The European Commission's science and knowledge service

Joint Research Centre

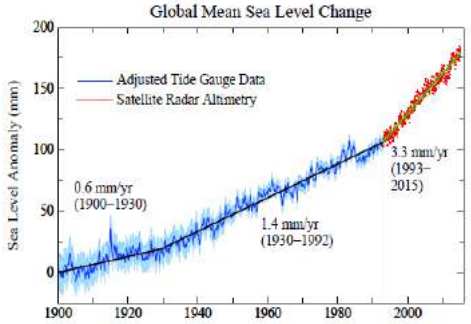
Coastal flooding risk in view of climate change-Adaptation analysis

LISCoAsT – Large scale Integrated Sea-level and Coastal Assessment Tool

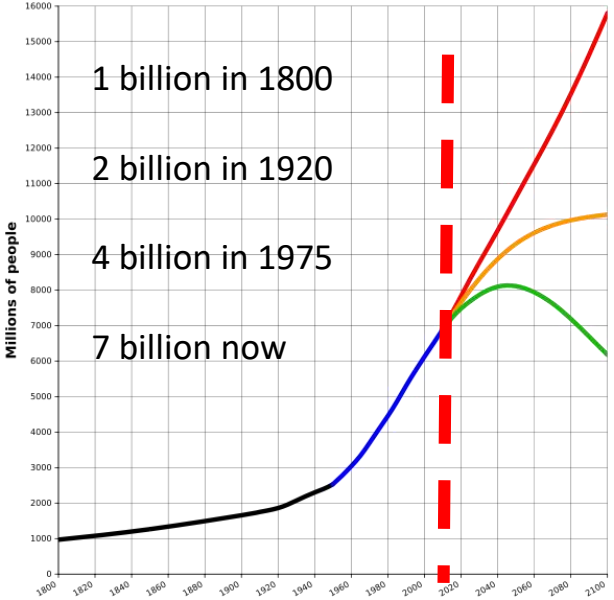
Michalis Vousdoukas, Lorenzo Mentaschi, Luc Feyen

E.1 Disaster Risk Management Unit

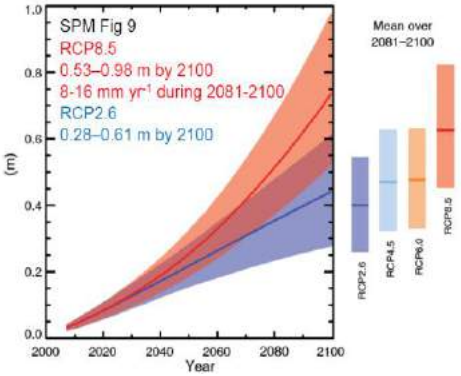
Coastal risks and challenges



Hansen ACPD, 2015



UN 2010



IPCC 2013

- >50% of EU population lives within 50 km of the coast
- 44% of global population lives within 100 km of the coast (UN Atlas 2010)
- A great proportion below 10 m elevation

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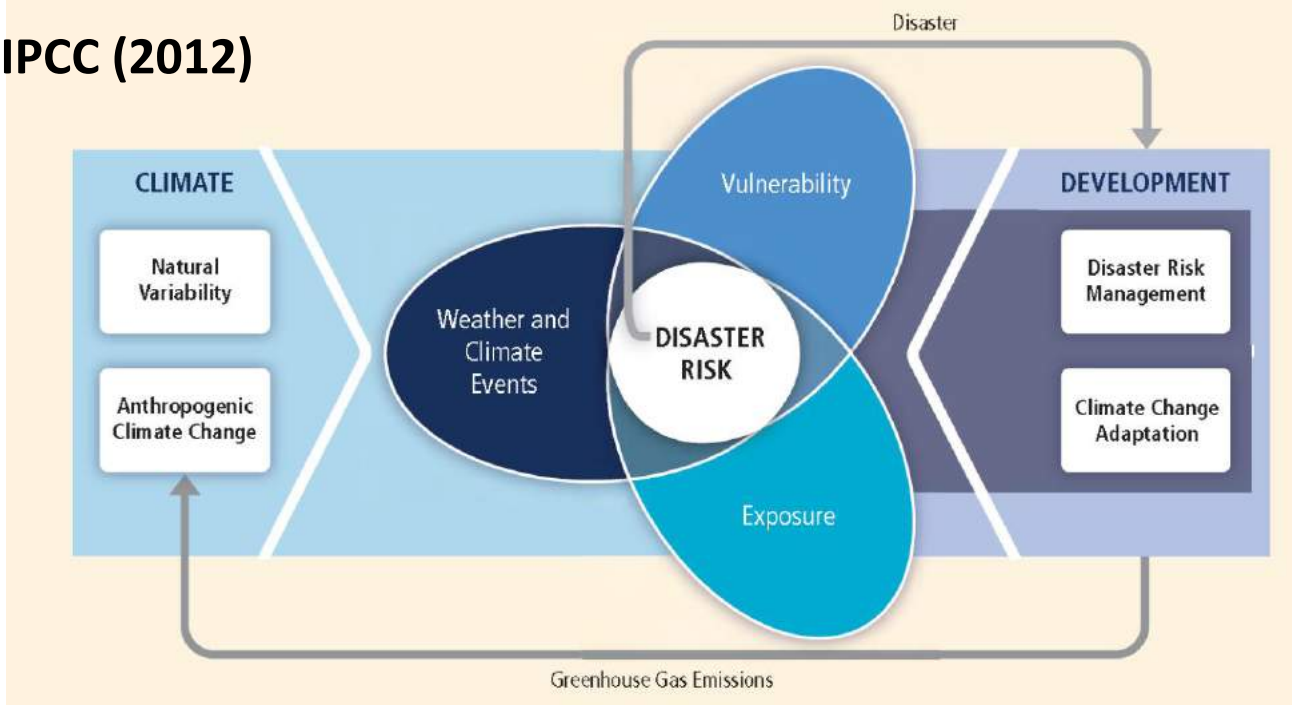
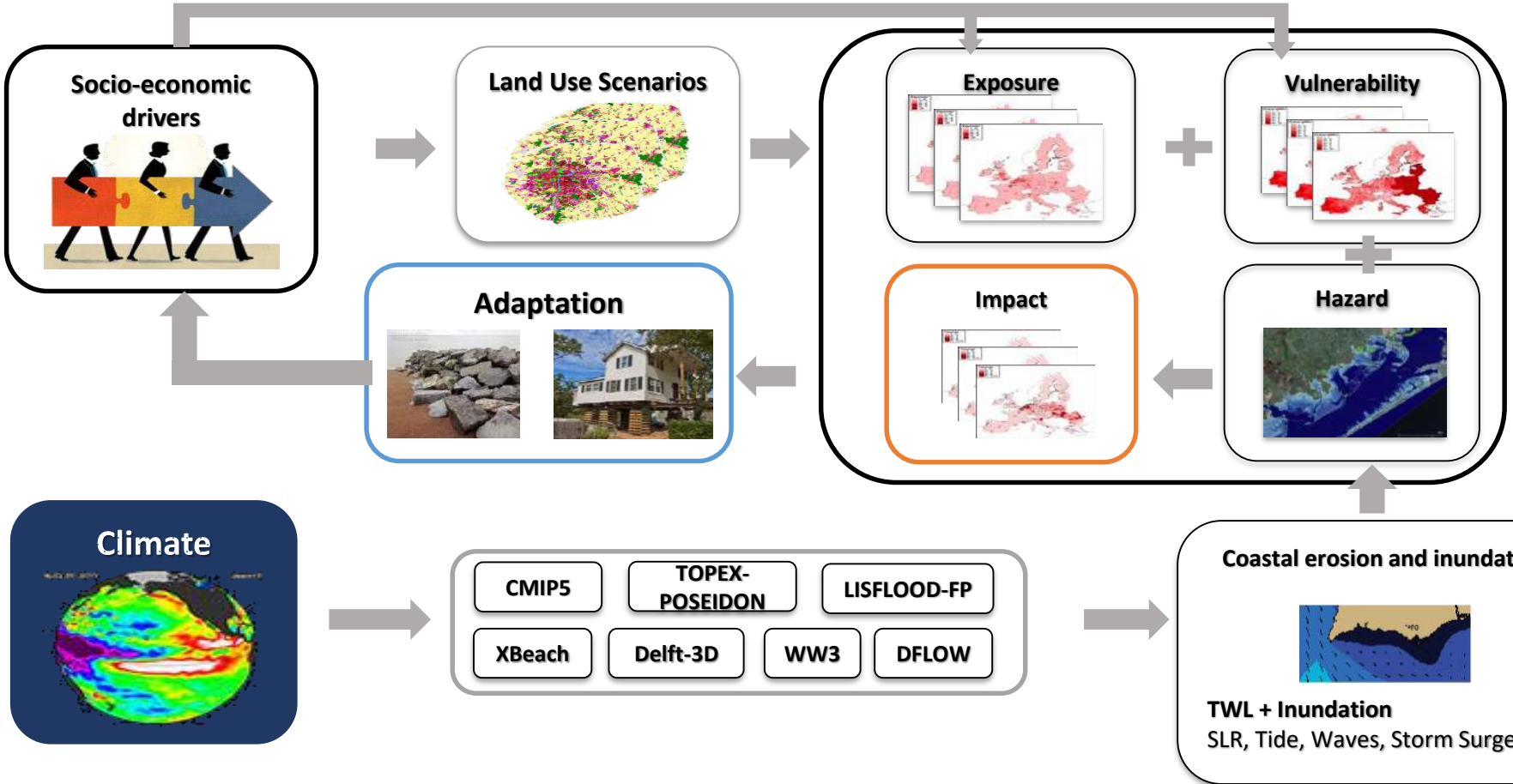
Climate risk - framework

