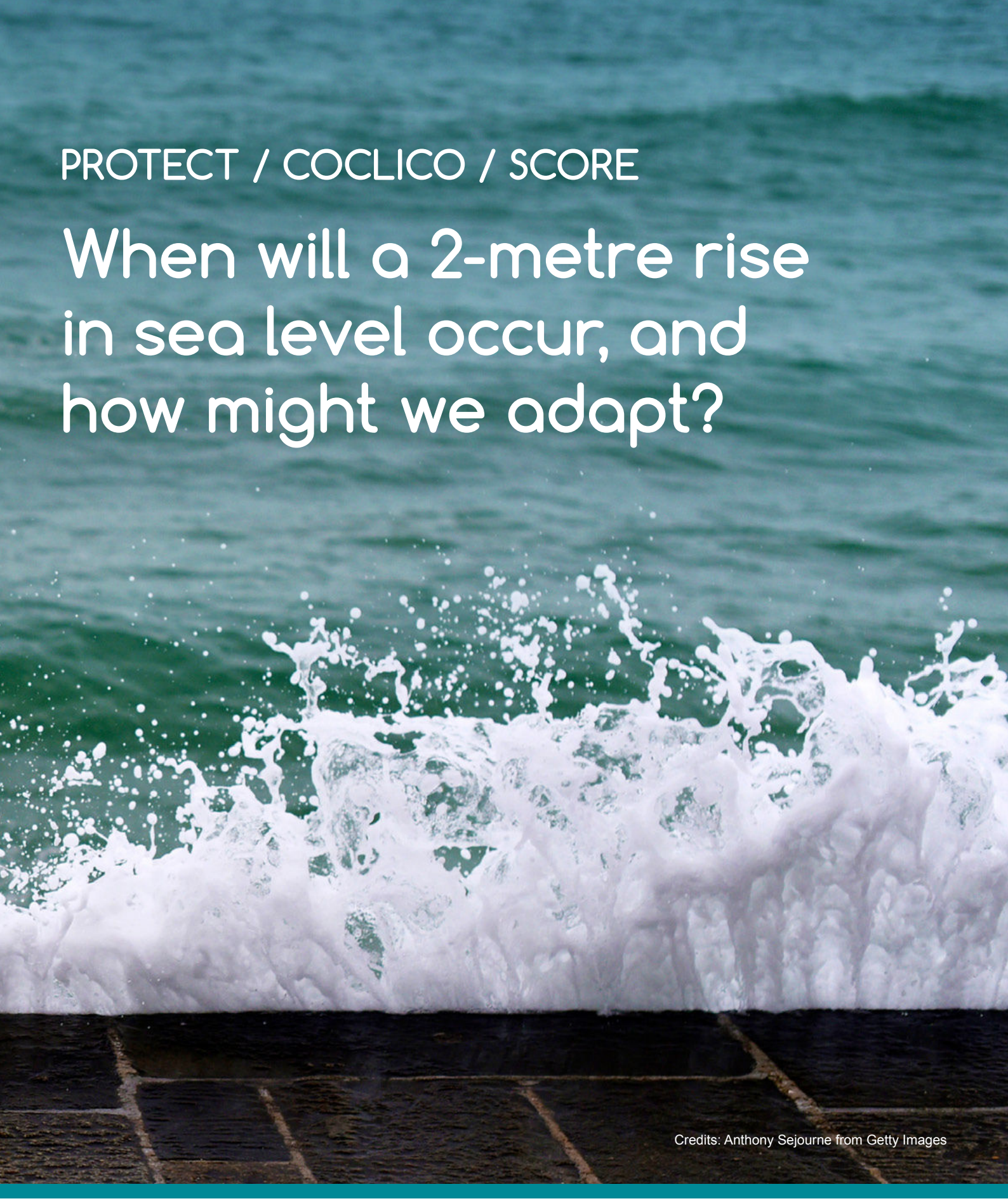
PROTECT / COCLICO / SCORE

When will a 2-metre rise in sea level occur, and how might we adapt?



