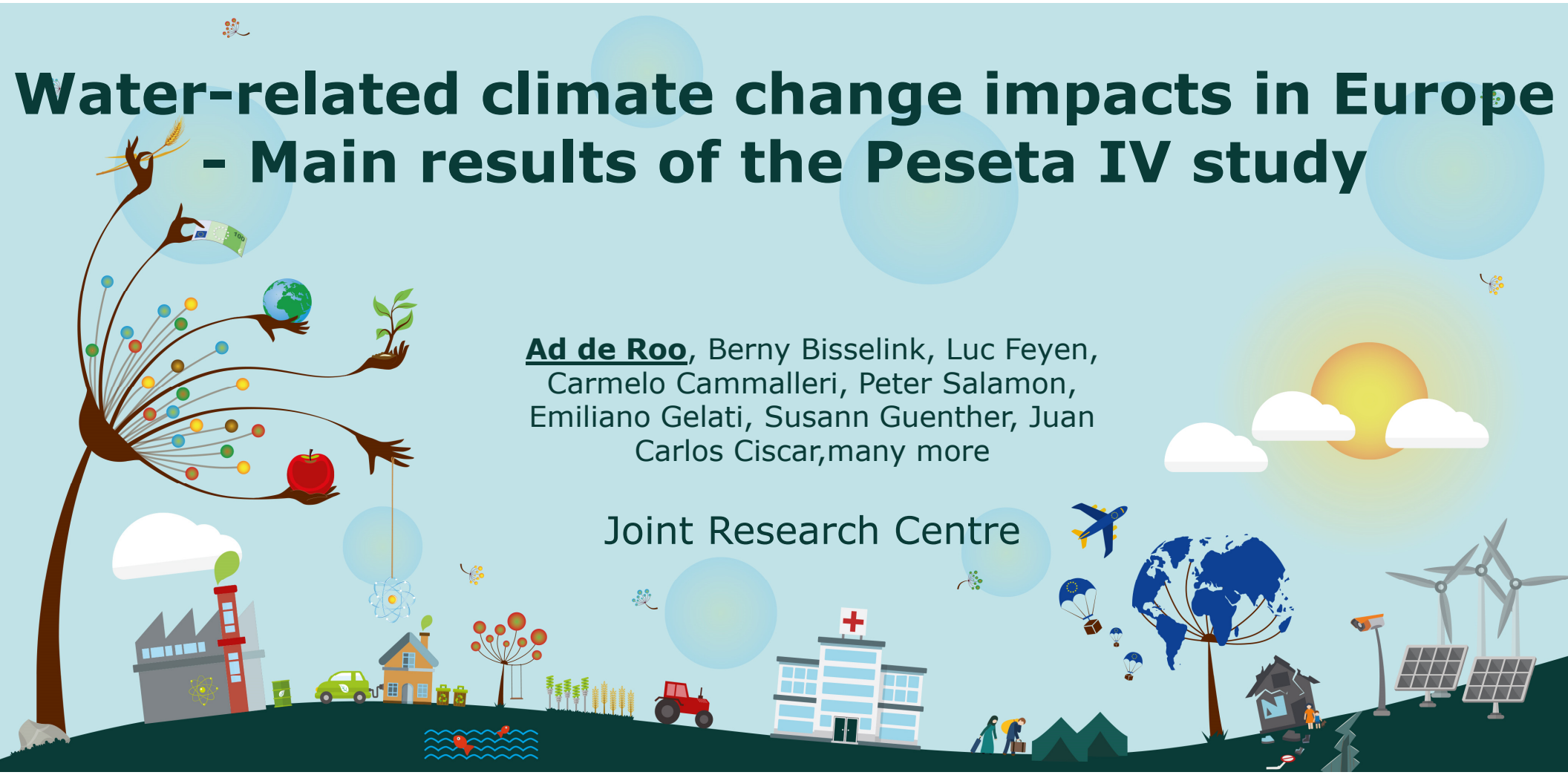
Water-related climate change impacts in Europe - Main results of the Peseta IV study



Ad de Roo, Berny Bisselink, Luc Feyen, Carmelo Cammalleri, Peter Salamon, Emiliano Gelati, Susann Guenther, Juan Carlos Ciscar,many more

Joint Research Centre

Climate change and the European water dimension - Enhancing resilience November 4-5, 2020

European Commission

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 at Paris targets?

How much climate impacts are avoided by adaptation?