SREX, IPCC (2012)



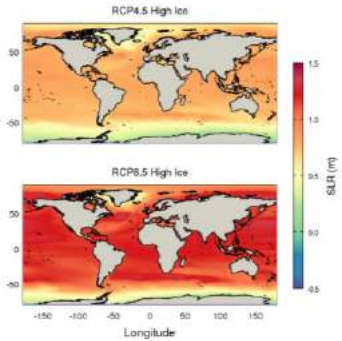
The LISCoAsT approach



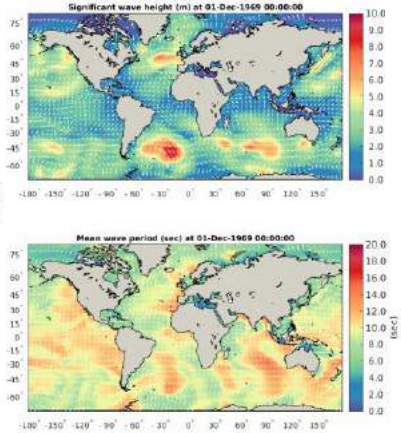
LISCoAsT – Large-scale Coastal Assessment Tool

Climate

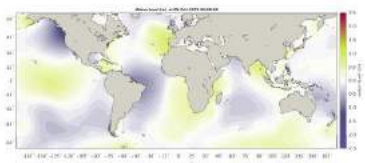
Sea level rise



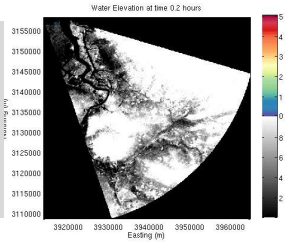
Waves



Tides-Storm surge

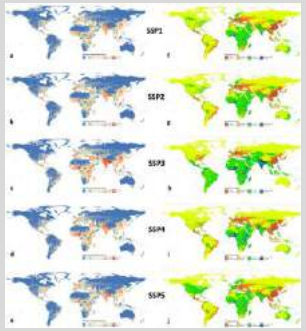


Inundation



Coastal Impacts

Gridded exposure projections



Models used

- WW3
- DFLOW-FM
- FES2014
- LisFloodFP

http://data.jrc.ec.europa.eu/collection/LISCOAST

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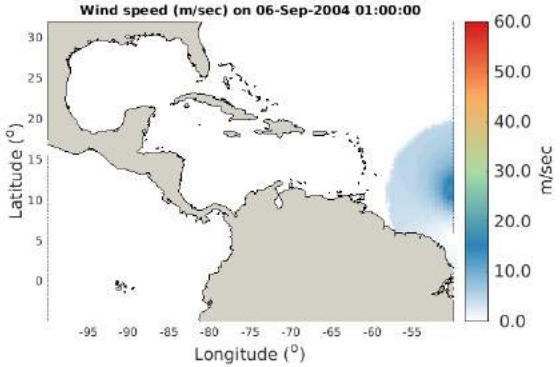
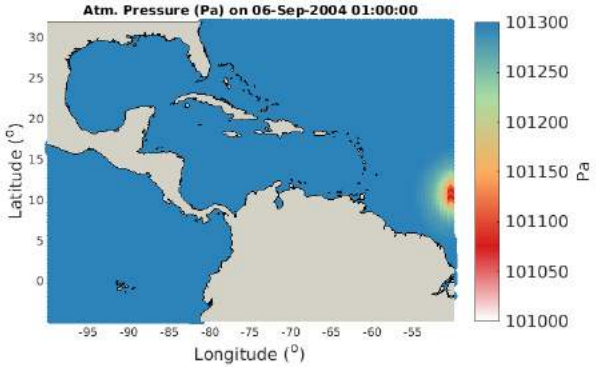
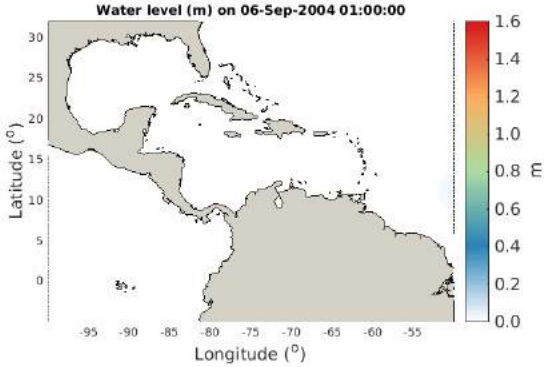
ESL extremes: Tropical cyclones



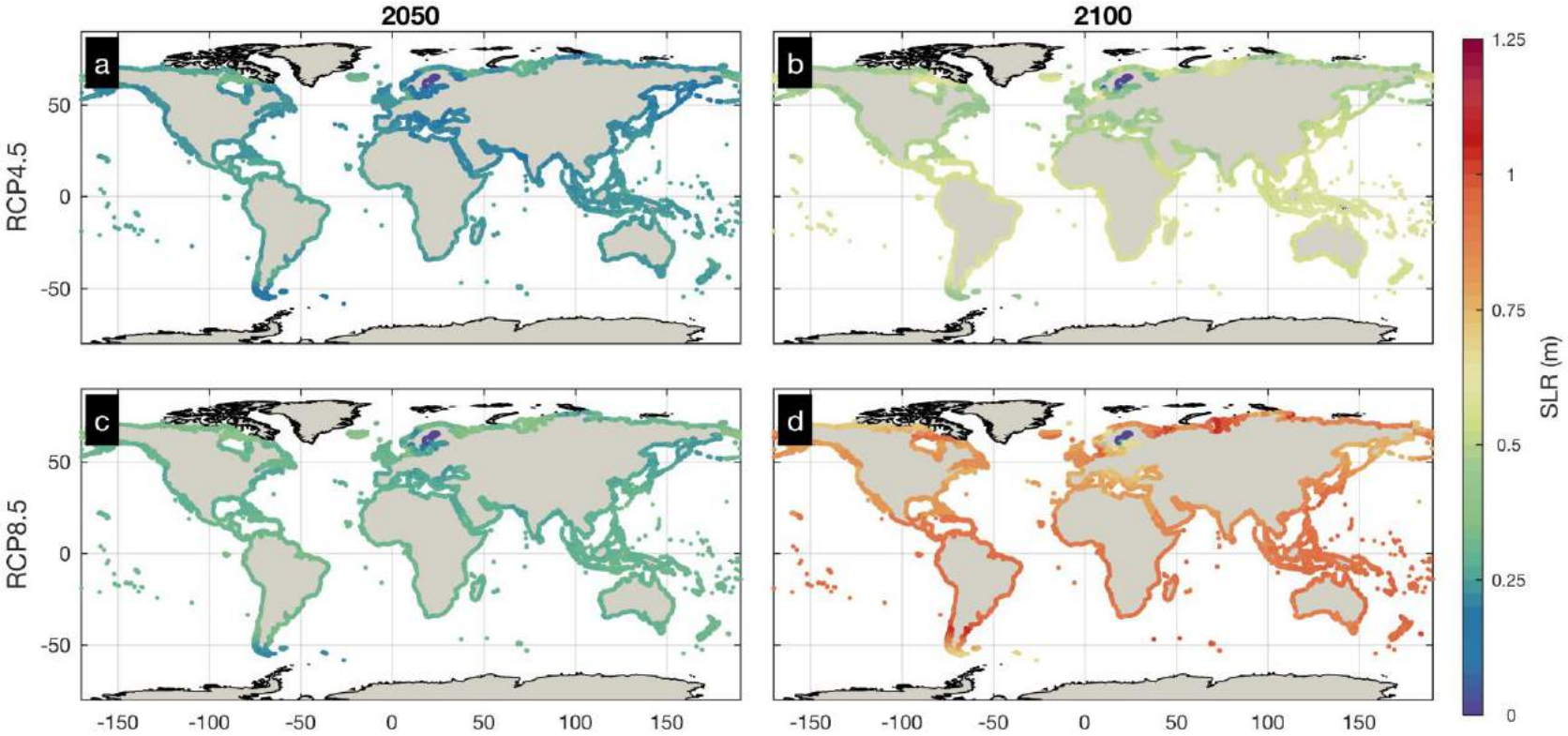




Thousands of storm surge simulations forced by all best tracks database IBTRACKS

ESL projections: SLR

Jevrejeva et al. (2016)