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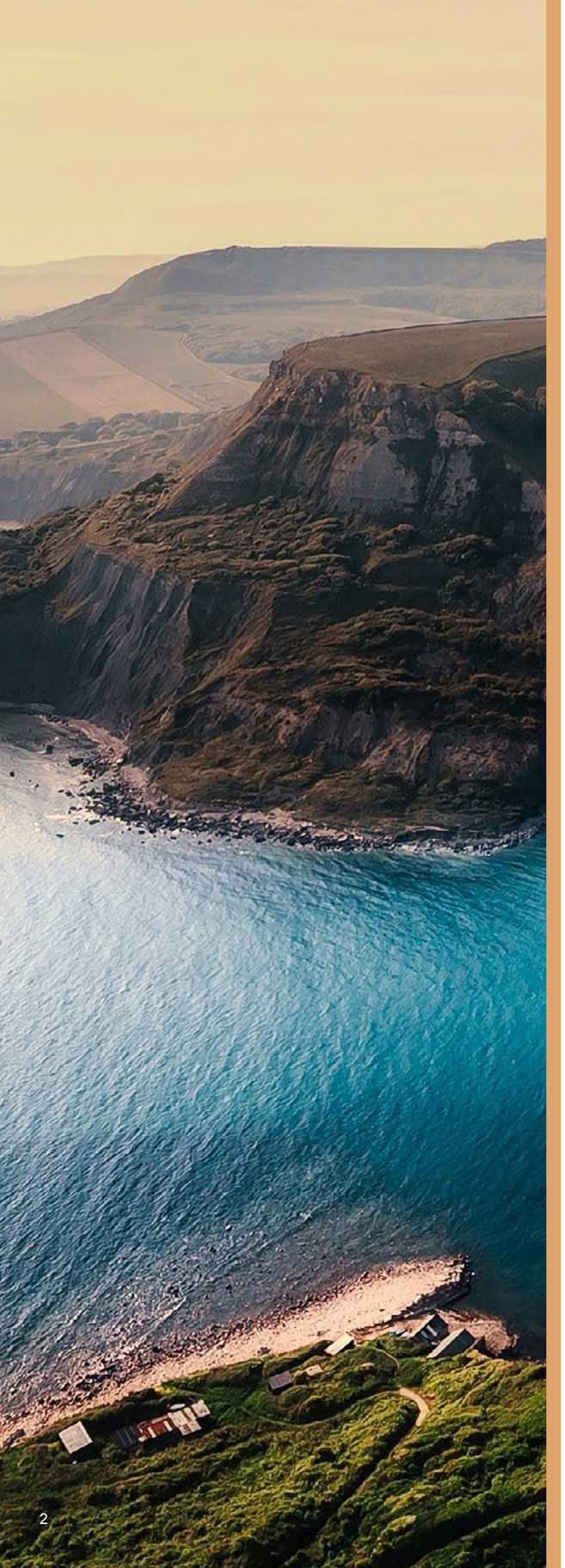
Protect CRYOSPHERE & SEA LEVEL