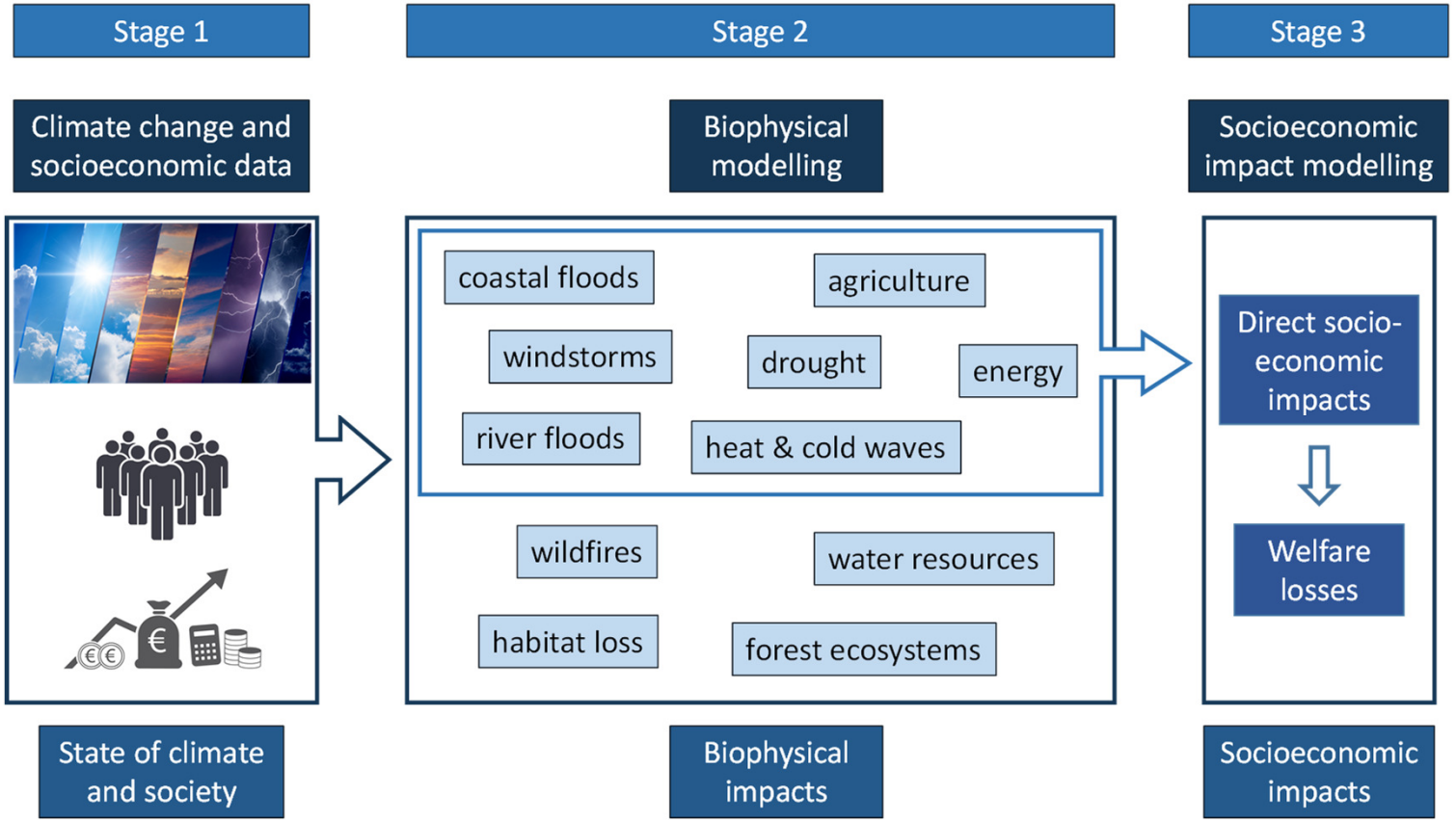
Strengths of PESETA approach

- Results are based on bottom-up, process-based impact models
- Consistency (common climate scenarios)
- Coupling with sectoral economic model

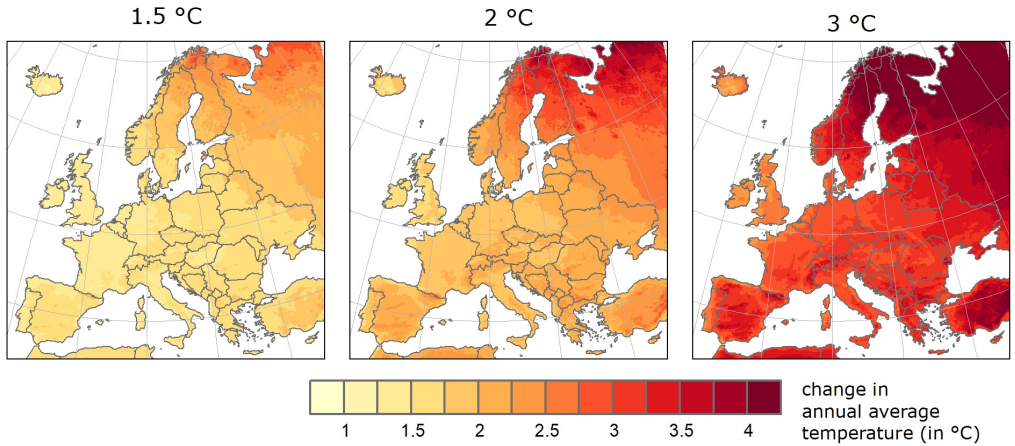
European Commission

PESETA climate impact categories

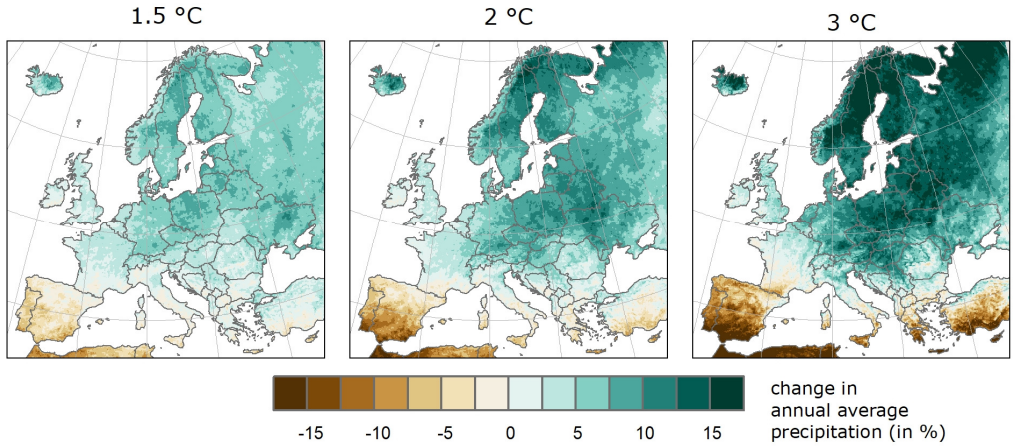
PESETA IV impact analysis framework



Climate change in Europe with global warming



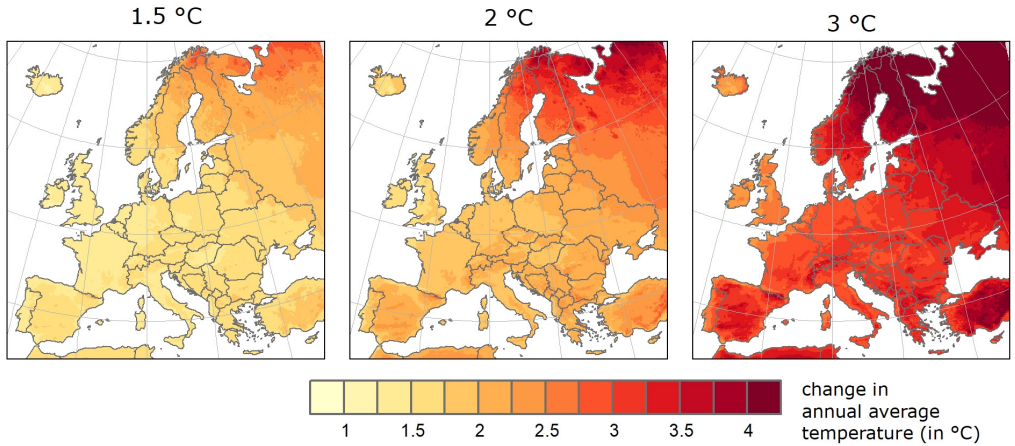
Projected change (˚C) in annual average temperature compared to pre-industrial times



