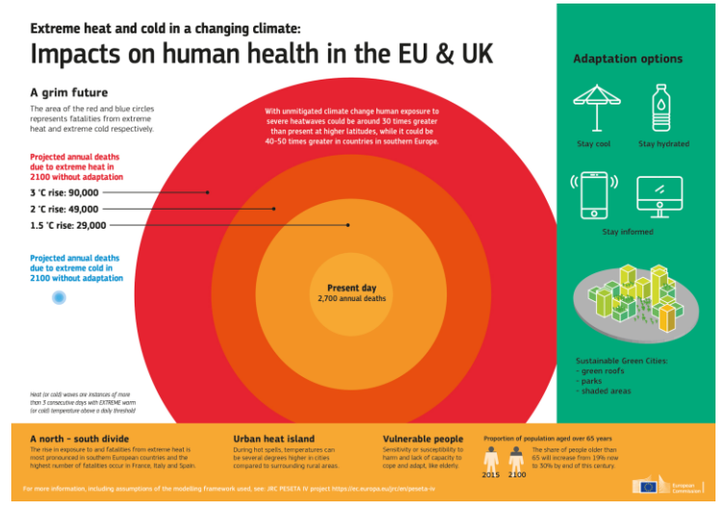
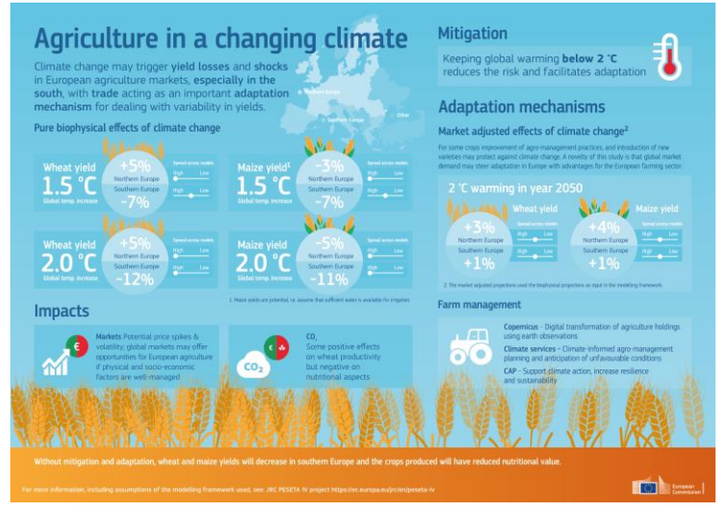
Dissemination







https://ec.europa.eu/jrc/en/peseta-iv

Conclusions

- Asymmetric geographical pattern of impacts
- Large potential to reduce impacts with mitigation
- Adaptation can also play a key role

Limitations/next steps

- Need to enlarge coverage of sectors (e.g. *European Climate and Health Observatory*)
- Better know impacts facts in Europe
- Adaptation modelling
- European climate risk assessment
- International scientific diplomacy and cooperation

Thank you !

L Feyen, JC Ciscar, S Gosling, D Ibarreta, A Soria, A Dosio, G Naumann, S Russo, G Formetta, G Forzieri, M Girardello, J Spinoni, L Mentaschi, B Bisselink, J Bernhard, E Gelati, M Adamovic, S Guenther, A de Roo, C Cammalleri, F Dottori, A Bianchi, L Alfieri, M Vousdoukas, I Mongelli, J Hinkel, P Ward, H Costa, D de Rigo, G Libertà, T Houston Durrant, J San-Miguel-Ayanz, JI Barredo, A Mauri, G Caudullo, G Ceccherini, P Beck, A Cescatti, J Hristov, A Toreti, I Pérez Domínguez, F Dentener, T Fellmann, C Elleby, A Ceglar, D Fumagalli, S Niemeyer, I Cerrani, L Panarello, M Bratu, J Després, W Szewczyk, A Matei, E Mulholland, M Olariaga

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