CoCliCo coastal climate core services

score



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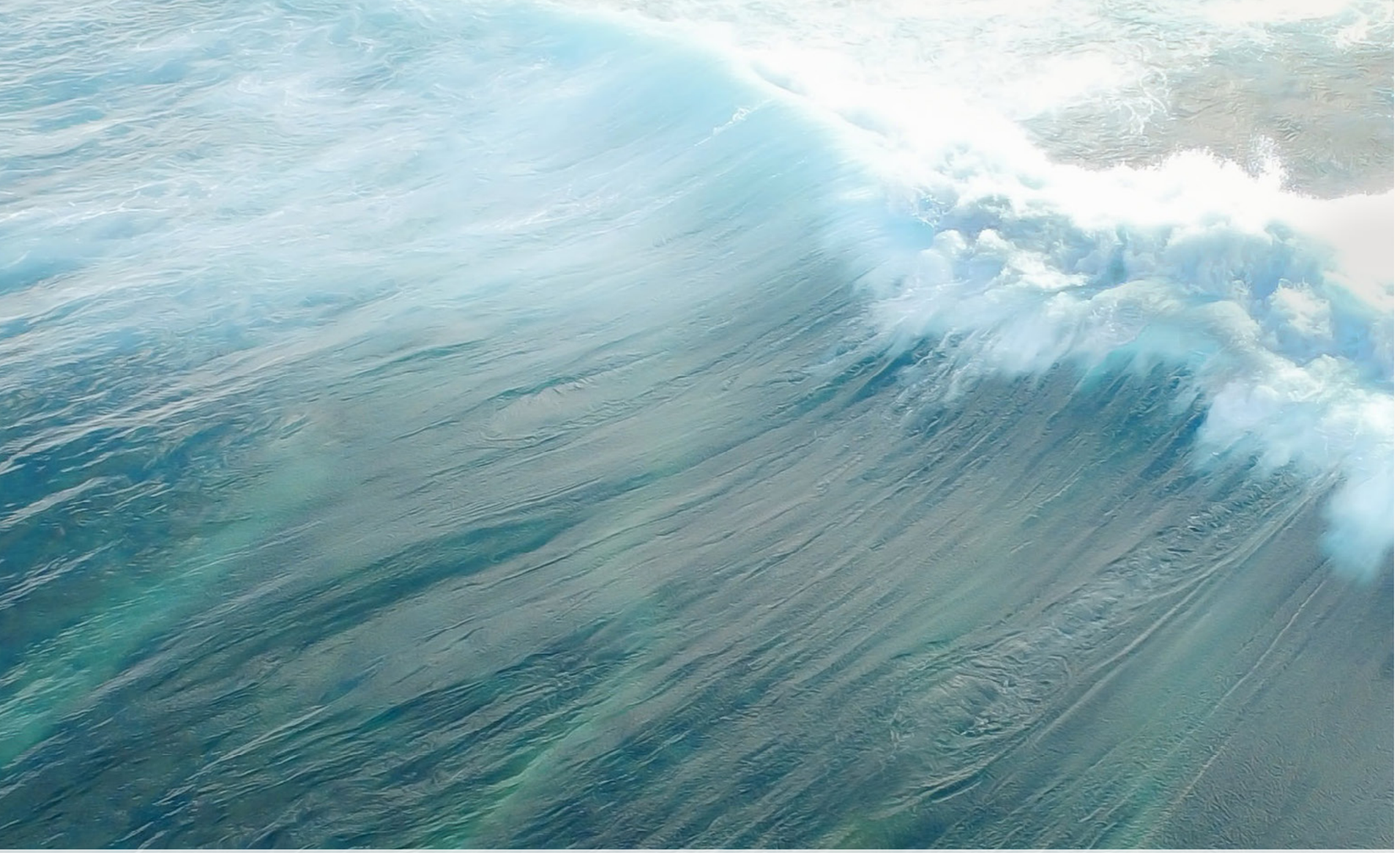


Key messages

A 2-metre rise in sea level is almost inevitable. The only thing uncertain is the timing, somewhere between one century and the next two thousand years depending on polar ice sheet melting and which socio-economic pathway we follow. Exceeding 2 meters of sea-level rise will fundamentally change European coastal zones.

Europe and National States recognise that coastal adaptation is an ongoing process that involves short-term actions, long-term planning and strategic thinking.

Three actions are urgently needed to limit losses, damages and lock-ins:

- **Massive and immediate reductions of greenhouse gas emissions** in order to slow down and limit the amplitude of sea level rise, thus giving more time and options for coastal adaptation.

- **Engagement in adaptation for sea-level rise**, including preparing the ground for adaptation, identifying challenges and options, monitoring trends and implementing effective solutions.
- **Support science and climate service development** to reduce uncertainties in future sea-level rise, assess risks and associated adaptation options and provide useable information and climate services to coastal adaptation stakeholders.

The climate is warming quickly, sea-level rise is accelerating and coastal adaptation takes time. We must start now.

When will a 2-metre rise in sea level occur?

Global mean sea-level rise will exceed 2 metres after 2100 and within less than 2 millenia.

