Climate risk and adaptation assessment: bottom-up, biophysical integrated modelling Experience and lessons from the PESETA suite of projects

Juan-Carlos Ciscar, Luc Feyen et al.
Joint Research Centre

NAVIGATE/ENGAGE Expert Workshop
20 September 2021

European Commission

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

***P**rojection of **E**conomic impacts of climate change in **S**ectors of the **E**uropean Union based on bo**T**tom-up **A**nalysis*

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

…

2019 The European Green Deal

2021 New EU Strategy on Adaptation

Methodology

Multi-disciplinary, integrative methodology

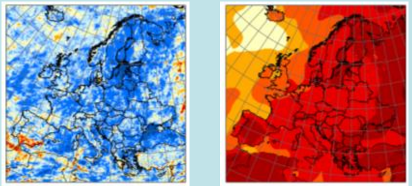
- Results are mostly based on bottom-up, process-based impact models
- Consistency: common, high-resolution climate scenarios; same socio-economic scenarios (ECFIN Ageing Report)

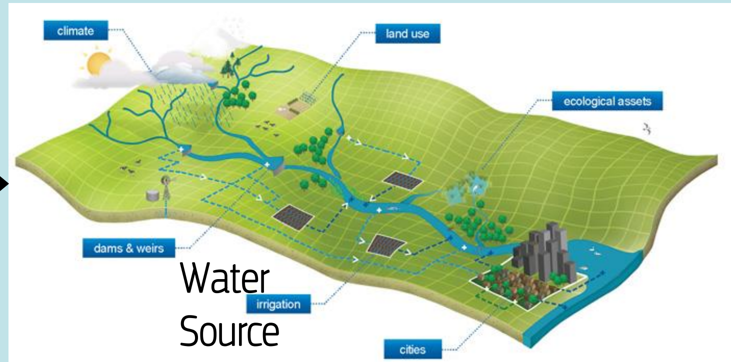
PESETA IV project:

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

Example impact modelling: river floods

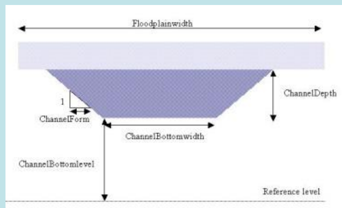
high-resolution climate information





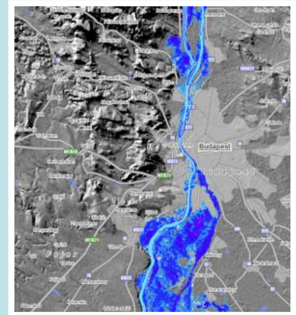
data on soils, land cover, river basins, ...