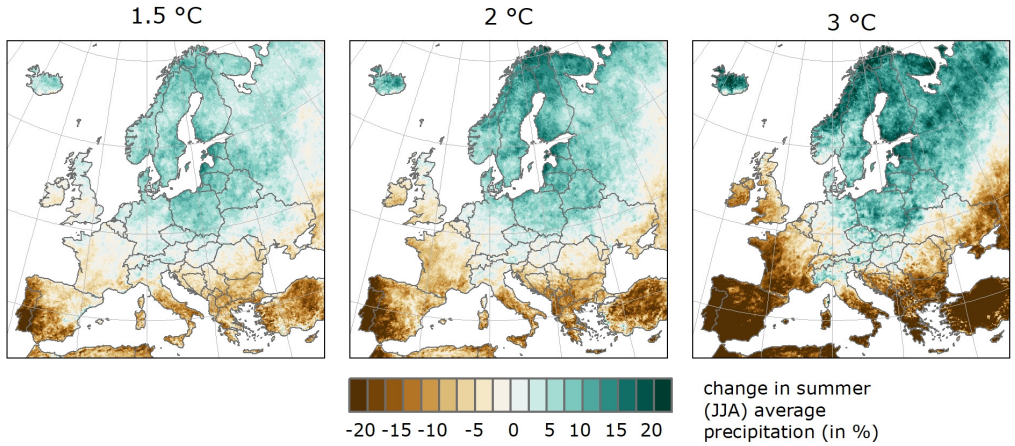
Projected change (%) in annual average precipitation compared to 1981-2010

European Commission

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

European Commission

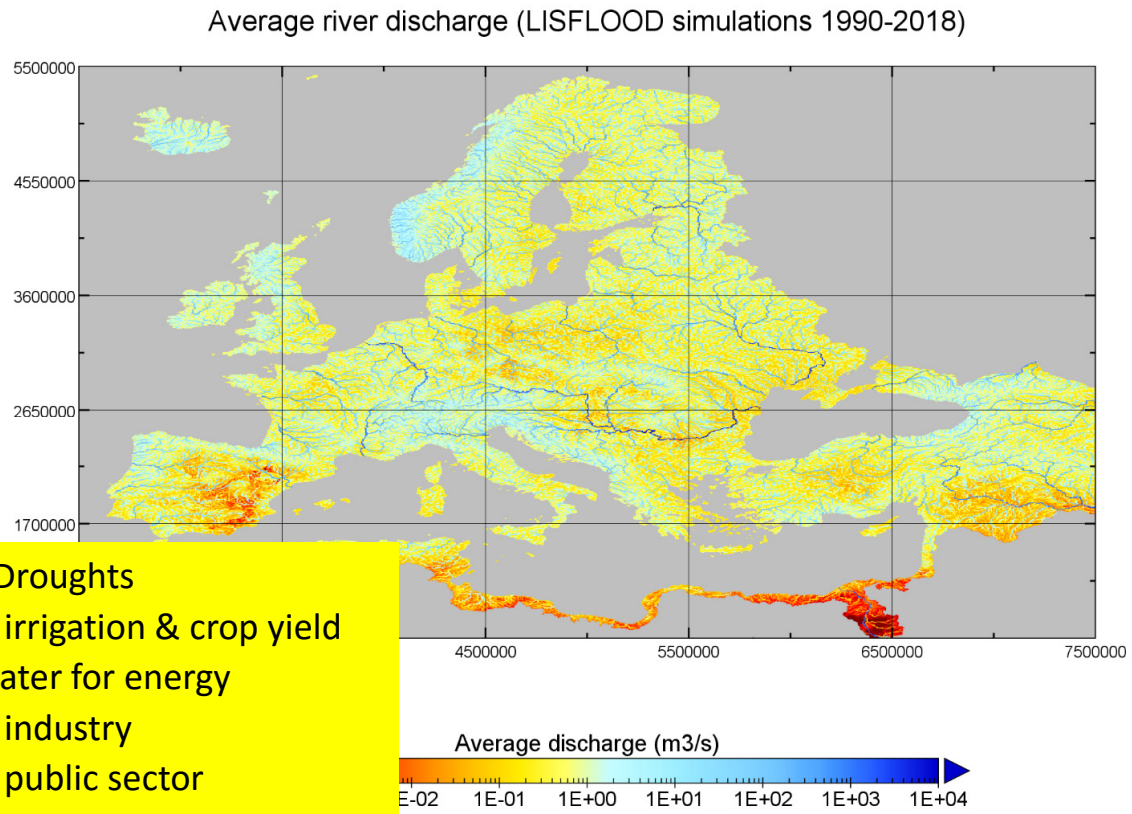
Key messages from PESETA and WEFE for water

- Benefits of climate **mitigation** - keep global warming at 1.5°C:
  - **172 billion €/year** reduced damages (river + coastal floods, droughts) by 2100
  - **7 million persons** less exposed to floods (1M) and water scarcity (6M)
- Benefits of climate **adaptation** (measures to reduce negative effects)
  - **122 billion €/year** reduced damages (river + coastal floods, droughts)
  - **~10 million persons** less exposed to floods (1M) and water scarcity (9M)
    - depending on the measures implemented

- More **ambition**, beyond current planned measures, seems needed to counter water scarcity effects and keep groundwater levels sustainable