Very likely SLR range under business as usual scenario 18-50 cm in 2050 and 47-198 cm in 2100

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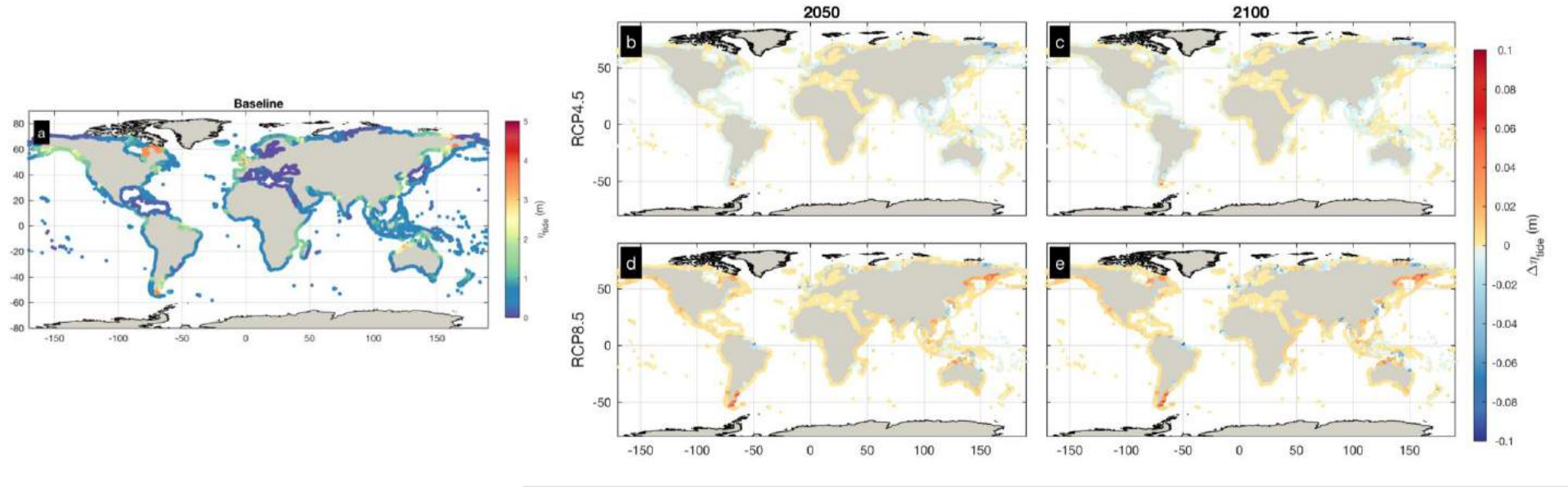
ESL projections: Tides



Local changes in tides can exceed 10% of SLR

Vousdoukas et al. 2018 Nature Communications

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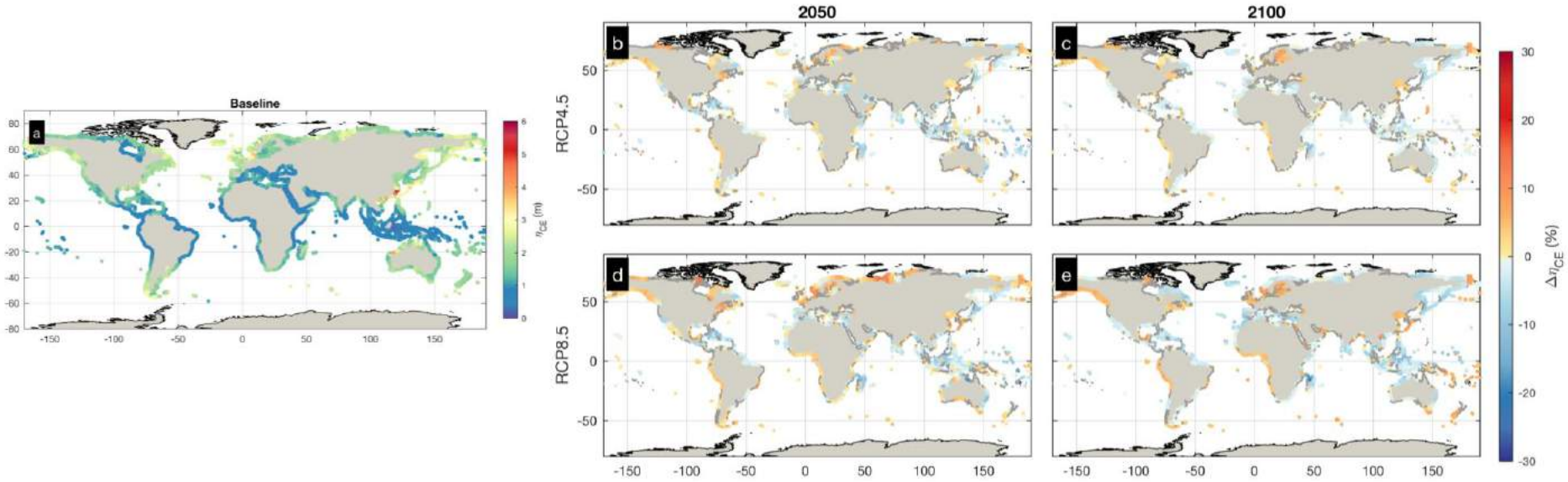
ESL projections: Climate extremes



Local changes in climate extremes can exceed 30% of SLR

Vousdoukas et al. 2018 Nature Communications

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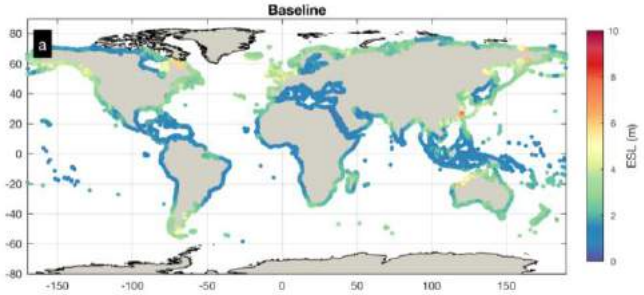
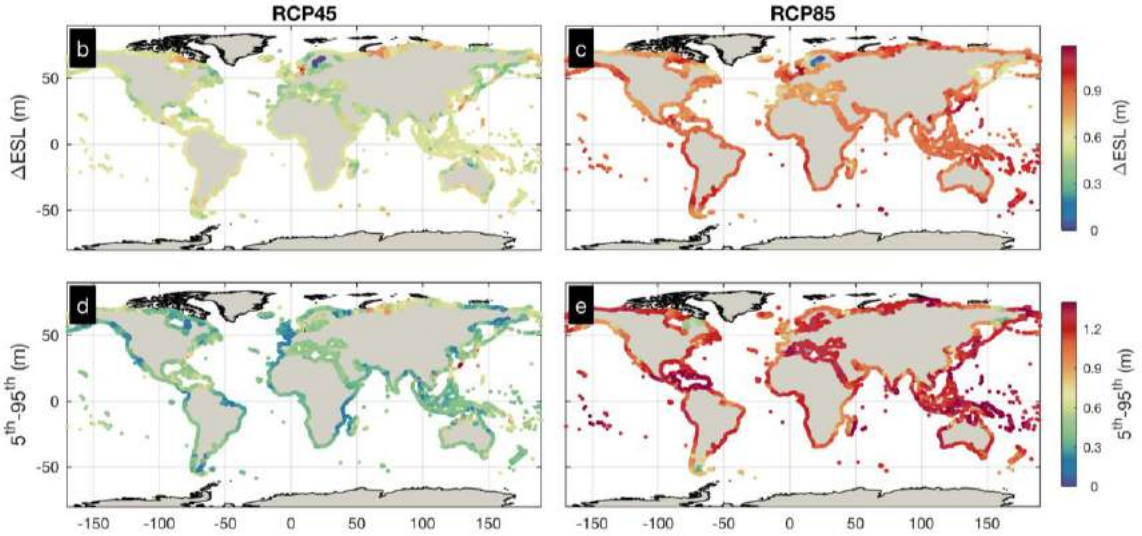
ESL projections: All components