data on river dimensions, discharges, etc



Hazard analysis

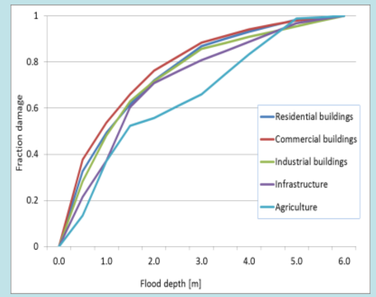
Hazard



Impact

Exposure

Vulnerability



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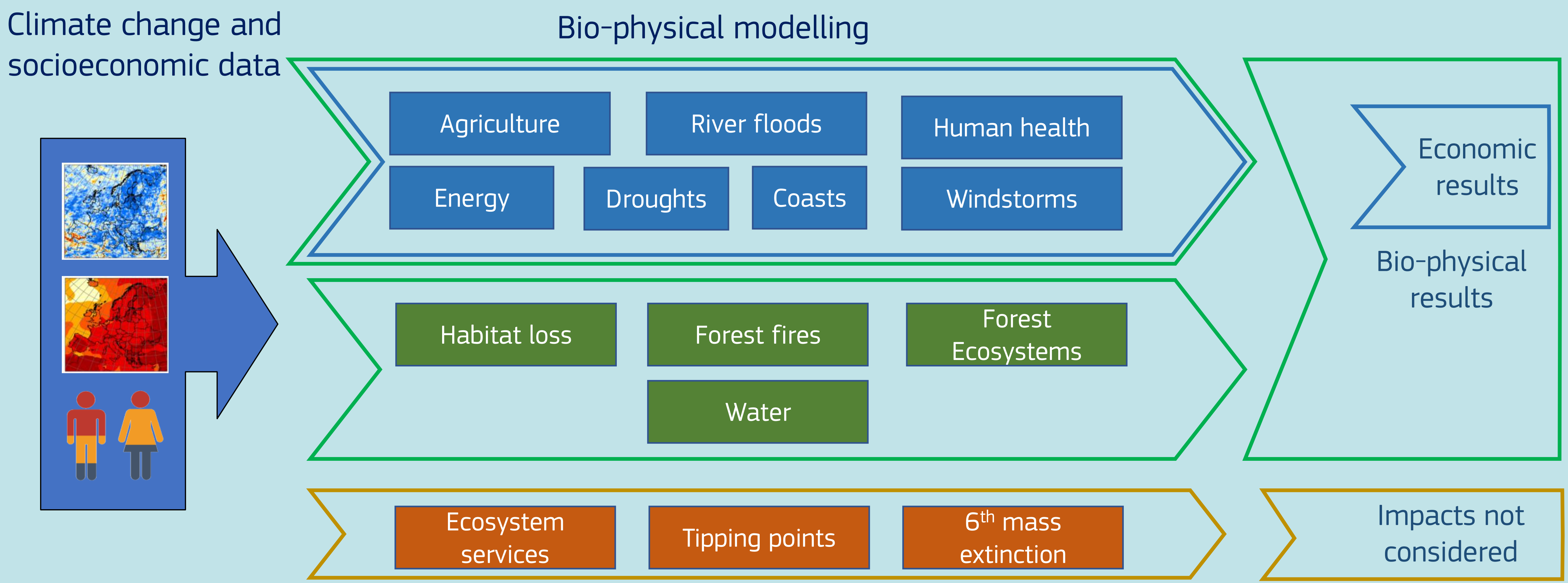