European Commission

LISFLOOD: water resources, floods, droughts and crop simulation model



Floods & Droughts
Water for irrigation & crop yield
Cooling water for energy
Water for industry
Water for public sector
Water for Hydropower
Low flow and environmental flow
Groundwater depletion

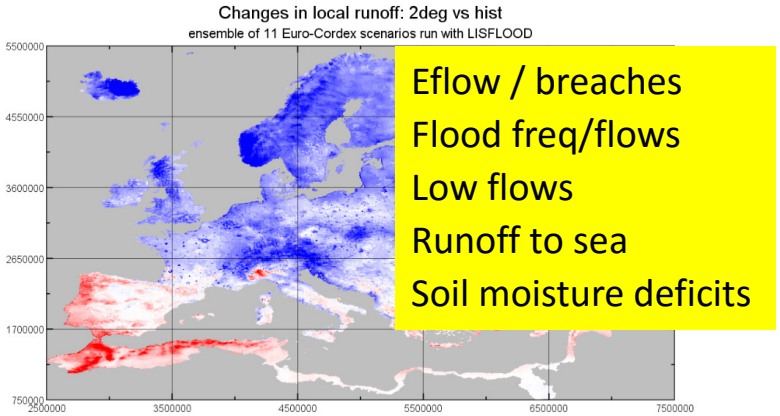
- 5km Europe
  - EFAS - floods
  - EDO - droughts
  - EU: WEFE Nexus, BLUE2, PESETA
- 0.1° Global
  - GloFAS – floods
  - E2O Tier1&2

0.083° Africa

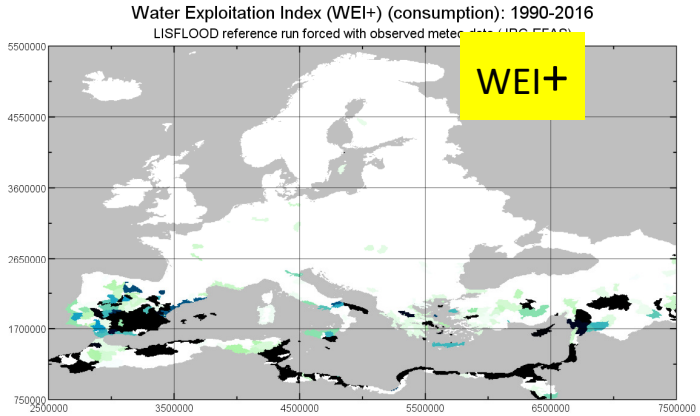
  - JRC WEFE nexus
- 0.5° Global
  - HELIX

European Commission

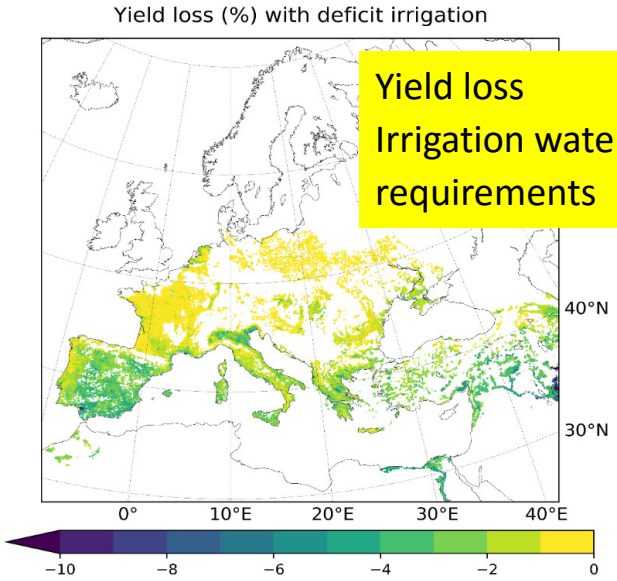
LISFLOOD – Example water/crop outputs



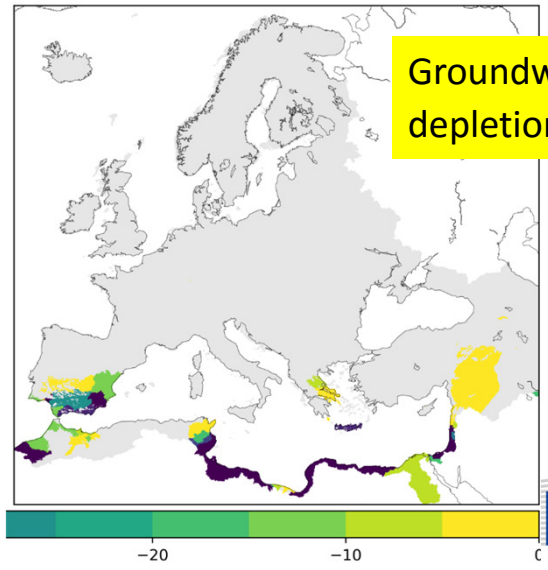
Eflow / breaches
Flood freq/flows
Low flows
Runoff to sea
Soil moisture deficits



WEI+



Yield loss
Irrigation water requirements



Groundwater depletion

European Commission

Table A1. Regional climate projections used in river flood impact analysis and corresponding year of exceeding 1.5, 2 and 3°C warming.

RCM (R)	Driving GCM (G)	RCP4.5	RCP8.5	RCP4.5	RCP8.5	RCP4.5	RCP8.5
		1.5 °C		2 °C		3 °C	
CCLM4.8-17	CNRM-CERFACS-CNRM-CM5	2035	2029	2057	2044		2067
	ICHEC-EC-EARTH	2033	2026	2056	2041		2066
	MPI-M-MPI-ESM-LR	2034	2028	2064	2044		2067
HIRHAM5	ICHEC-EC-EARTH	2032	2028	2054	2043		2065
WRF331F	IPSL-IPSL-CM5A-MR	2023	2021	2042	2035		2054
RACMO22E	ICHEC-EC-EARTH	2032	2026	2056	2042		2065
RCA4	CNRM-CERFACS-CNRM-CM5	2035	2029	2057	2044		2067
	ICHEC-EC-EARTH	2033	2026	2056	2041		2066
	IPSL-IPSL-CM5A-MR	2023	2021	2042	2035		2054
	MOHC-HadGEM2-ES	2021	2018	2037	2030	2069	2051
	MPI-M-MPI-ESM-LR	2034	2028	2064	2044		2067