Accepted facts[1]

Observations

- Sea levels are committed to rise for centuries to millennia
- Global mean sea level increased by 0.20±0.05 m between 1901 and 2018 and the average rate of sea-level rise has increased from 1.3±0.7 mm/yr between 1901 and 1971, to 1.9±1.0 mm/yr between 1971 and 2006, and to 3.7±0.5 mm/yr between 2006 and 2018.

The potential for ice sheet collapse

- A collapse of large ice sheet regions in Antarctica is an devastating scenario that cannot entirely be excluded, even if the world stays under 2°C global warming.
- The likelihood of ice-sheet collapse increases with warming. A rapid onset of these processes could result in 2 metres sea levels being exceeded in the early 2100's.
- Several decades of research have revealed continued surprises related to ice sheet behaviour. Uncertainties are likely to persist for the foreseeable future.
- Global mean sea-level rise will almost certainly exceed 2 metres by 2120 if climate change remains unmitigated and exceeds a 4°C global warming level (under the very high emissions SSP5-8.5 scenario).
- Emerging climate policies and the ongoing deployment of new options (e.g. renewables energy) have started to change potential emission pathways following the SSP5-8.5 less likely than previously anticipated. Yet, global mean temperature above 4°C in 2100 cannot be excluded, for example in case of reversal of current mitigation trends or for high values of climate sensitivity.

Global mean versus regional sea level rise

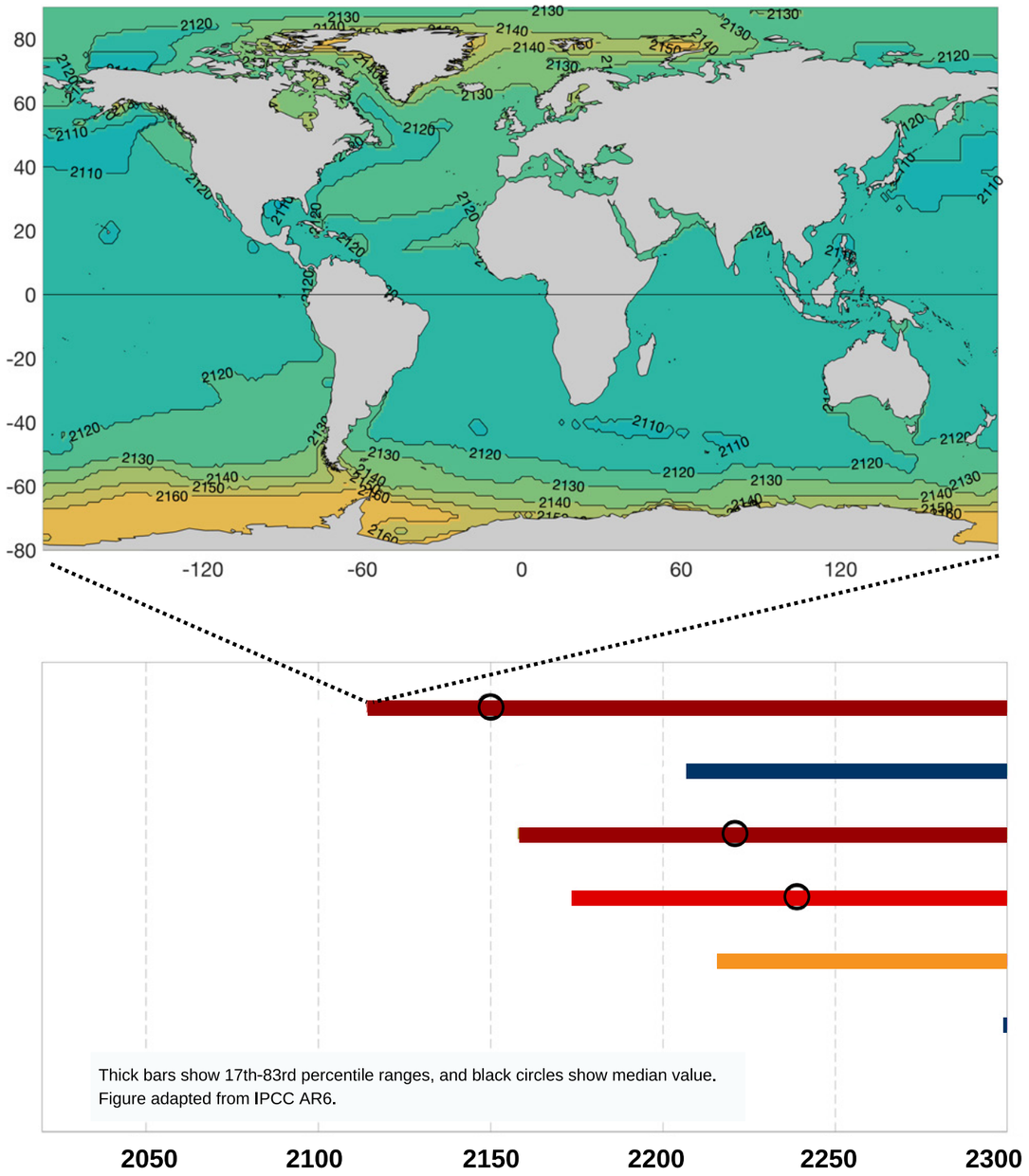
- In the majority of coastal locations, projected regional sea-level rise will be within +/-20% of the global mean.
- Under conditions of strong global warming and unfavourable collapse of large ice masses the 2 metres threshold may be exceeded between 2100 and 2150 in the vast majority of coastal locations (Figure 1).
- In areas affected by land subsidence due to processes such as groundwater extraction, two metres of sea-level rise could be exceeded earlier in the 21st century (e.g., Thessaloniki coastal plain in northern Greece, north-western Adriatic coast in Italy).