PESETA IV climate impact categories

JRC PESETA IV project



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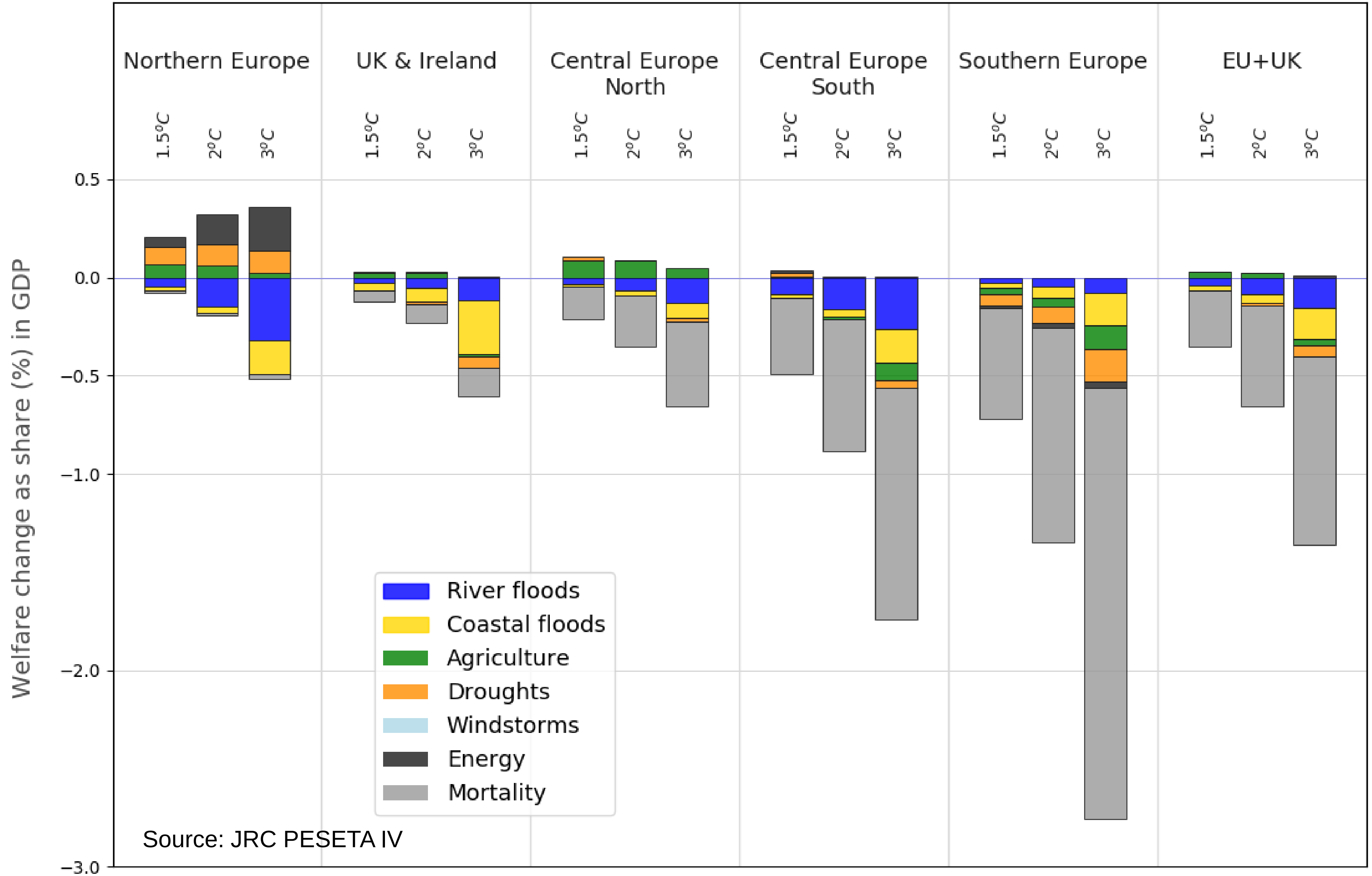
Distribution of Welfare damages, with mortality