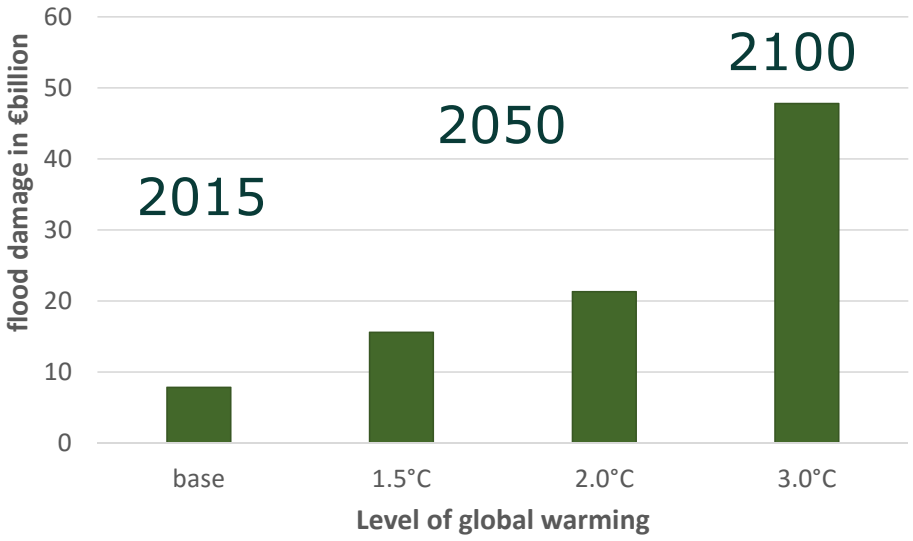
PESETA methodology

11 RCP 4.5
11 RCP 8.5
1980-2100

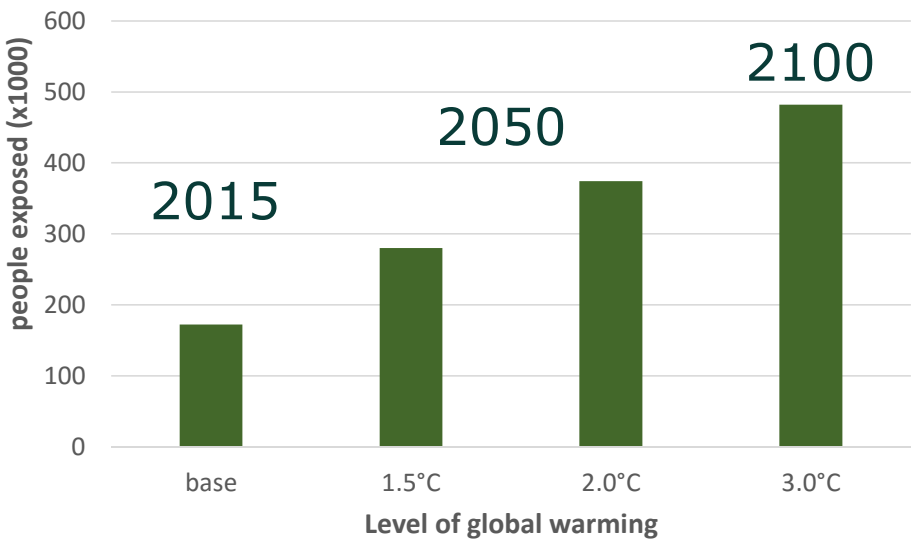
European Commission

River flood risk in Europe

Annual flood losses in EU + UK



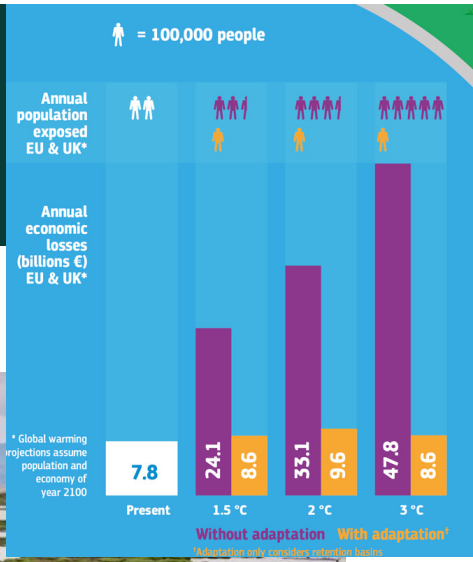
Population annually exposed in EU + UK



River risk in Europe will increase with global warming

European Commission

Adaptation to rising river flood risk in Europe



Hard infrastructure

- Benefit to cost ratio of 2.4
- Transfer risks downstream
- Levee effect

Retention areas

- Benefit to cost ratio of 3.3
- Restores natural functioning of floodplain areas
- Improves ecosystem quality

Other measures evaluated: Flood Proofing; Relocation

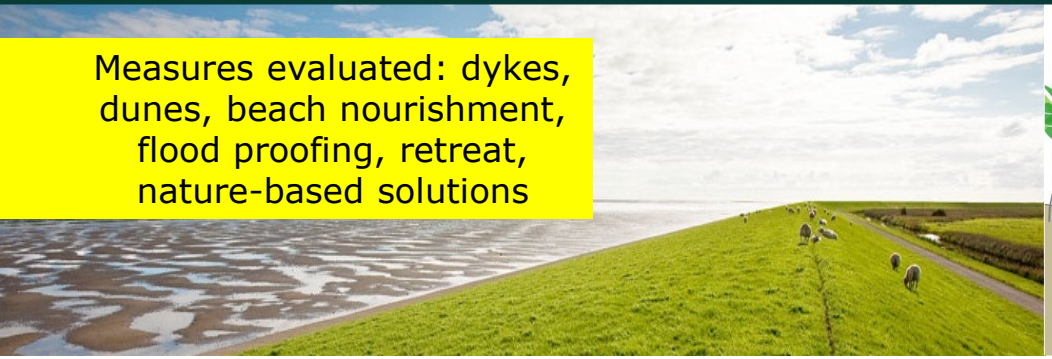
Adaptation to increasing coastal flood risk

