Coastal zones are under pressure from climate change: Transformational adaptation is needed

French coastal storm damage. Credits: Manuel Garcin

CoCliCo

coastal climate core services

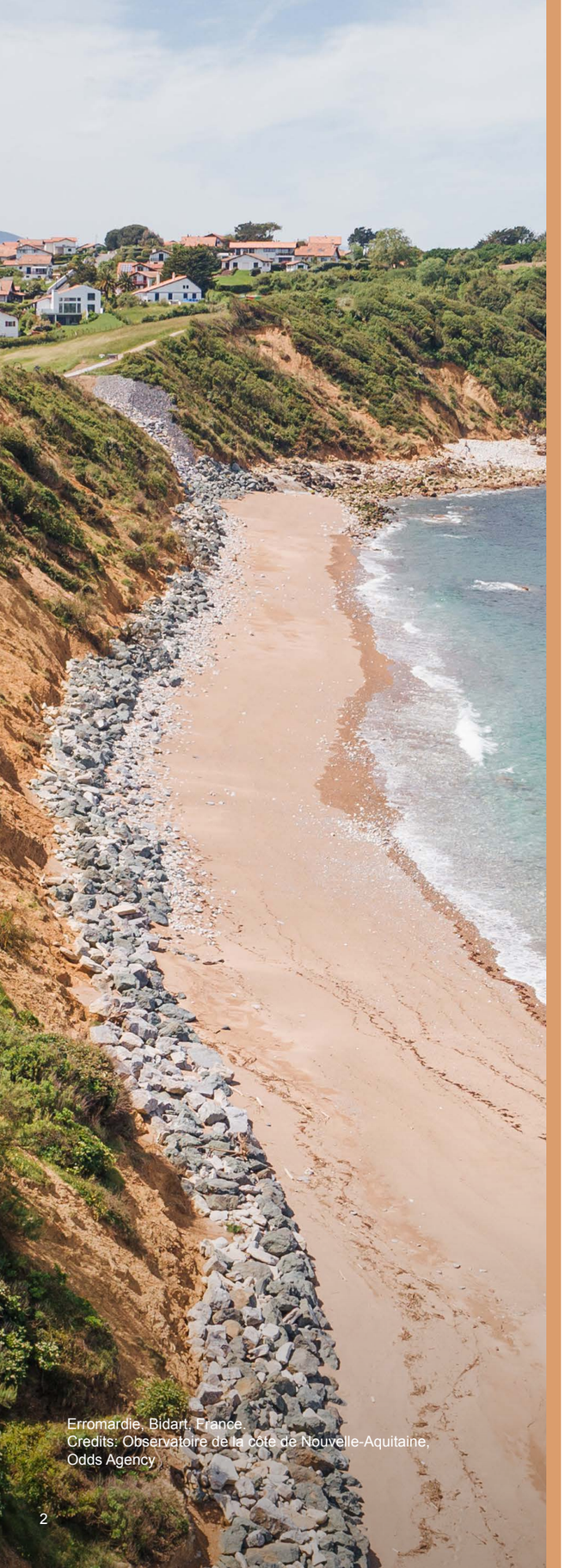
In association with

Protect CRYOSPHERE & SEA LEVEL

score

REST-COAST

CoCliCo has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 101003598



Erromardie, Bidart, France.
Credits: Observatoire de la côte de Nouvelle-Aquitaine, Odds Agency