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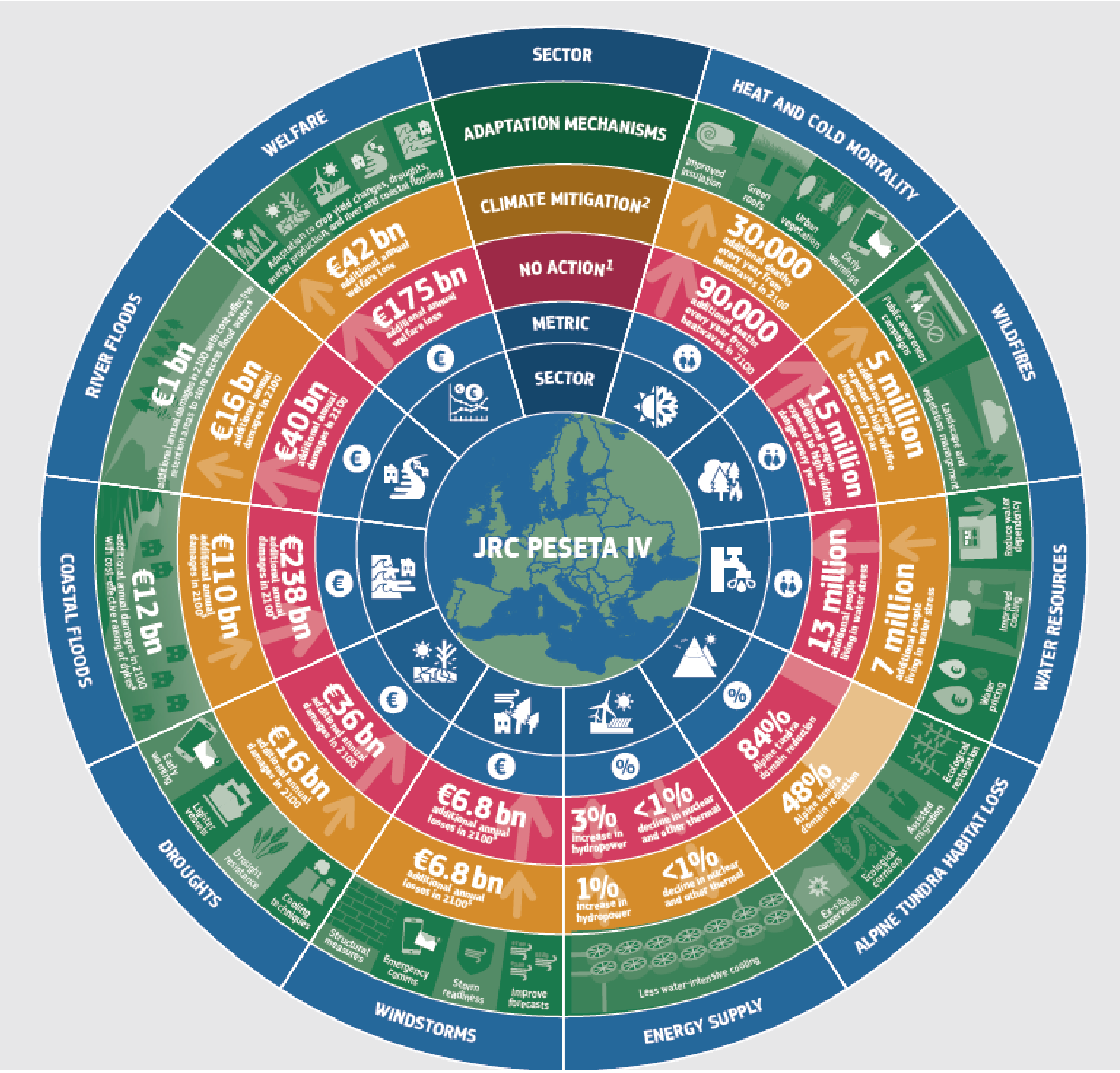
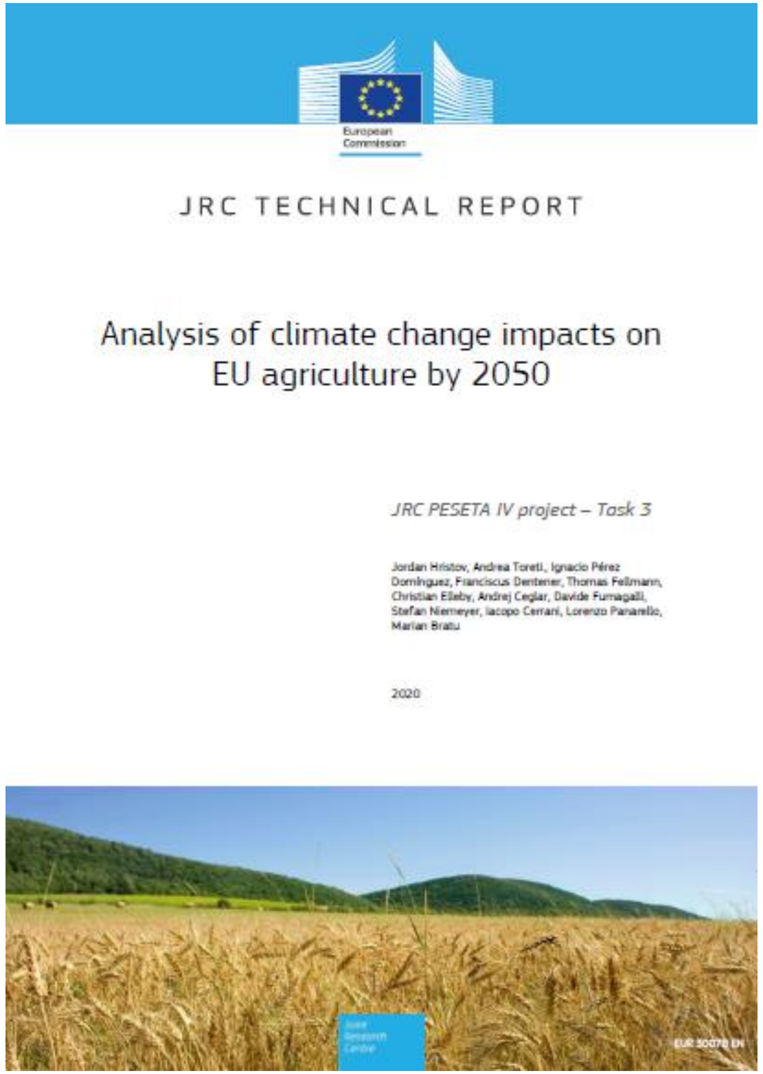
Dissemination