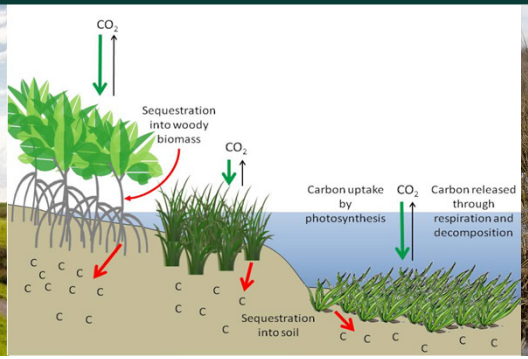
EU + UK annual damages with and without adaptation in 2100

	Today	High emissions		Moderate mitigation	
		No adapt	Adapt	No adapt	Adapt
Damages (€ billion/year)	1.4	239	23	111	12
People exposed (million/year)	0.1	2.2	0.8	1.4	0.6

Coastal flood risk in Europe will dramatically increase with global warming - with mitigation and adaptation economic losses can be reduced by 95%

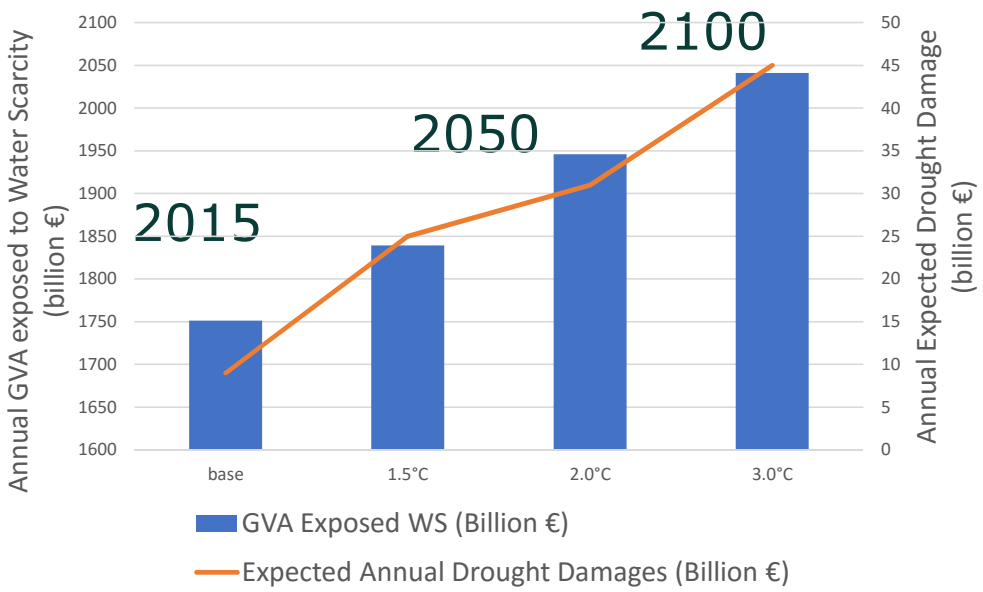
Measures evaluated: dykes, dunes, beach nourishment, flood proofing, retreat, nature-based solutions