Contents

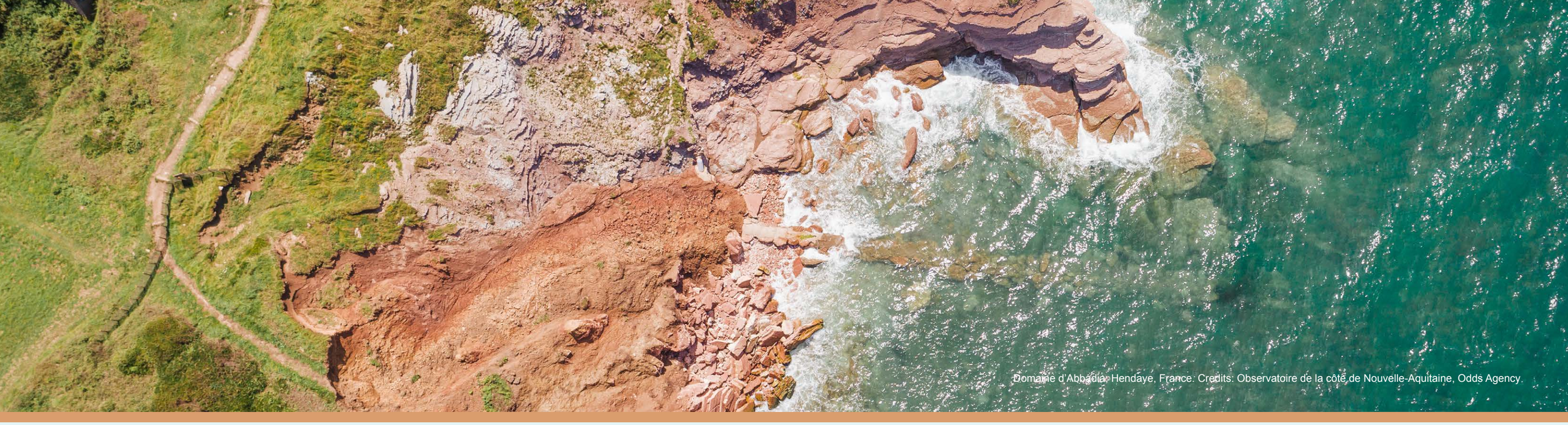
Recommendation

A European core climate service is needed to support timely coastal adaptation to sea-level rise. Integrating CoCliCo into the European Digital Twin of the Ocean initiative would provide a significant step towards this goal.

Dawlish Devon UK. Credits: Coast Cams

Executive summary

Coastal zones are under pressure. Transformational adaptation is needed to respond to climate change and biodiversity losses whilst continuing to deliver opportunities for economic growth and well-being. The research project CoCliCo demonstrates that climate services can support this transformation. Yet they will require further development to move from advanced demonstrators to operational services. In Europe, this could take place within Copernicus and the Digital Twin of the Ocean. While climate services are essential to support adaptation, implementing transformational adaptation in practice is difficult and will require leadership at local and regional scales. If Europe's coasts are to remain safe, vibrant, and productive areas for people and nature taking decisions for the long term is however essential.



Domaine d'Abbadia, Hendaye, France. Credits: Observatoire de la côte de Nouvelle-Aquitaine, Odds Agency.

Summary of key messages

Coastal zones demand major transformations

- Climate change and coastal development have led European coastal zones to a critical point, where urgent adaptation decisions are necessary.
- Adaptation limits are increasingly being reached in various locations, motivating a critical re-evaluation of past management practices.
- Adaptation practitioners are increasingly considering innovative adaptation options, but often these efforts are insufficient to address the radical transformations necessary in the face of sea-level rise.
- The evidence has been well established for decades: action is needed now.

Broad-scale climate services supporting coastal adaptation are ready for implementation

- CoCliCo demonstrates the feasibility of developing a pre-operational European-scale core climate service supporting adaptation to sea-level rise and coastal flooding.
- Broad-scale climate services supporting coastal adaptation are designed to be valuable for both advanced and new users.
- New, more accurate, and more precise observations, data and information will increase European climate services relevant to coastal adaptation to sea-level rise.
- To become fully operational, climate services supporting adaptation to sea-level rise will require sustained institutional and financial support.

A dedicated European Coastal Climate Service can help make adaptation happen

- Climate services play a pivotal role in enabling coastal adaptation by providing actionable knowledge to inform decisions made by public authorities, private businesses and civil society. Other enablers such as adequate governance, finance, an honest public debate prioritising equity and justice are required too.
- CoCliCo's research shows that different adaptation pathways are possible, but current choices are strongly constrained by past ones such as the implementation of hard coastal protection infrastructures; developments in the coastal flood plain and past emissions inevitably leading to future sea-level rise.
- Coastal adaptation offers a unique opportunity to improve coastal zone management while addressing climate change mitigation, adaptation to its impacts, and achieving social, environmental, and sustainable development goals.

The science is clear, but the response is a choice.