Driven by SLR, changes in tides, waves, and storm surges





Median rise within 20-30 cm by 2050, 51-86 cm by the end of the century

Vousdoukas et al. 2018 Nature Communications

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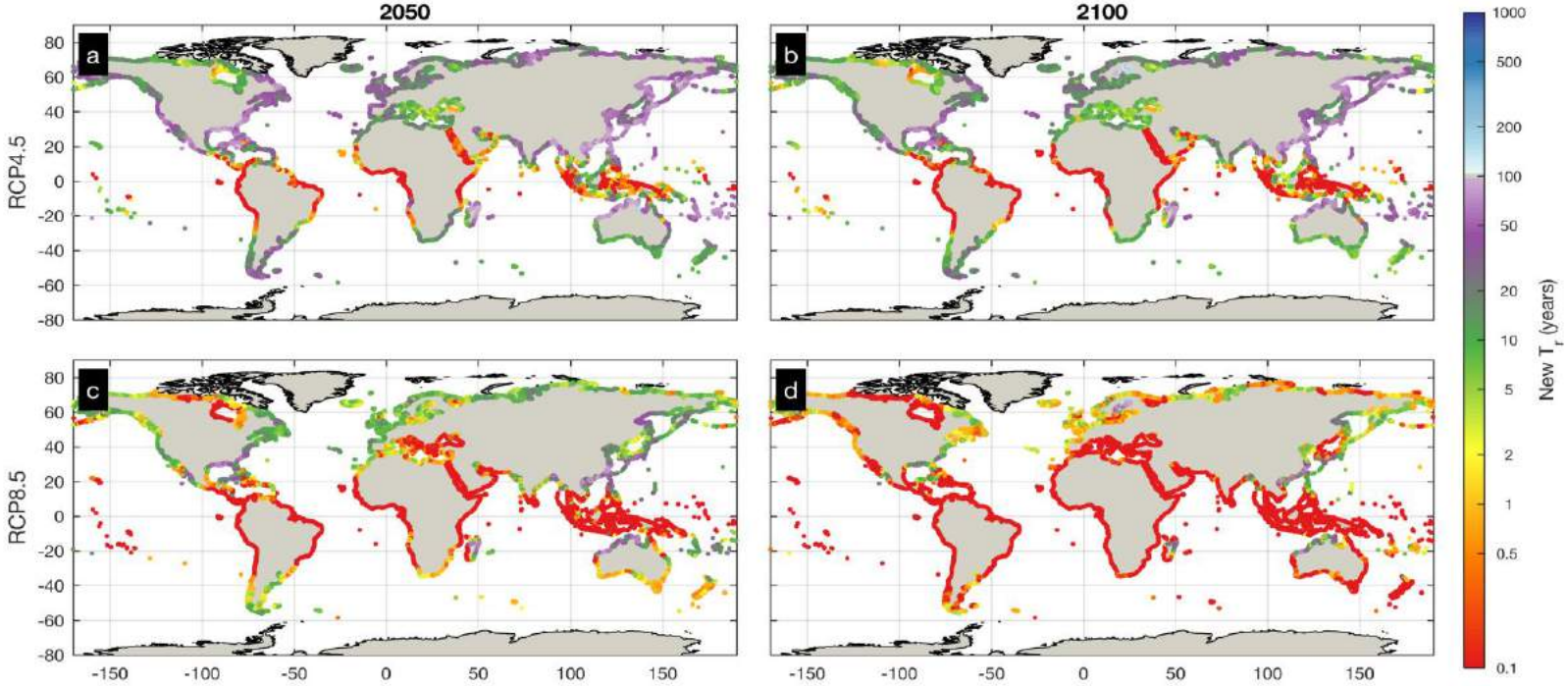
Intensification of ESLs

Vousdoukas et al. 2018 Nature Communications



Storm of the century occurs every year by 2050 along most of the tropics

By the end of the century along most of the global coastline

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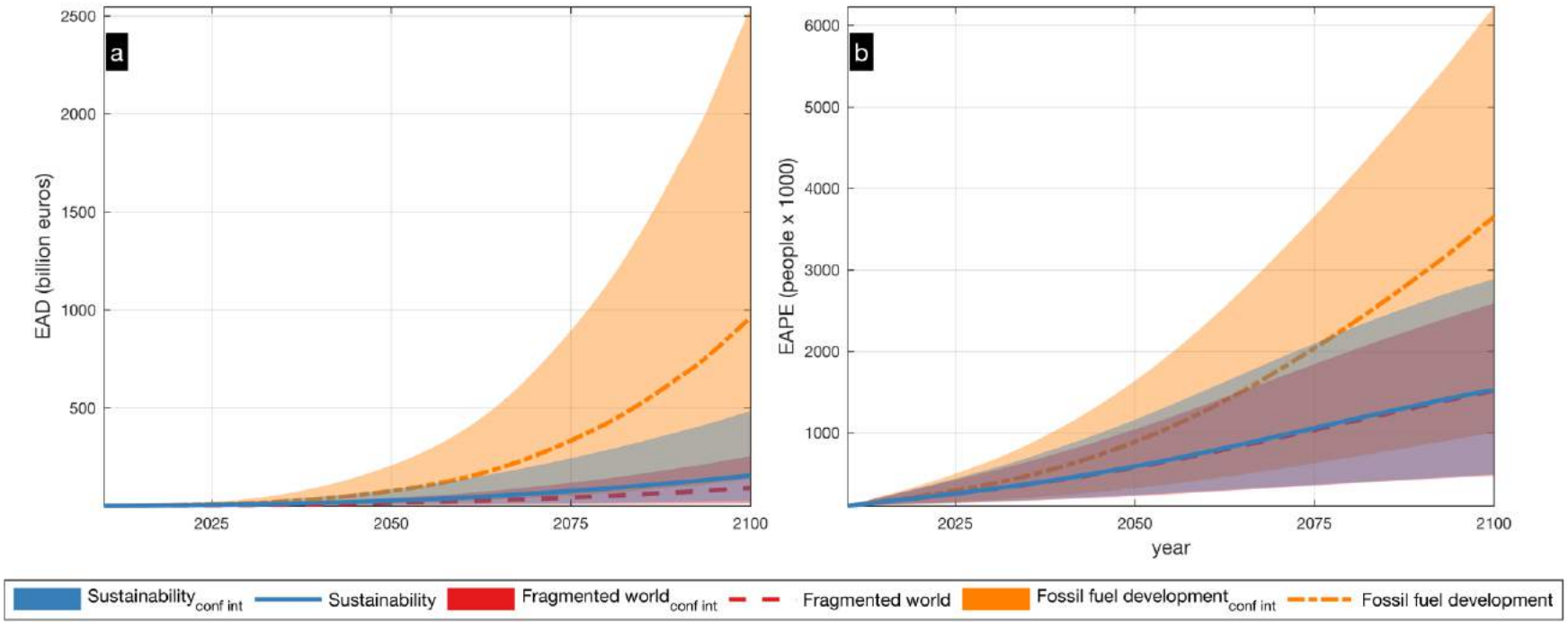
Projections of EAD for RCP4.5 and 8.5

Vousdoukas et al. 2018 Nature Climate Change



Present EAD of €1.25 billion is projected to increase by 2-3 orders of magnitude by the end of the century, ranging between 93 and €961 billion.

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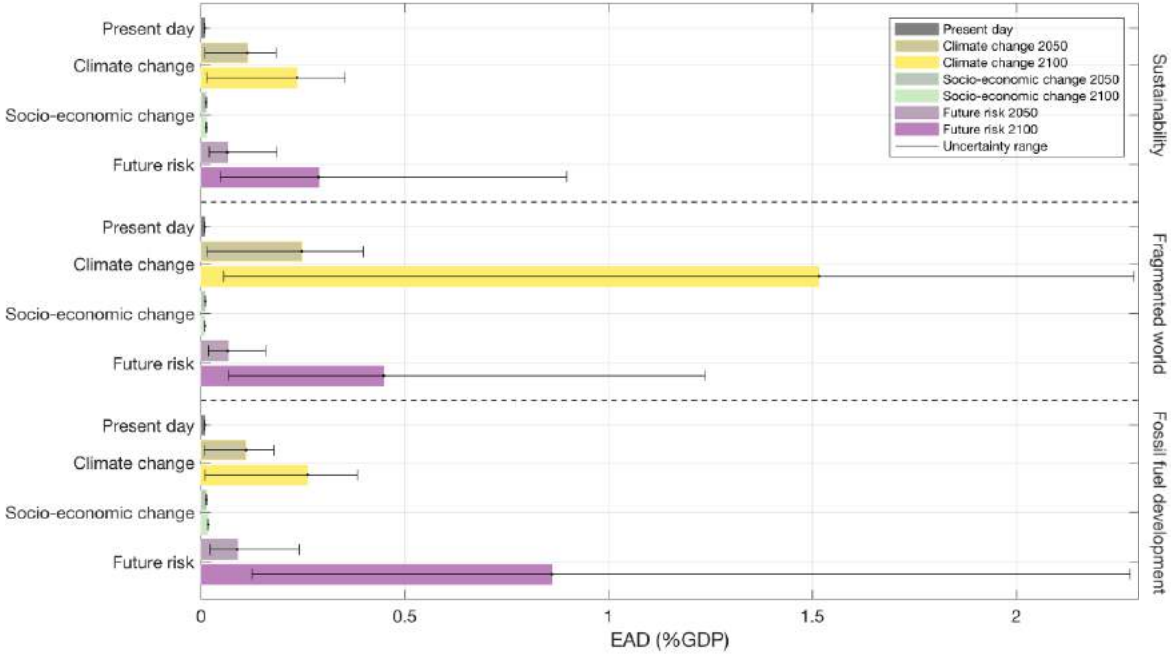
Coastal impacts- Socio-economic vs Physical