Even if the targets of the Paris Agreement are met and climate change stabilises at a 1.5°C globally, the commitment of global mean sea-level rise over the next two millennia is 2 to 3 metres.

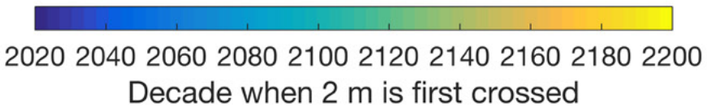
[1] The statements presented here are based on the 6th IPCC Assessment Report published in 2021

A 2-metre rise in sea level is almost inevitable.

The uncertainty is on the timing, somewhere between one century and the next two thousand years.



Early potential occurrence of a 2-m rise of regional sea-level rise assuming very high greenhouse gas emissions (SSP5-8.5) and initiation of ice-sheet collapse

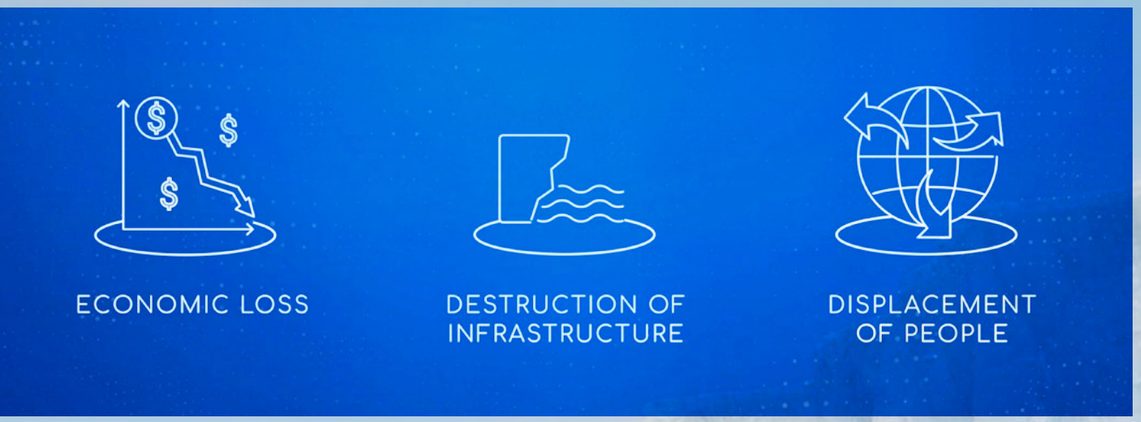


First year of the decade in which a 2m relative sea-level rise is exceeded in different regions around the globe, based on the 83rd percentile of SSP5-8.5 projections. Local subsidence may cause an earlier exceedance in some cities.