Vieux Salins, Hyères, France. Credits: Frédéric Larrey

1. Coastal zones demand major transformations

Climate change and coastal development have led European coastal zones to a critical point; decisions around how to adapt are urgently needed. On the ground, coastal stakeholders and scientists are increasingly reporting chronic flooding events under calm weather conditions in areas that were not previously inundated at high tides. CoCliCo's research shows that between 0.6 and 1 million people were exposed to a 100-year flooding event in Europe in 2010 (United Kingdom and European Union, without the Black Sea Coast). Without additional adaptation, Without additional adaptation, between 100,000 and 750,000 additional people are projected to be exposed to a 100-year flooding event in Europe in 2050 depending on the magnitude of sea-level rise and coastal development scenarios. Coastal adaptation practitioners also need to consider many other unprecedented environmental changes, including increased temperatures, and, depending on the context, drought, salinisation, eutrophication, hypoxia and acidification and the degradation or loss of coastal ecosystems. This happens in the context of rapid socio-economic development involving increased pressures such as urbanisation, tourism, and resource exploitation.

Adaptation limits are increasingly being reached in various locations, motivating a critical re-evaluation of past management practices. Adaptation limits are related to the lack of affordable measures such as to compensate and manage sediment losses, as well as to social conflicts where space available for human activities, ecosystems and adaptation is constrained and expensive. Institutional fragmentation exacerbates these challenges, with numerous stakeholders holding diverse roles in coastal zone management. This fragmentation can hinder efforts to ensure the safety and resilience of coastal communities in the face of rising sea levels, continued storms and intensifying extreme precipitation events.

Adaptation practitioners already consider a wide range of adaptation options addressing the adaptation limits mentioned above, but often these efforts are insufficient to address the radical transformations necessary in the face of sea-level rise. This innovation includes adopting more strategic and integrated management of coastal zones, considering the synergies and trade-offs between policies addressing coastal risk management, coastal adaptation, human health and well-being, economic development, ecosystem protection and restoration and mitigation of climate change.

2. Broad-scale climate services supporting coastal adaptation are ready for implementation

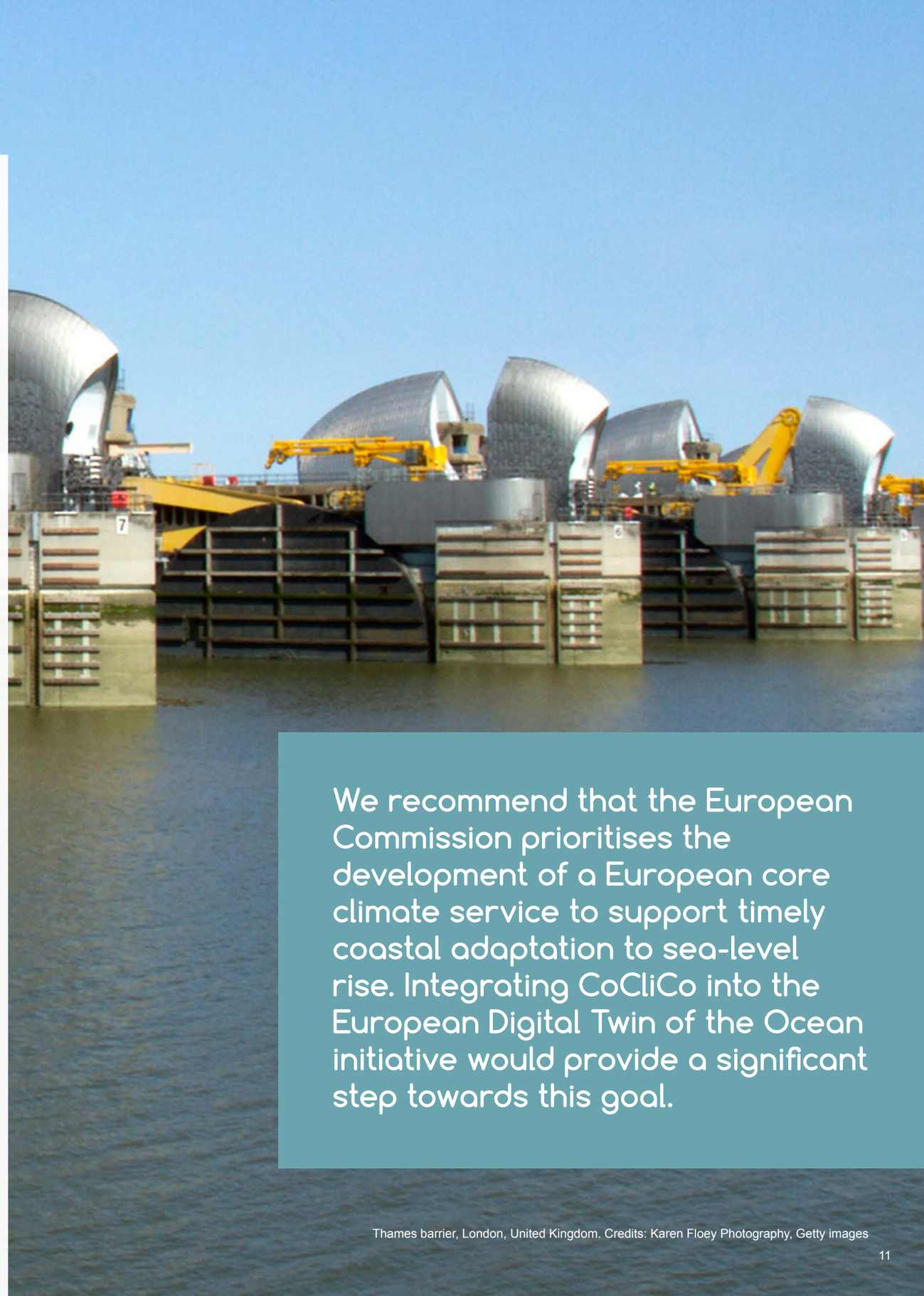
CoCliCo is a research project implemented by 18 institutions and supported by the European Commission (H2020). It has delivered an advanced prototype of climate service supporting adaptation to sea-level rise and coastal flooding. The service is an advanced demonstrator, validated in a relevant environment (Technology readiness level TRL 6). Yet CoCliCo cannot be considered an operational service (TRL 9). Implementing such an operational service will involve further developments as well as continued financial and institutional support.