Vousdoukas et al. 2018 Nature Climate Change

Climate becomes the main driver of rising losses in contrast to historical trends which were dominated by socioeconomic development

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The challenges of coastal adaptation

Photos by www.wikipedia.org

Protect (Hard protection, beach nourishment, hybrid)

Accommodate (Reduce vulnerability) High population density → limited space to accommodate

Retreat (Reduce exposure) Critical infrastructure → retreat costly and technically difficult

Do nothing Not an option with high population density and presence of critical assets

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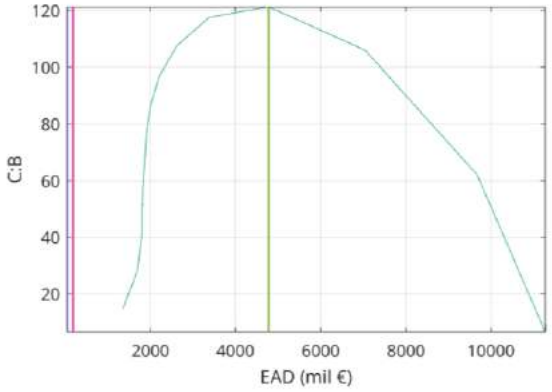
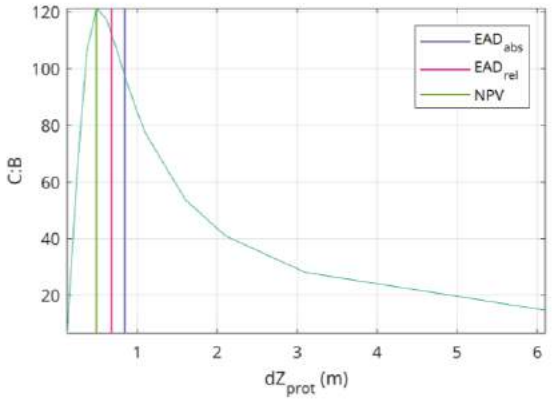
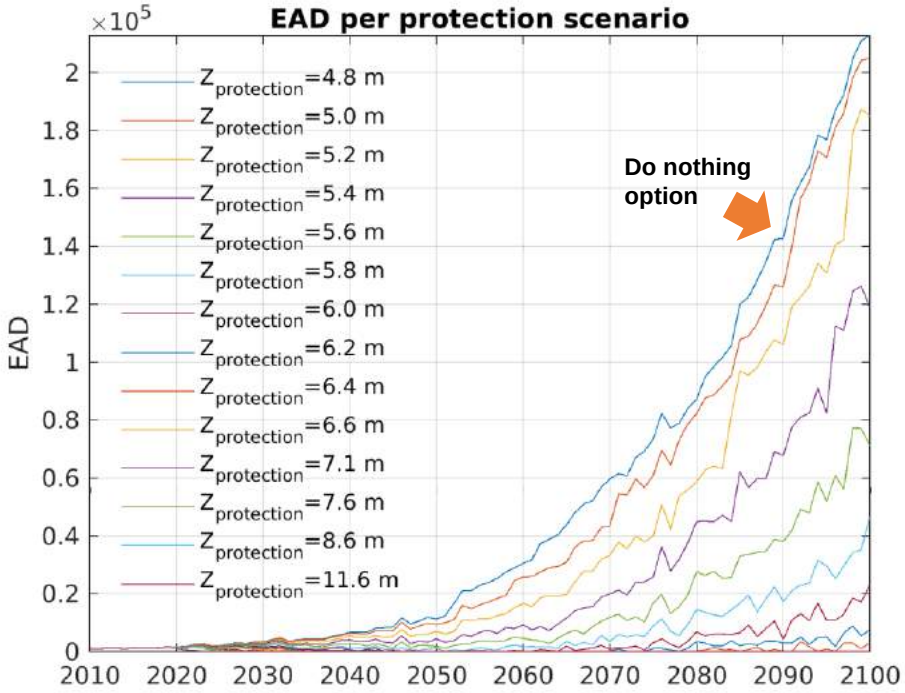
Assessing different protection scenarios







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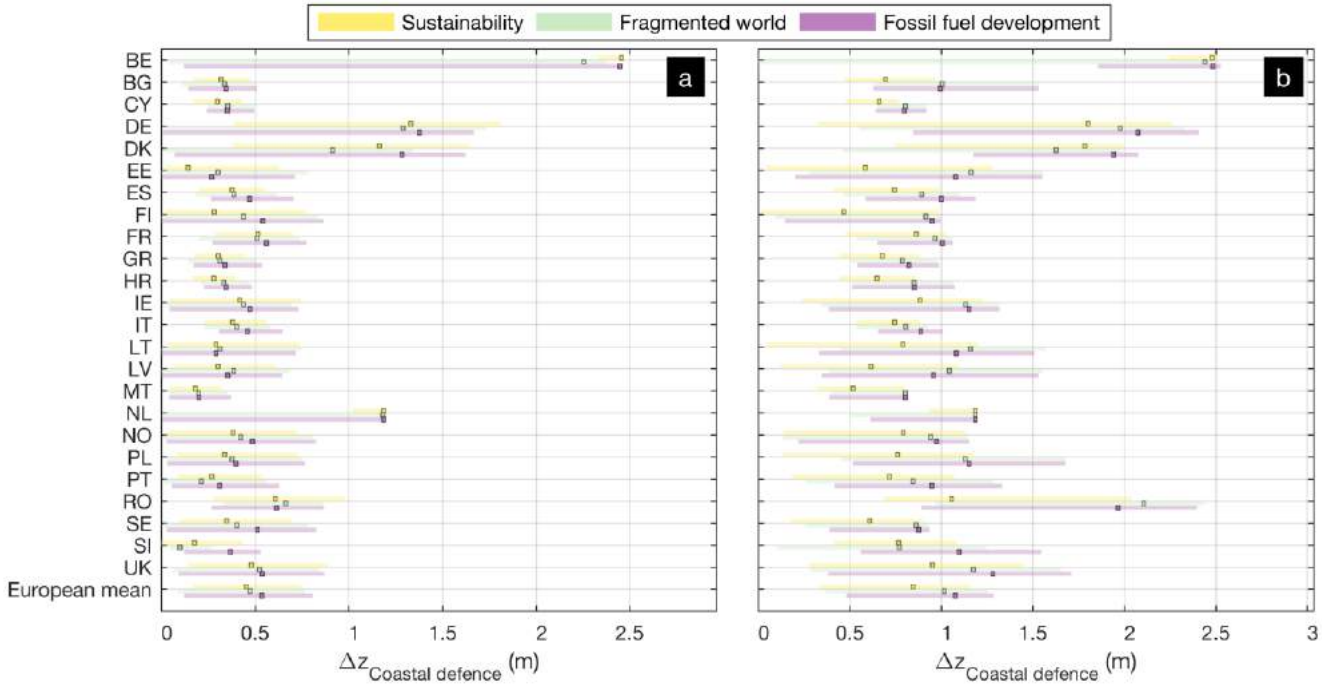
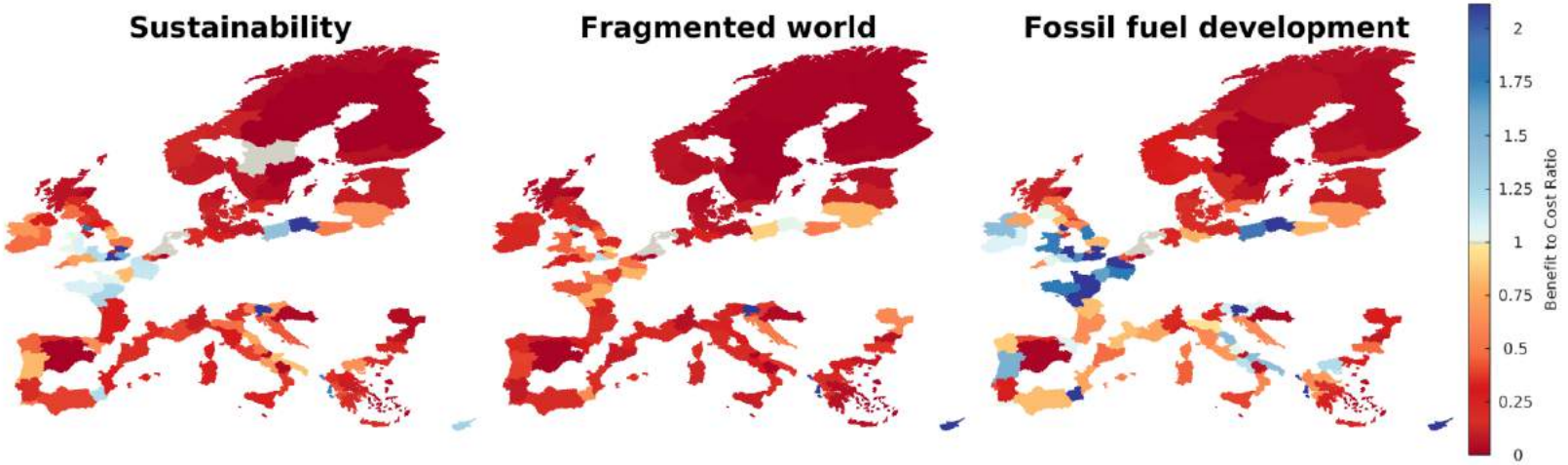
Adaptation challenges