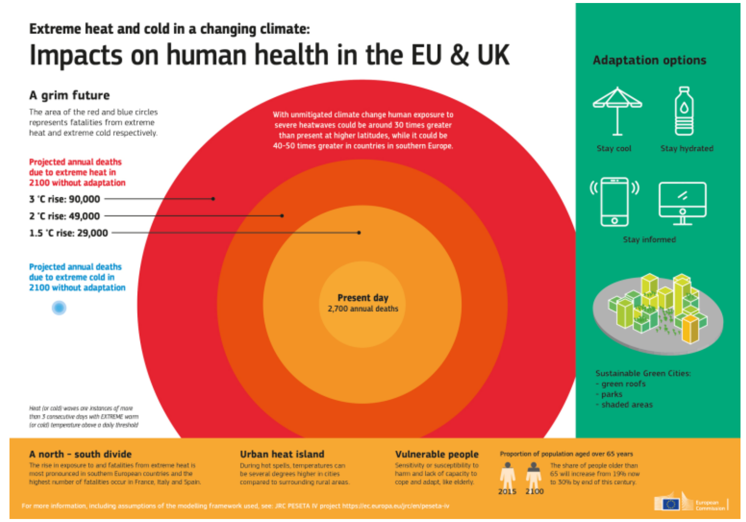


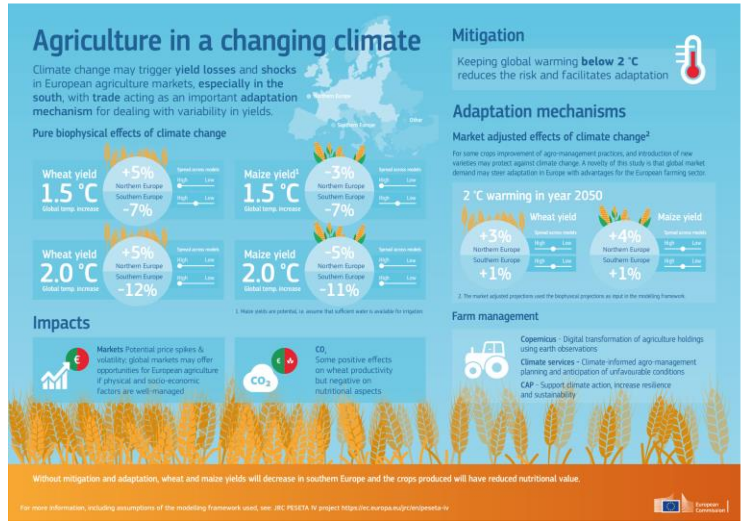
- Technical reports
- Scientific reports
- Infographics
- Summary cards
- *[Video](#)*