Shared Socioeconomic Pathway (SSP) scenarios		Temperature anomalies in °C	Initiation of ice-sheet collapse
			On Off
	SSP5-8.5	4.8 (3.6-6.5)	
	SSP1-2.6	2.0 (1.3-2.8)	
	SSP5-8.5	4.8 (3.6-6.5)	
	SSP3-7.0	3.9 (2.8-5.5)	
	SSP2-4.5	2.9 (2.1-4.0)	
	SSP1-2.6	2.0 (1.3-2.8)	
	SSP1-1.9	1.5 (1.0-2.2)	

Mean surface air temperature anomalies in 2081-2100 relative to 1850-1900: average and very likely range (data from IPCC AR6 Table 4.2)

Figure 1: Year by which a rise of 2 metres above 1995-2014 is projected following the different Shared Socioeconomic Pathways (SSP) from the IPCC AR6



Credits: Anne Chapuis, IGE-CNRS

What are the impacts of a 2-metre sea level rise in Europe?

- Sea-level rise since the late 19th century has already had demonstrable impacts on Europe's coasts in terms of reducing return periods of extreme water levels, increasing flood and erosion risks and promoting saltwater intrusion in estuaries, deltas and coastal aquifers.
- In the European Union plus the United Kingdom, 18 million people and €3.9 trillion of assets are currently located in the 100-year coastal flood plain[1]. If sea levels were 2 metres higher than today, 9 million additional people (total 27 million) and €1.8 trillion of additional assets (total €5.7 trillion) would be exposed across Europe's coastal flood plain.
- Risk grows faster than exposure. At present, coastal flood losses in EU/UK amount to €1.4 billion per year[2], and each year about 100,000 EU citizens are affected by coastal flooding. Under a high emissions scenario assuming a rise in sea levels exceeding 1 metre and no additional adaptation by 2100 these direct impacts to people and economic losses increase by at least two orders of magnitude in 2100. Indirect costs can propagate across sectors and regions.
- A 2 metres rise in sea level will transform our coastal areas and requires a choice between accepting major losses or proactive adaptation that prepares for these changes as outlined on the next page. The rate of rise is an important factor: the slower the rise, the slower the emergence of the impacts, the more time is available to adjust and adapt and the more adaptation options remain feasible and efficient.
- This demonstrates a key benefit of strong mitigation action.

[1] areas with a 1% annual chance of flooding
[2] all values are expressed in 2015 € values

Recommendations for climate policies

- **Postpone the exceedance of a 2-metre sea-level rise as far as possible into the future: mitigation is crucial: all actors in Europe can reinforce and achieve their climate target to collectively contribute to keeping global temperatures well below a 2°C global warming level.** This action will also slow down sea-level rise rates, give more time for adaptation and reduce all other climate risks.
- **Acknowledge the commitment for adaptation:** Europe and National States should inform all relevant stakeholders about the rise in sea level and its implications for adaptation. Anticipating sea-level rise and adaptation can avoid significant damage, losses and lock-in. An adaptation process with multiple steps is likely to be required.
- **Monitor for early warning signs of ice-sheet collapse:** international implementation of monitoring systems to detect tipping points in ice sheet instabilities leading to more rapid sea-level rise need to be be developed.
- **Develop climate services for coastal adaptation:** governments have to make sure that information is available to inform societal actions, including implementing emergency plans where necessary.

The H2020-PROTECT project is currently preparing projections to 2500 based on existing literature, and will make new projections using new ice-sheet melting simulations by the end of the project.

How might we adapt?

Coastal practitioners must identify risks and initiate adaptation responses

Challenges

- Coastal adaptation practitioners need to consider that for the coming decades, sea-level science may not provide a more precise timing for the occurrence of a 2 metres rise in sea levels. This uncertainty may either paralyze coastal adaptation action, or alternatively lead to earlier-than-needed adaptation investments or over-adaptation.
- Coastal zones are still developing in Europe. While this can bring immediate social and economic benefits, it is increasing exposure and residual risk with the danger of lock-ins in the long-term.
- For existing infrastructure, adaptation to 2 metres of sea-level rise will require a forward-looking perspective, decades in advance, including appropriate funding and stable governance mechanisms.
- While adapting to 2 metres of sea-level rise, stakeholders will have to manage the consequences of having exceeded other planetary boundaries. This includes other consequences of climate change. Heatwaves, drought and heavy rainfall will cause widespread harm and significant consequences for prople, ecosystems, water management, agriculture, tourism and industry.