Adaptation challenges: NPV path



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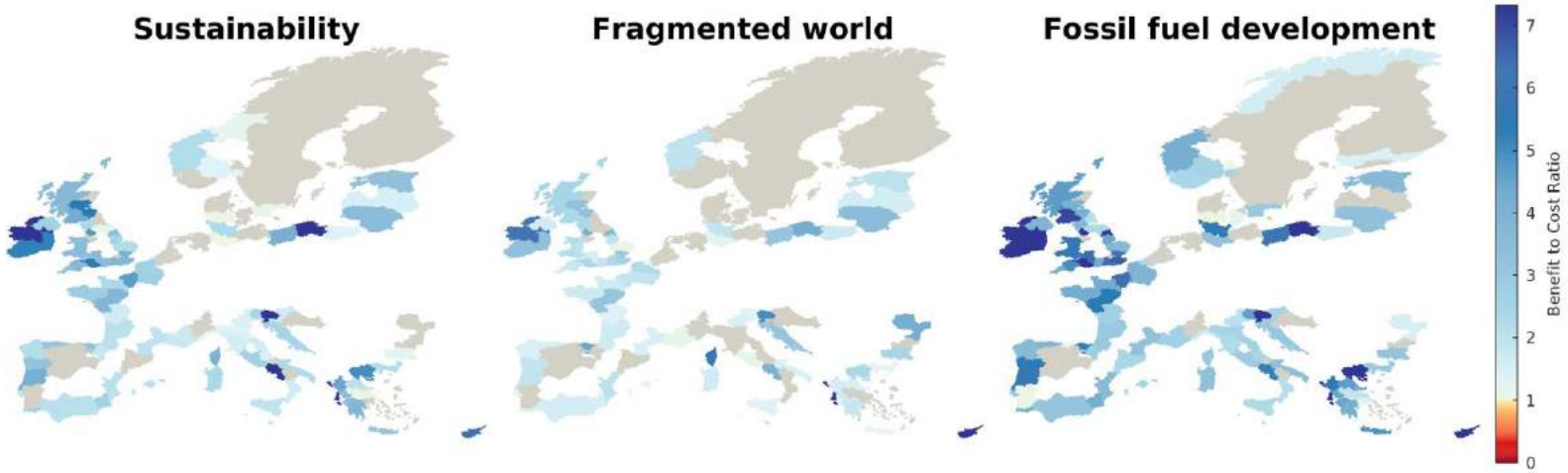
Adaptation challenges: economic criteria first



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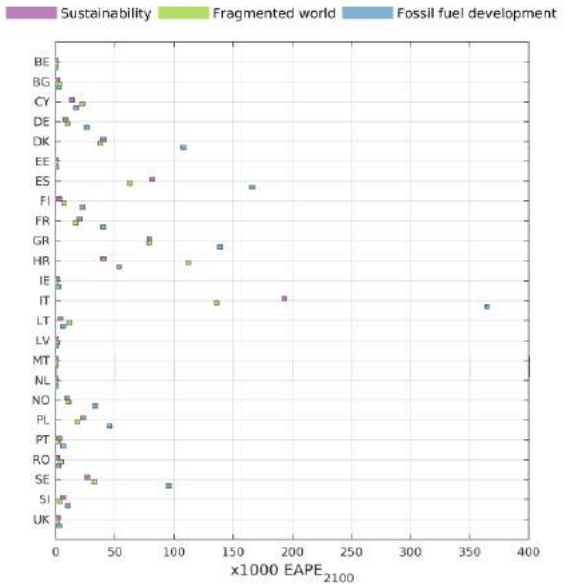
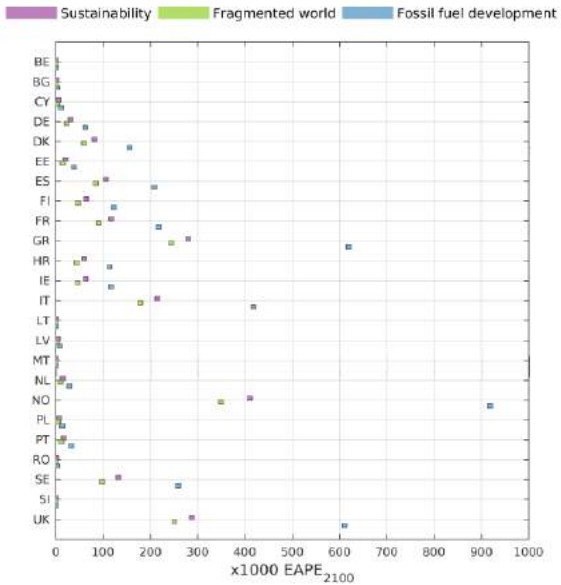
Adaptation challenges: economic criteria first

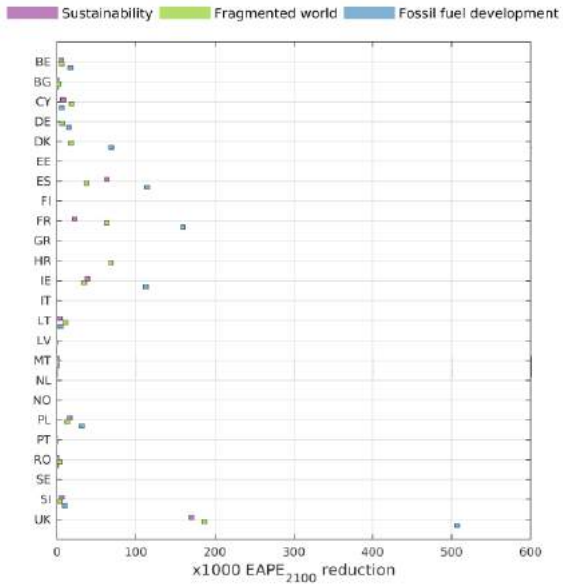
Adapting everywhere NPV



Adapting only when BCR>1



EAPE reduction



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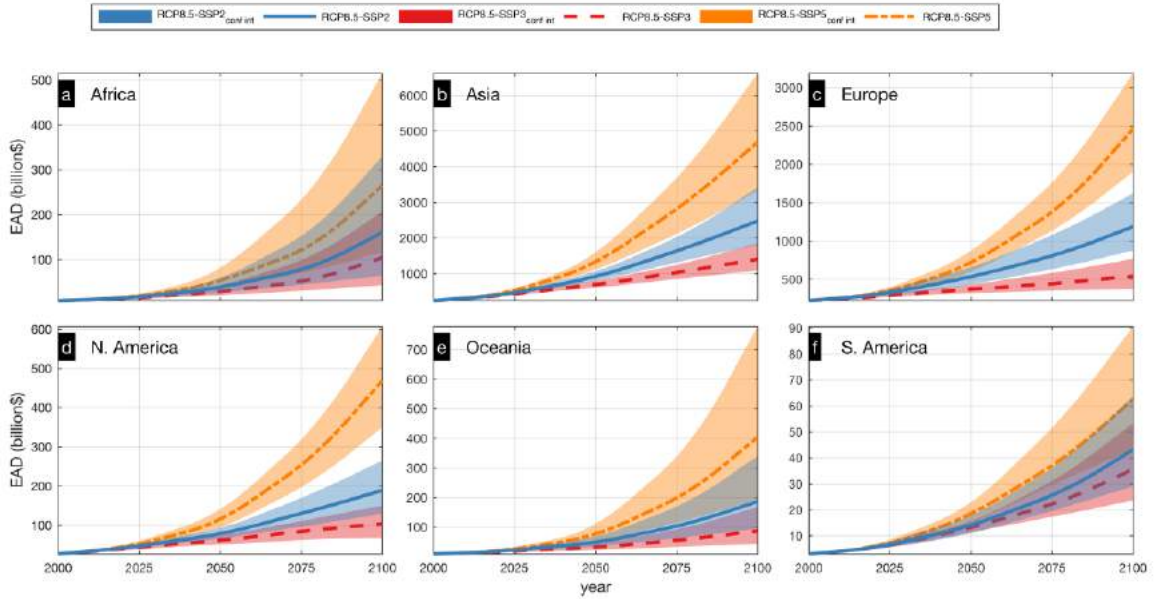
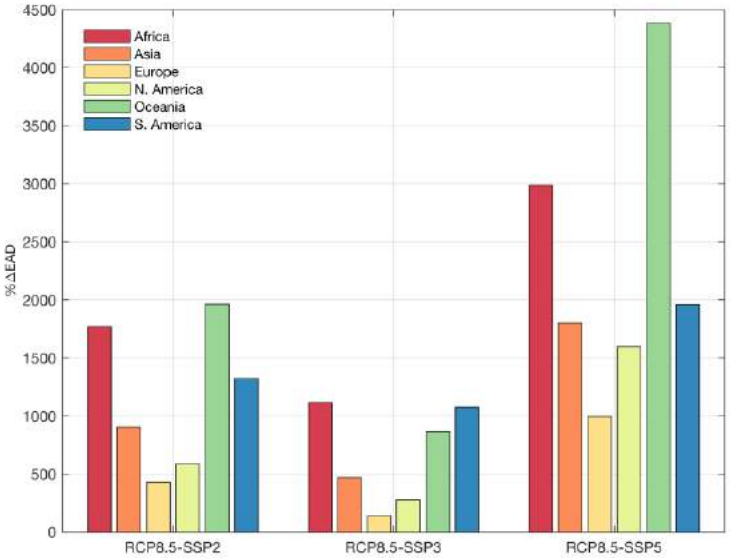
Projections of EAD per continent