CoCliCo demonstrates the feasibility of developing a pre-operational European-scale core climate service supporting adaptation to sea-level rise and coastal flooding. A core service building upon CoCliCo can inform a range of users such as European, national authorities, cities, and critical infrastructure owners about the broad-scale risks they face. In turn, this core service can be complemented by downstream services tailored to user needs such as high-resolution hazard and risk assessments for various adaptation options, which integrate locally available models or data with European scale information from CoCliCo. Research conducted in CoCliCo confirms that this layered model of climate services can be expanded to cover additional climate services and more challenges such as biodiversity conservation and restoration or mitigation and resilient development.

Broad-scale climate services supporting coastal adaptation are designed to be valuable for both advanced and new users. For new users, these services offer a starting point to screen risks, set priorities and initiate more detailed studies. Advanced users, on the other hand, can leverage from a comprehensive set of scenarios exploring a large range of climate change and socio-economic development pathways. They can also benefit from intercomparisons with other regions and access specific datasets that are currently not widely disseminated, such as population density projections or cost-efficient adaptation outcomes.

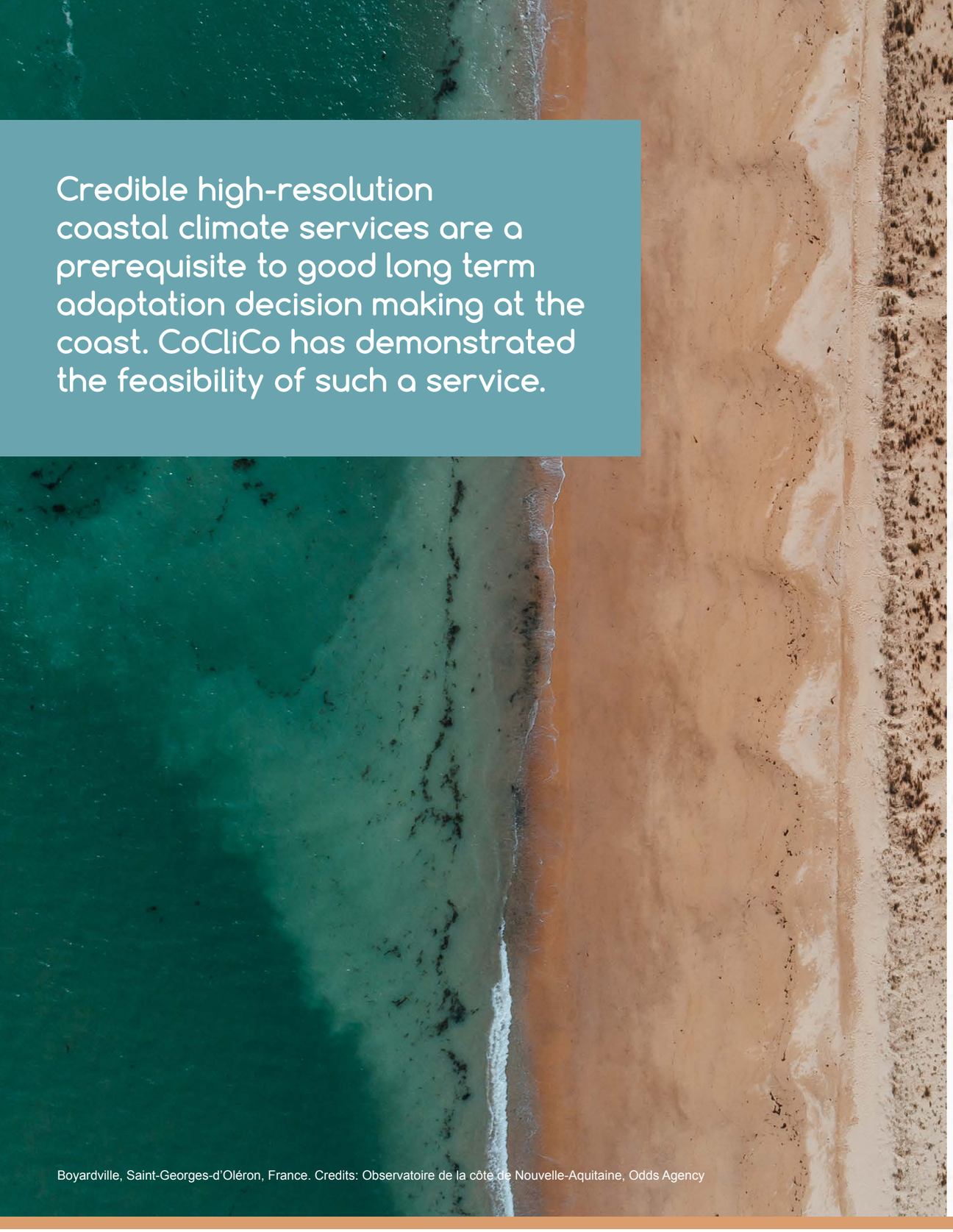
New, more accurate, and more precise observations, data and information will increase European climate services relevant to coastal adaptation to sea-level rise. Information on current and planned protection measures, higher-resolution models of mean and extreme sea-level changes, and refined digital elevation models, will bolster broad-scale services addressing present and future coastal flood risks in Europe. Some of the datasets used in CoCliCo are relying on datasets that are now outdated and require an effort from regional, national, or European authorities to update and harmonise. Collecting localised data on observed flooding, erosion, and impacts, including those due to compound events in estuaries, will further support the validation and accuracy of broad-scale models.