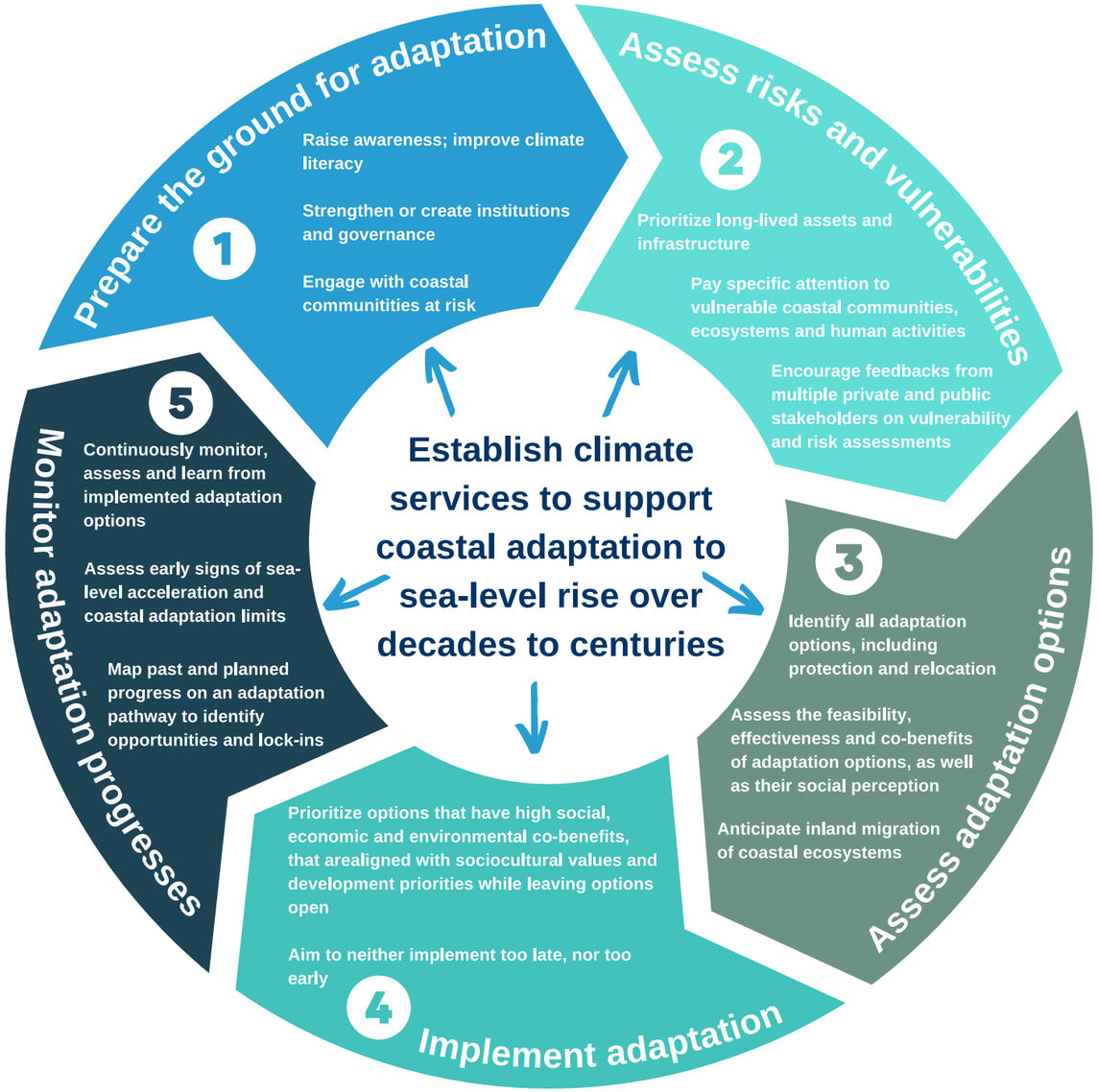
Coastal adaptation should be seen as an iterative process that evolves over time. All stakeholders need to realize that relocation may be ultimately necessary in many locations. Effective adaptation requires coordination with all public and private stakeholders.