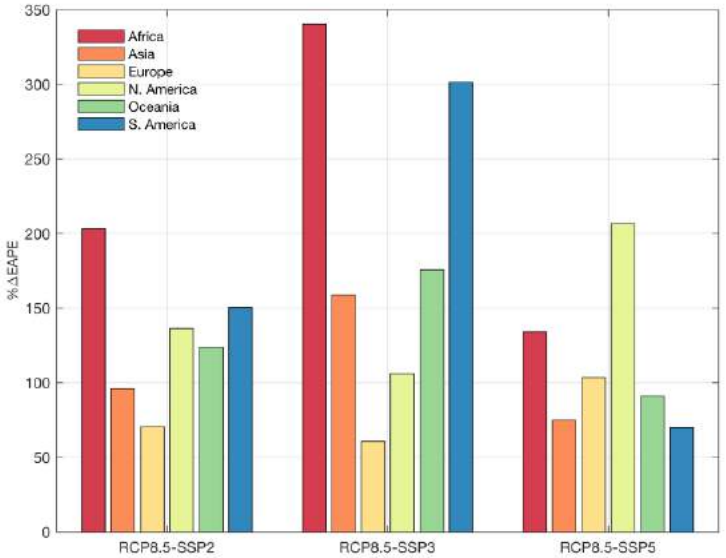
The projected global expected annual damage by the end of the century varies from 2 to 7.5 trillion USD, depending on the greenhouse gas emission and socioeconomic development scenarios

The projected global expected annual number of people exposed to coastal flooding by the end of the century varies from 150 to 185 million.

Relative change of global impacts



The most pronounced rises in damages is projected for Oceania and Africa, followed by South America.



These continents see also the highest projected increase in the number of people exposed, but under a Fossil Fuel Based Development scenario, North America is projected to experience the highest rise.

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FORESIGHT AND CLOSING REMARKS

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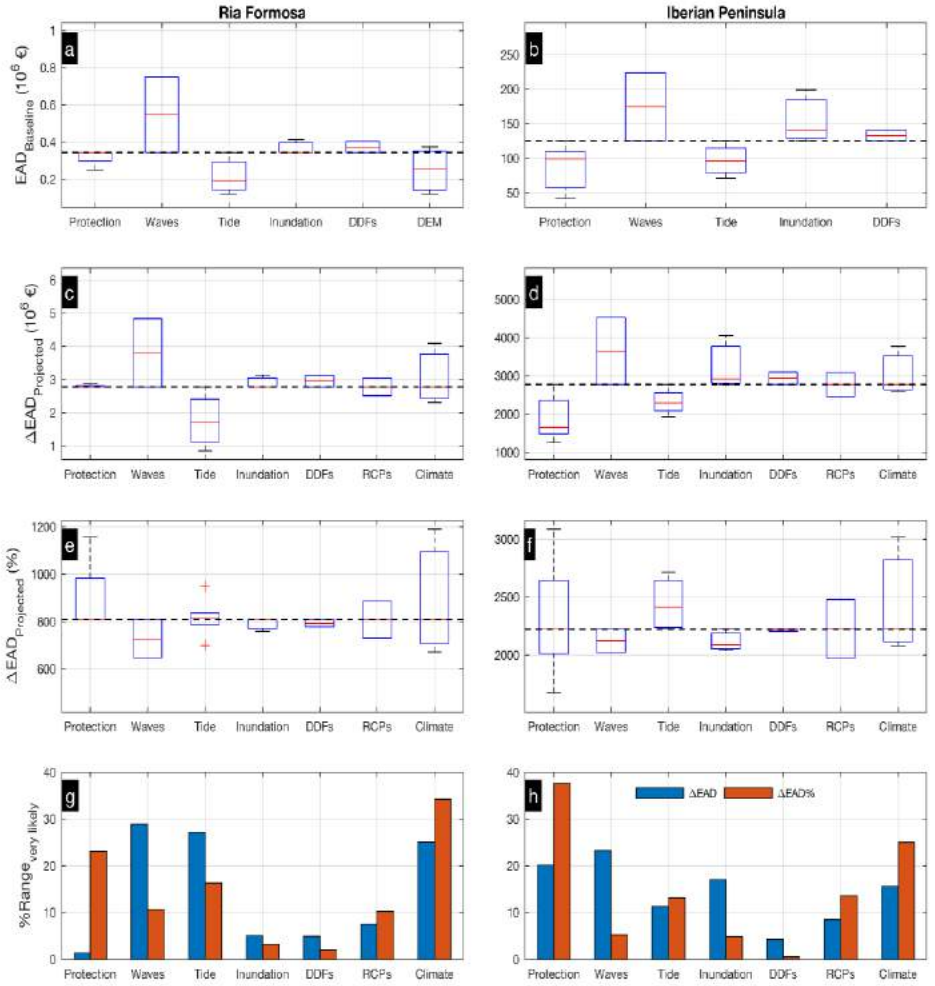
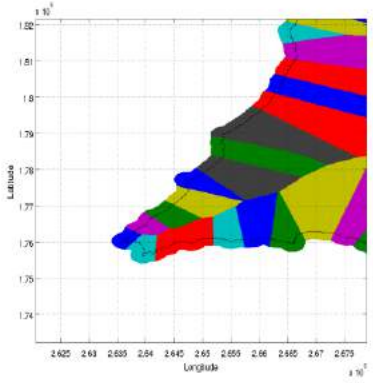
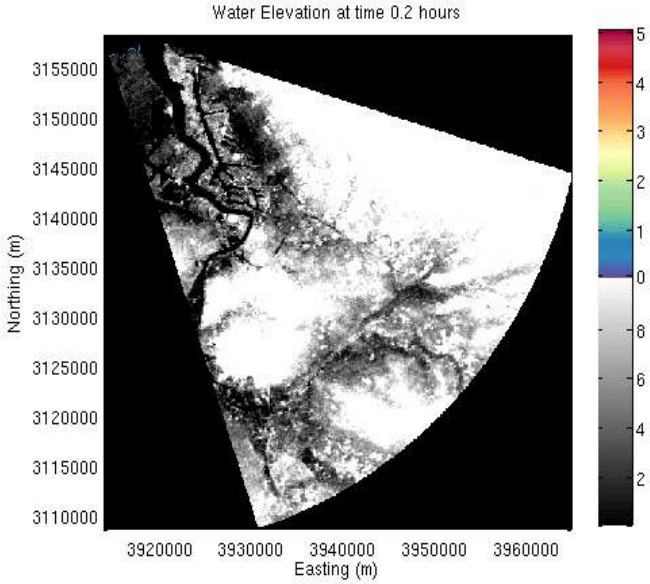
Relative contributions and uncertainty

Uncertainty from coastal protection data accuracy, DEM quality and ESLs, comparable to the one from climate and greenhouse gas emissions



LISCOAST II





- Improving inundation algorithms and DEMs
- Improving resolution of ocean models
- Coupled models
- Compound events