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

Dissemination







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

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

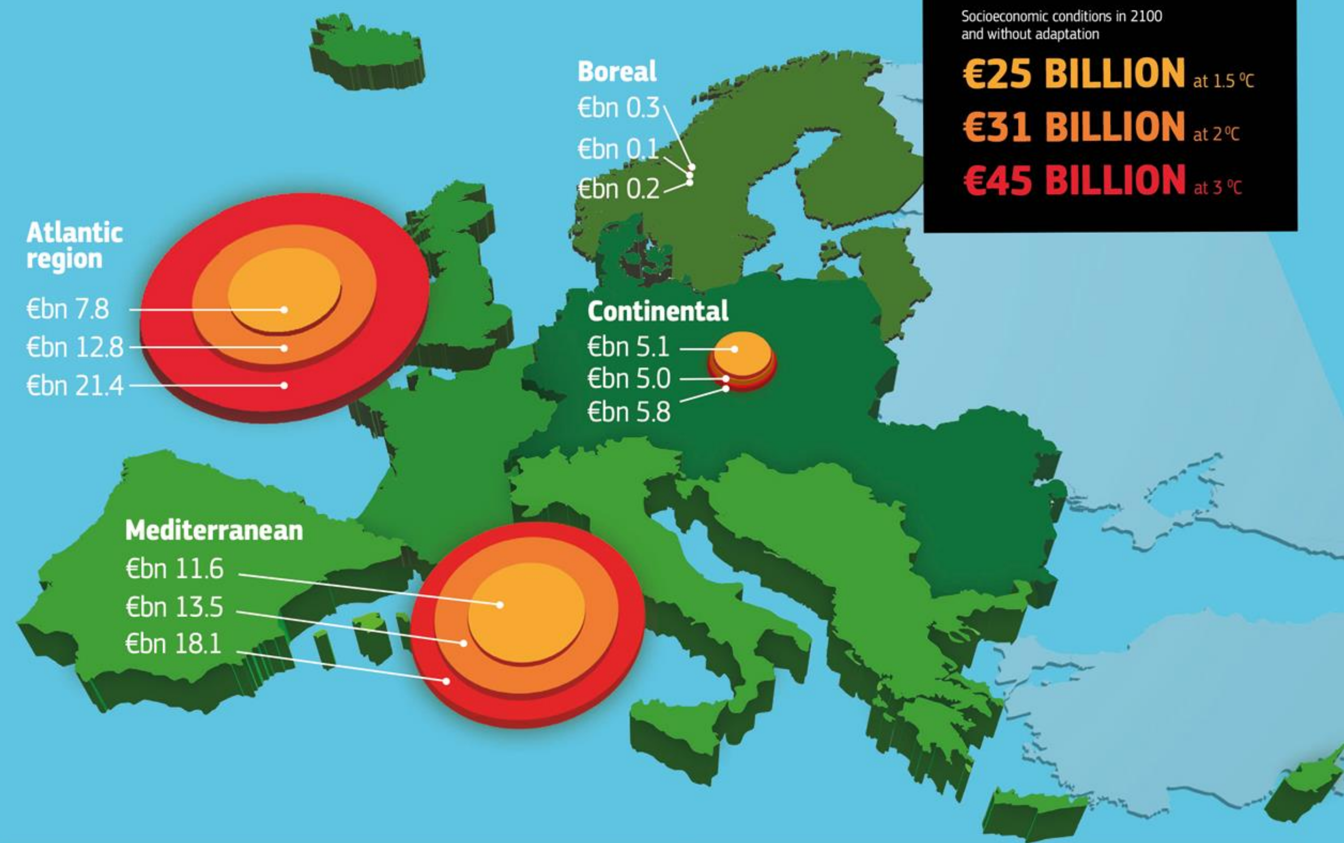
€9 BILLION present (1981 - 2010)

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

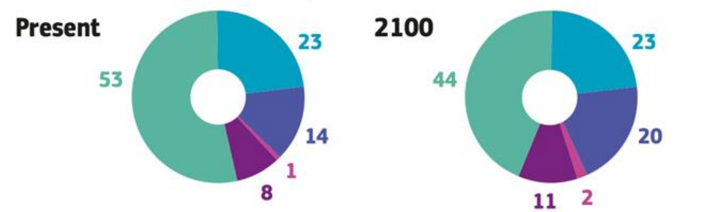
Power generation
- Reduction in hydroelectricity production
- Reduced capacity of cooling systems
- Possible shutdown of thermal and nuclear power plants