Recommendations on how to address adaptation

- Coastal practitioners should engage with communities exposed to flooding and erosion, as well as scientists and science educators in order to develop climate literacy and the foundations for adaptation action. Involvement of a broad range of stakeholders who can bring together their knowledge, expertise and resources will help support climate change adaptation.
- Given the uncertainty in the timing of a 2 metres rise of sea-levels, priority should be given to identifying risks, vulnerabilities and adaptation challenges at high sea levels to reduce or avoid lock-ins (Figure 2).
- A climate service dedicated to coastal adaptation to sea-level rise will help to anticipate future risks and adaptation needs.
- Coastal adaptation practitioners can learn from success stories in other countries or regions, in order to identify management issues that require considering multiple meters of sea-level rise (Box 2) and how existing sea-level rise projections can be turned into action today.

Credits: Portland UK - Carole Ortega BRGM

Figure 2: Engaging with adaptation to the range of sea-level rise possibilities: an ongoing process with priorities for today.



Think strategically: what is your vision for different coastal management units?

What we do

Within the H2020-CoCliCo Project, we are developing a climate service for coastal adaptation on a pan European scale, informing broad scale flood risks and providing boundary conditions for users concerned with local adaptation in cities and ports.
https://coclicoservices.eu/

Within the H2020-SCORE project, different stakeholders are co-creating adaptation solutions with stakeholders in 10 coastal cities and regions in Europe. This allows for mutual exchange of knowledge and sharing expertise and success stories.
https://score-eu-project.eu/

The H2020-PROTECT project is currently preparing projections to 2500 based on existing literature, and will make new projections using new ice-sheet melting simulations by the end of the project.
https://protect-slr.eu/

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BOX 1 – Low-likelihood/ high-impact sea-level rise scenarios in practice: Example - United Kingdom

Within its nationally-defined climate scenarios, the UK has explicitly provided low-likelihood/high impacts sea-level rise scenarios, which are considered by relevant stakeholders such as those managing London's coastal flood defenses, including the Thames Barrier. In this case it supports an adaptive management approach with a flexible plan which can be adjusted based on the observed rise in sea level.

BOX 2 - Examples of coastal adaptation problems that require consideration of multi-metre sea-level rise today:

- The management of critical and long living infrastructure in coastal and estuarine areas, such as ports, cities, barriers and industrial infrastructure (especially nuclear plants).
- Coastal landfills and contaminated soils that would pollute coastal waters if released by submergence or erosion.
- The conservation of cultural heritage in coastal areas, such as Venice in Italy or the Er Lannic stonehenge in France.
- The conservation of coastal habitats such as wetlands and intertidal biotas, which require space for migration inland with rising sea levels to survive.

2 meters of sea-level rise is inevitable. We must act now to plan and implement strategies to minimise the damage, economic and environmental loss which is inevitable. Anticipating 2 meters of sea-level rise and designing adaptation plans to deal with this will also help us better manage coastal and estuarine areas today.

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Lead authors: Gonéri Le Cozannet (BRGM), Gaël Durand (CNRS), Robert Nicholls (University of East Anglia)

Extended drafting team & Figures: Aimée Slangen (NIOZ), Daniel Lincke (GCF), Anne Chapuis (CNRS)

Contributions & Reviews: Adina Creugny, Elena Marie Enseñado, Salem Gharbia, Geronimo Gussmann, Marjolijn Haasnoot, Klaus Keller, Arjen Luijendijk, Angélique Melet, Luís Campos Rodrigues, Jeremy Rohmer, Paul Sayers, Aimée Slangen, Mar Riera Spiegelhader, Rémi Thiéblemont, Fiona Turner, Roderik Van De Wal
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