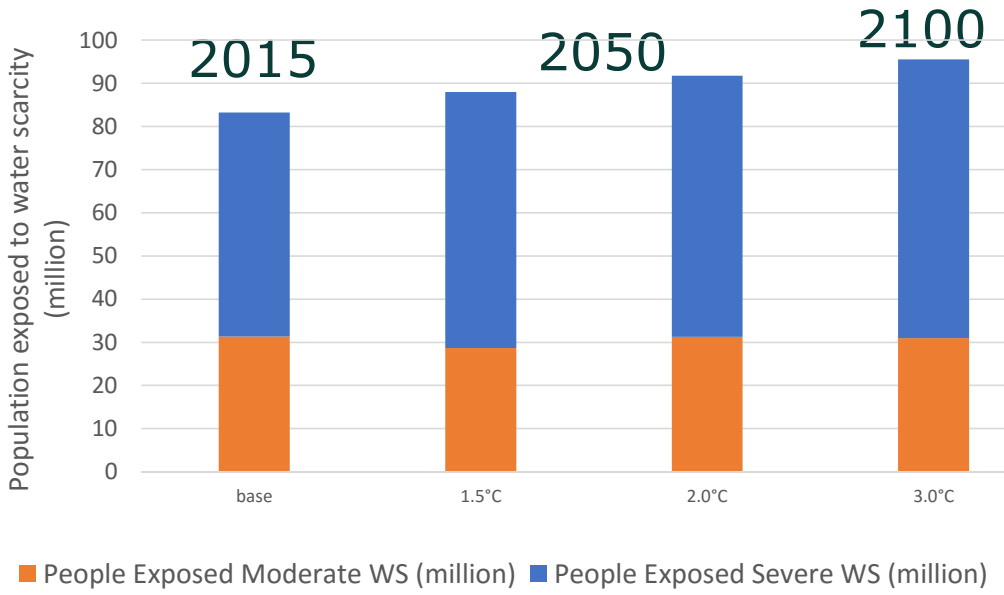


Water scarcity & Drought risk in Europe

Annual drought losses in EU + UK



Population annually exposed in EU + UK



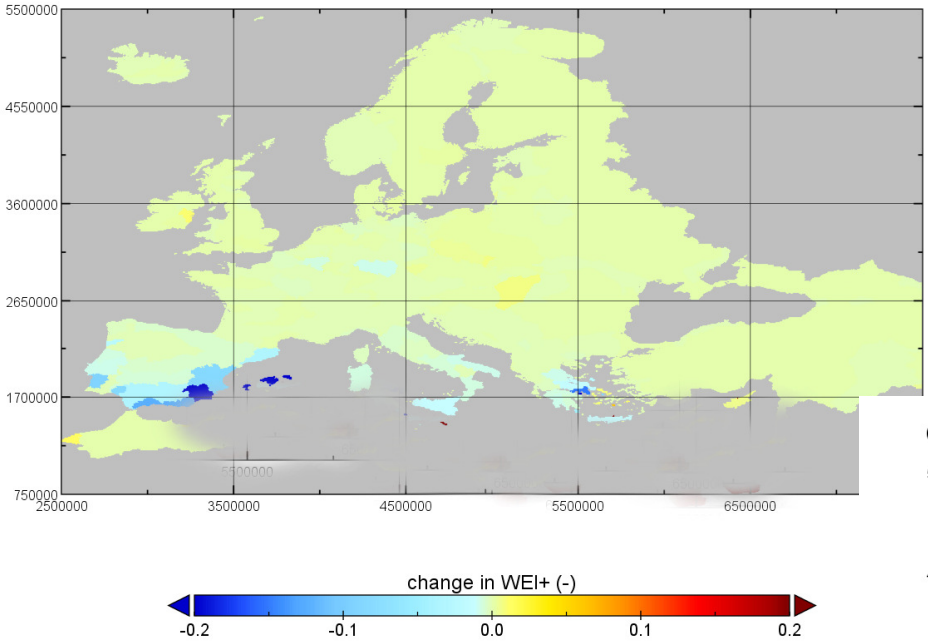
Water scarcity exposure in Europe will increase with global warming

European Commission

Adaptation measures reducing water scarcity

- Irrigation efficiency increases
- Water re-use for irrigation
- Changing crop varieties to less water depending ones (CAP?)
- Groundwater recharge (south and central Europe)
  - Current and future groundwater depletion underrated issue
- Desalination (using renewable energy) for urban water supply

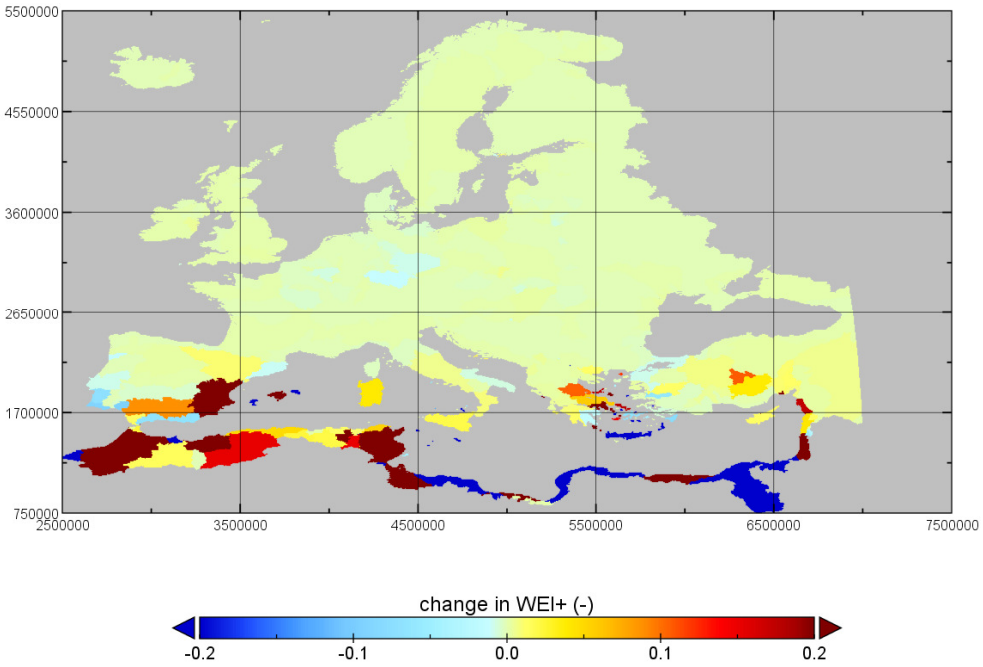
Change in WEI+ by all 4 measures combined (BAU)



WEI+

impact of PoM measures 2030 & climate change 2 degrees

Change in WEI+ 2013-2042 climate + 4 BAU measures as compared to 1981-2010 climate



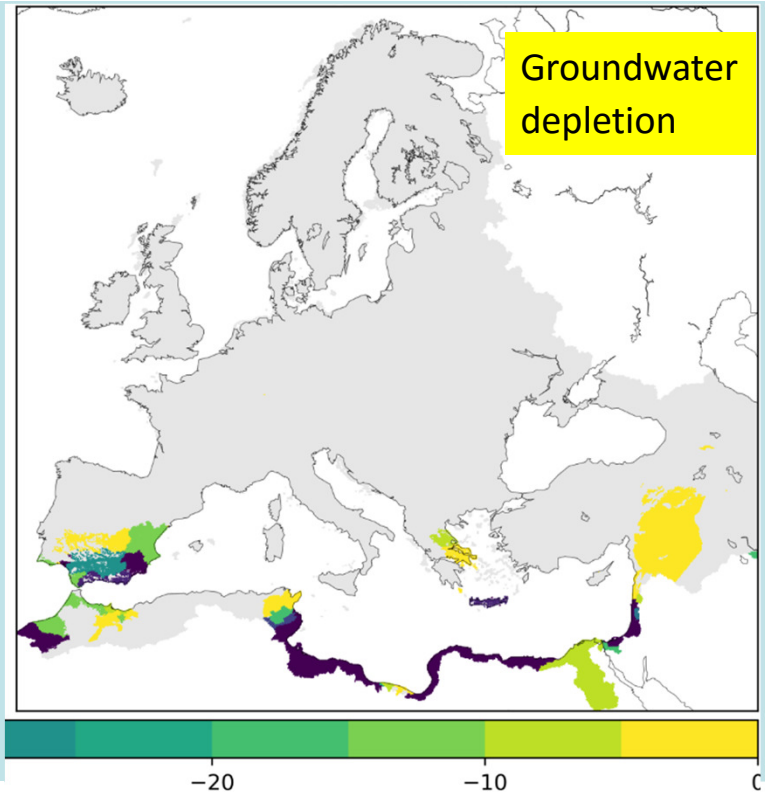
Planned (adaptation) measures:

- ok under current climate
- might not be sufficient under climate change

Water quality & climate change

- Not included in PESETA (until now)
- Key uncertainties:
  - CO2 effects on crop yield <> fertilizer management
  - Shifting crop patterns/varieties <> fertilizer management
  - Drought resistant crops <> different fertilizer needs
  - Farmer adaptation planting & harvesting dates <> fertilz
  - Climate models not designed for short duration rainfall events, influencing urban runoff & sewer overflows

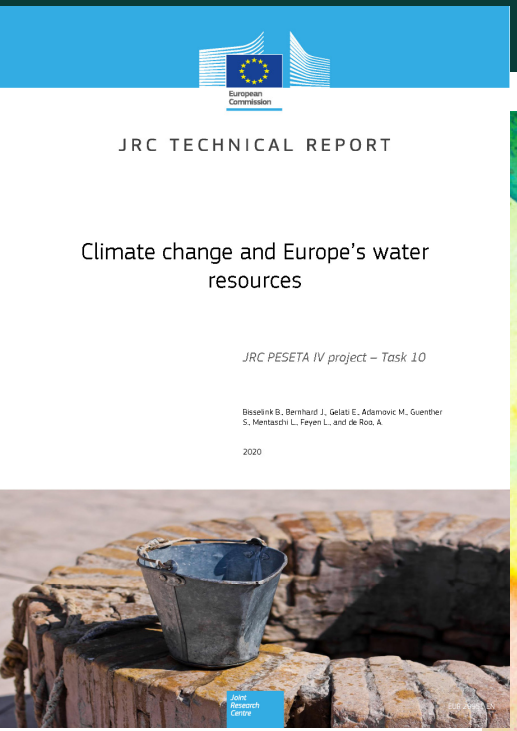
Beyond PESETA: research challenges

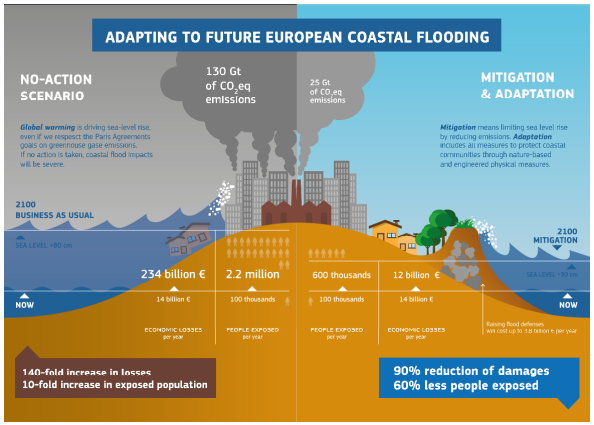


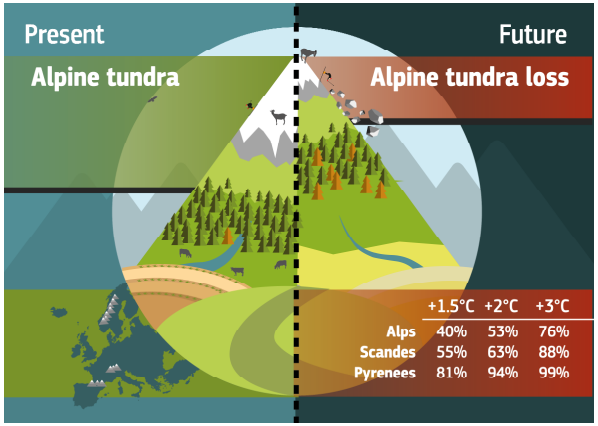
- PESETA agriculture computations done under assumption of sufficient irrigation water
- Groundwater taken as an unlimited source of water -> use of groundwater depletion as a restriction
- Projections of industrial water usage depend on innovations in sector; variations cause different results
- Other additions:
  - Various energy scenarios & cooling water scenarios evaluated
  - Further computations including water re-use
  - Further computations including desalination water
- Seasonal effects & recent droughts in NW & central Europe
- Addressing water quality using CAPRI 2030>
- JRC-WEFE & BLUE2-V2 are addressing some of those issues

European Commission

Dissemination – reports & infographics







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

Conclusions water & climate change

- Benefits of climate **mitigation** - keep global warming at 1.5°C:
  - **172 billion €/year** reduced damages (river + coastal floods, droughts) by 2100
  - **7 million persons** less exposed to floods (1M) and water scarcity (6M)
- Benefits of climate **adaptation** (measures to reduce negative effects)
  - **122 billion €/year** reduced damages (river + coastal floods, droughts)
  - **~10 million persons** less exposed to floods (1M) and water scarcity (9M)
    - depending on the measures implemented

- More **ambition**, beyond current planned measures, seems needed to counter water scarcity effects and keep groundwater levels sustainable

- **Water quality** projections hampered by uncertainties

Damages (billion/year)	Today	1.5-NoAdapt	1.5-Adapt	Mod-NoAdapt	Mod-Adapt	High-NoAdapt	High-Adapt
Coastal	1.4	111	9	111	12	239	23
Floods	7.8	24	8.6	33	9.6	48	8.6
Droughts	9	25		31		45	
SUM	18.2	160		175		332	
Water Resources (exp)	996	1130		1130		1256	
Adaptation		135	17.6	144	21.6	287	31.6
People (million/year)	**Today**	**1.5-NoAdapt**	**1.5-Adapt**	**Mod-NoAdapt**	**Mod-Adapt**	**High-NoAdapt**	**High-Adapt**
Coastal	0.1	1.4	0.5	1.4	0.6	2.2	0.8
Floods	0.172	0.252	0.092	0.338	0.1	0.482	0.09
Water Resources (exp)	52	59	50	60	50	65	50
		60.652	50.592	61.738	50.7	67.682	50.89

-> Benefit of climate mitigation (from 3degrees to 1,5 degrees) = 172 billion/year (332 minus 160)
-> Benefit of adaptation (from NoAdapt to Adapt) = 122 billion/year (144 minus 21.6)
-> Benefit of climate mitigation: Number of persons exposed = 7.03 million (67.682 minus 60.652 million)
-> Benefit of adaptation (from NoAdapt to Adapt) = ~10 million people (mostly depending on reducing water stress)

Thanks to all JRC, ENV and CLIMA colleagues for the collaboration!

European Commission