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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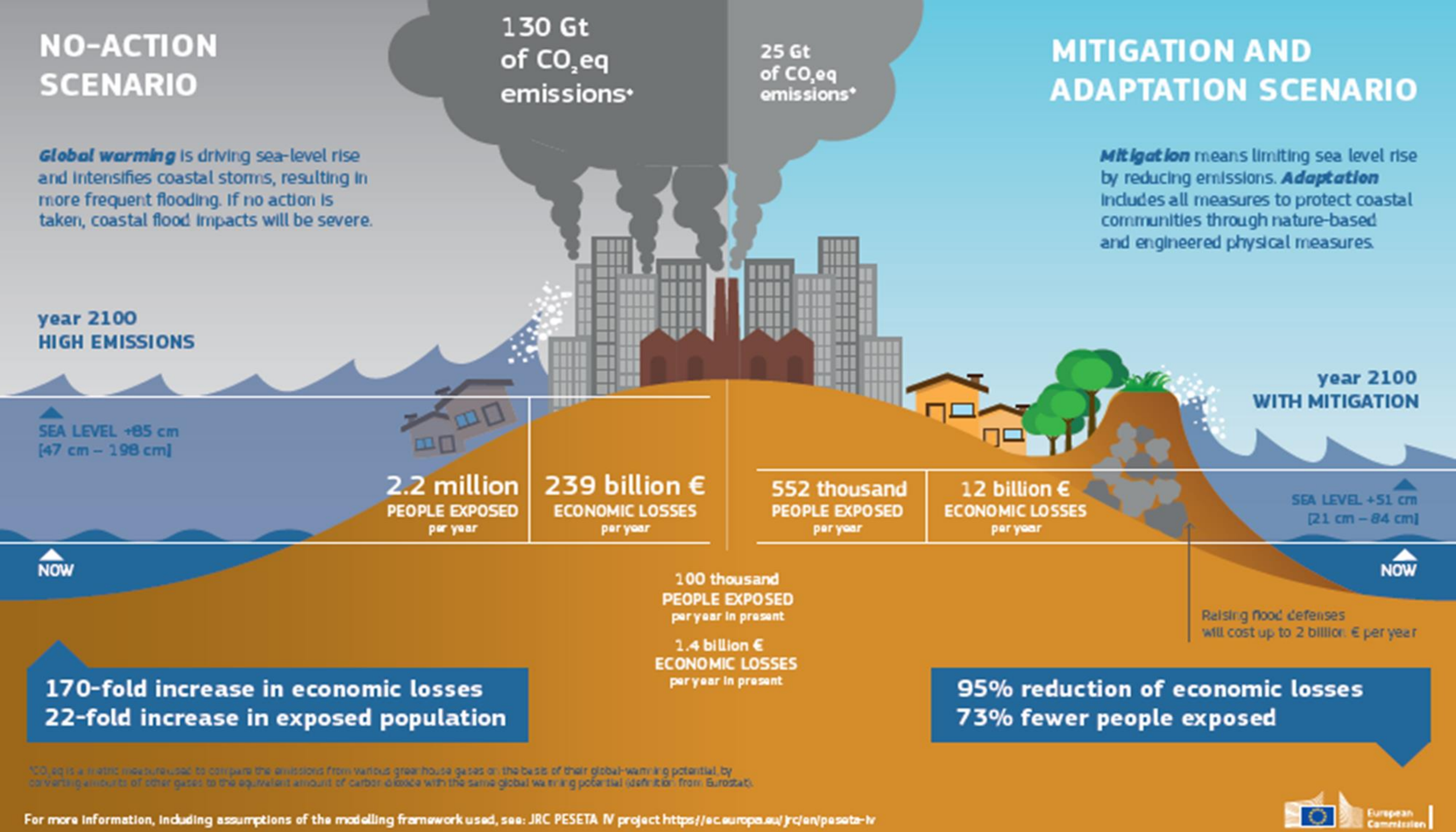