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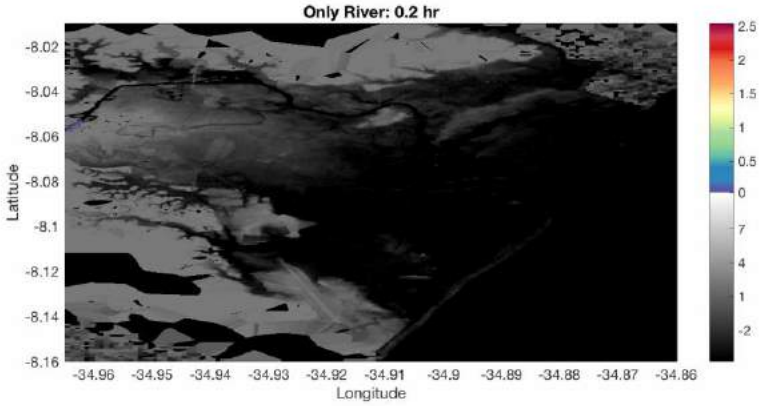
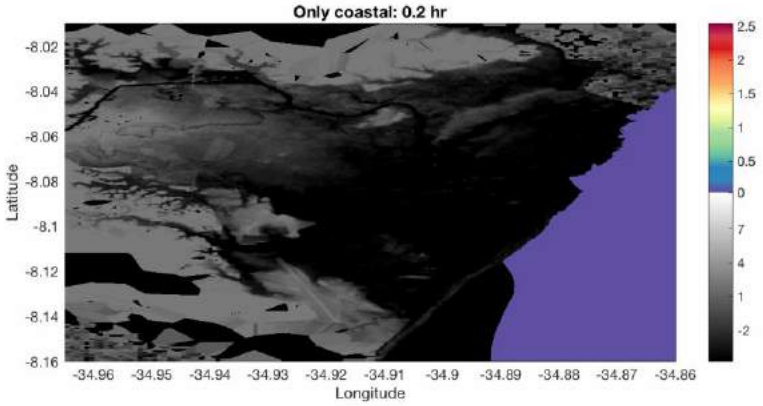
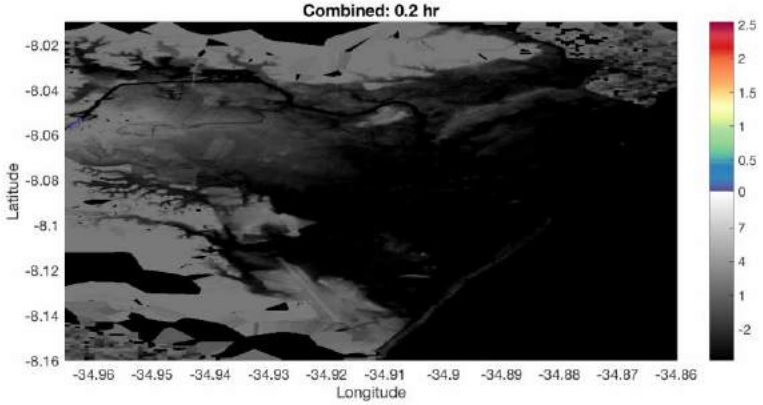
Compound events







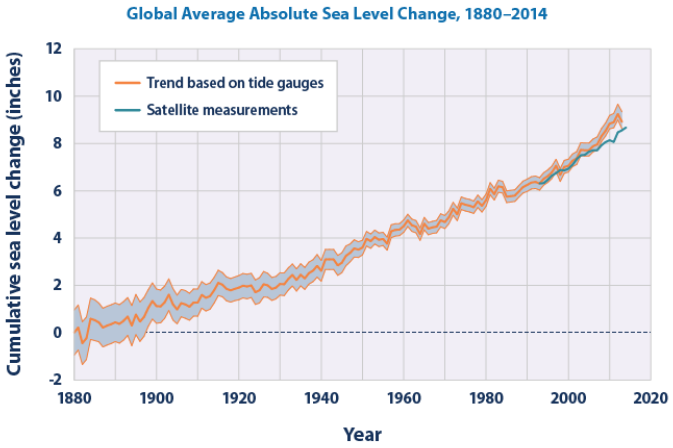
2 m Storm surge
80 m^3/s Peak discharge

Max water depth

Only coastal:	2.1 m
Only river:	**0.5 m**
Compound:	2.5 m

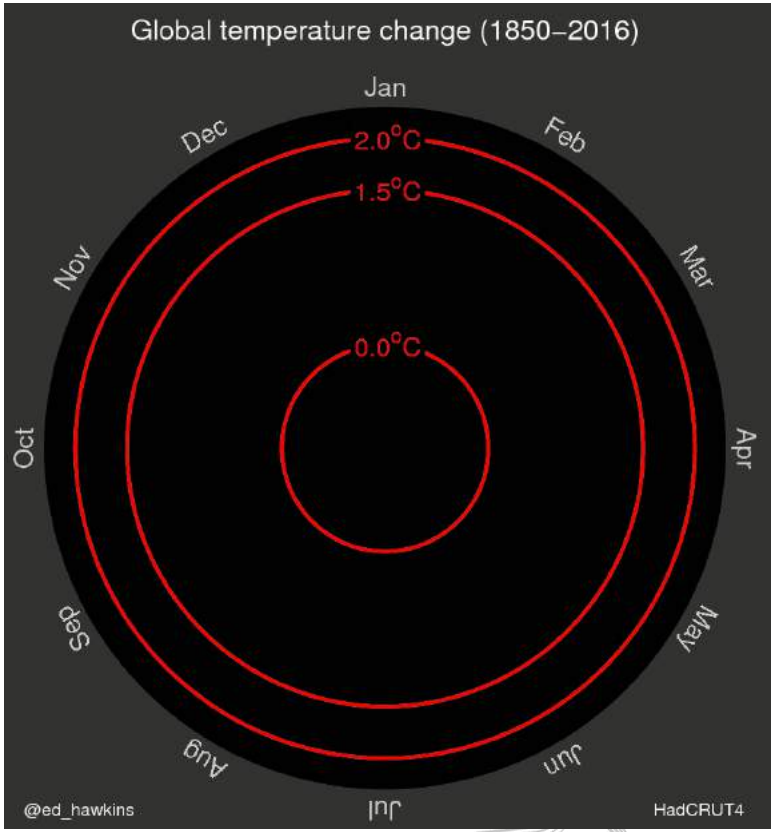
What is really at stake?

- The ocean absorbs >90% of the increase in energy
- Past sea levels under +1.5-2°C were 6-10 m higher than present
- Expansion of sea water per °C of warming is greater at higher temperature and higher pressure



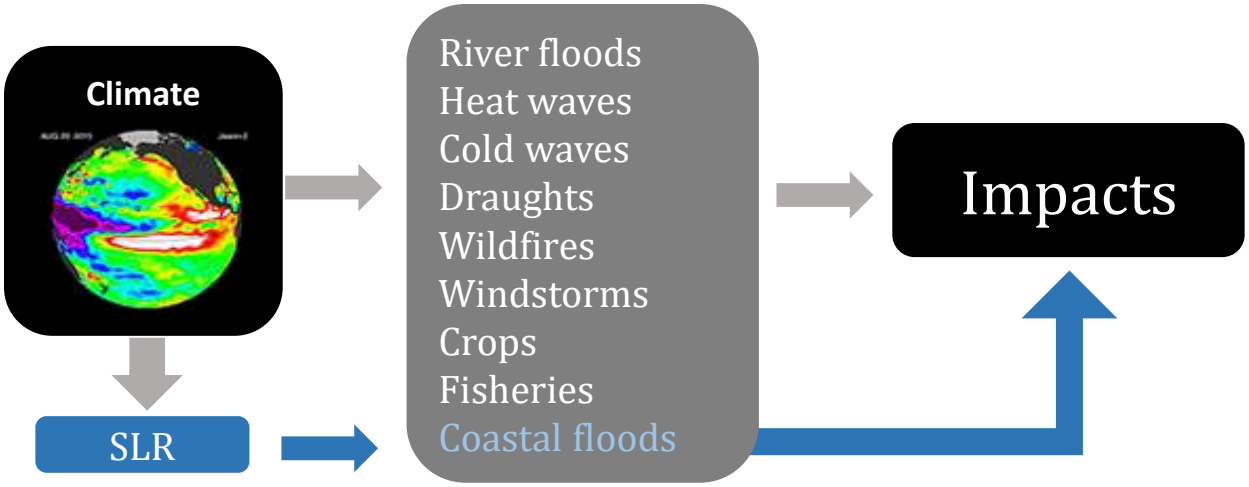
Data sources:
- CSIRO (Commonwealth Scientific and Industrial Research Organisation). 2015 update to data originally published in: Church, J.A., and N.J. White. 2011. Sea-level rise from the late 19th to the early 21st century. Surv. Geophys. 32:585–602. www.cmar.csiro.au/sealevel/sl_data_cmar.html.
- NOAA (National Oceanic and Atmospheric Administration). 2015. Laboratory for Satellite Altimetry: Sea level rise. Accessed June 2015. http://ibis.grdl.noaa.gov/SAT/SeaLevelRise/LSA_SLR_timeseries_global.php.

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climatechange/indicators.



Hawkins, MetOffice, 2016

What is really at stake?



Coastal risk becoming one of the most threatening natural hazard

River floods: 0.04% Europe's GDP (present) ⇒ 0.1% GDP (future)

Coastal floods: 0.01% GDP ⇒ 0.29-0.86% GDP

The challenges of coastal adaptation

Photos by www.wikipedia.org

- **Technical adaptation solutions**
- **Implementation at global scale can be challenging**
- **Political, economic, and environmental costs**
- **Social justice issues**

	Coastline (km)	GDP	Expenses	GDP%
Jamaica	894	14	0.7599	5.43%
NL	2000	752	1.7	0.23%

Thank you very much…

http://data.jrc.ec.europa.eu/collection/LISCOAST

www.vousdoukas.com

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