NO-ACTION SCENARIO
130 Gt of CO2eq emissions*
25 Gt of CO2eq emissions*
MITIGATION AND ADAPTATION SCENARIO
Global warming is driving sea-level rise and intensifies coastal storms, resulting in more frequent flooding. If no action is taken, coastal flood impacts will be severe.
Mitigation means limiting sea level rise by reducing emissions. Adaptation includes all measures to protect coastal communities through nature-based and engineered physical measures.
year 2100
HIGH EMISSIONS
SEA LEVEL +85 cm
[47 cm – 198 cm]
year 2100
WITH MITIGATION
SEA LEVEL +51 cm
[21 cm – 84 cm]
2.2 million
PEOPLE EXPOSED
per year
239 billion €
ECONOMIC LOSSES
per year
552 thousand
PEOPLE EXPOSED
per year
12 billion €
ECONOMIC LOSSES
per year
NOW
NOW
100 thousand
PEOPLE EXPOSED
per year in present
1.4 billion €
ECONOMIC LOSSES
per year in present
Raising flood defenses
will cost up to 2 billion € per year
170-fold increase in economic losses
22-fold increase in exposed population
95% reduction of economic losses
73% fewer people exposed
*CO2eq 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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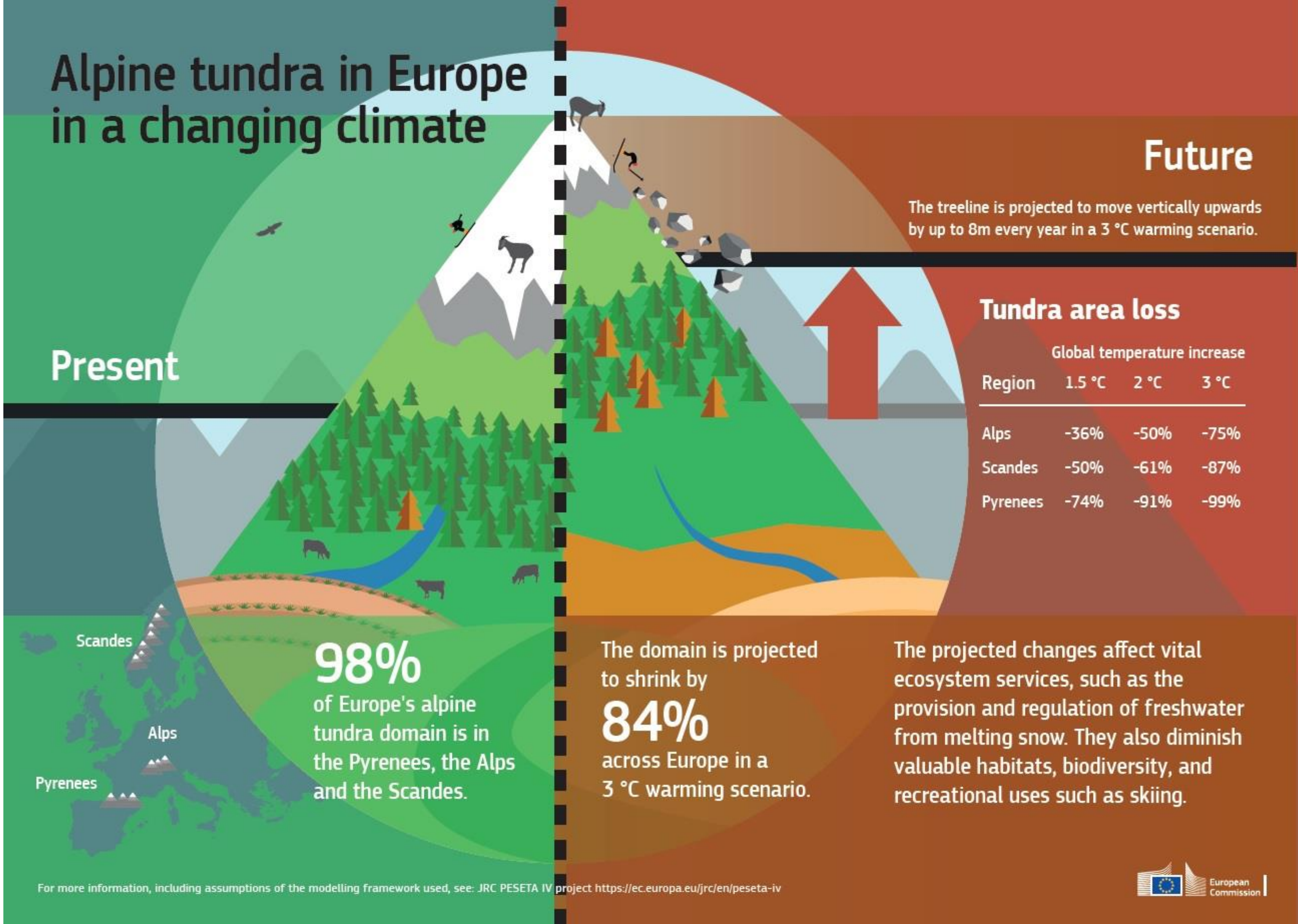
Alpine tundra in Europe in a changing climate
Present
Scandes
Alps
Pyrenees
98%
of Europe's alpine tundra domain is in the Pyrenees, the Alps and the Scandes.
Future
The treeline is projected to move vertically upwards by up to 8m every year in a 3 °C warming scenario.
Tundra area loss
Global temperature increase
Region 1.5 °C 2 °C 3 °C
Alps -36% -50% -75%
Scandes -50% -61% -87%
Pyrenees -74% -91% -99%
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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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]

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[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

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

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

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NEXT

Policy needs

Climate risk and adaptation assessment

- Regional and local focus
- Asset-level

Methodological challenges

- Enlarge coverage of impact areas
- Integration (toward IAM)
  - Across-biophysical impacts
  - Economics modelling

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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