To become fully operational, climate services supporting adaptation to sea-level rise will require sustained institutional and financial support. Integrating CoCliCo into the European Digital Twin of the Ocean represents a critical step toward transitioning it into a sustained European public infrastructure, enabling broader dissemination to stakeholders. The European Digital Twin of the Ocean, in collaboration with the Copernicus Marine Service, provides a robust technological, institutional and financial framework to sustaining CoCliCo's climate services demonstrator and advance it to a fully operational system (TRL9). Achieving this transition requires dedicated funding and goes beyond research, calling for strategic investments to ensure its sustainability and impact.



We recommend that the European Commission prioritises the development of a European core climate service to support timely coastal adaptation to sea-level rise. Integrating CoCliCo into the European Digital Twin of the Ocean initiative would provide a significant step towards this goal.

Thames barrier, London, United Kingdom. Credits: Karen Floey Photography, Getty images



Credible high-resolution coastal climate services are a prerequisite to good long term adaptation decision making at the coast. CoCliCo has demonstrated the feasibility of such a service.

Boyardville, Saint-Georges-d'Oléron, France. Credits: Observatoire de la côte de Nouvelle-Aquitaine, Odds Agency

3. A dedicated coastal climate service can help make adaptation happen

Climate services play a pivotal role in enabling coastal adaptation by providing actionable knowledge to inform decisions made by public authorities, private businesses and civil society. The actual decision, however, still needs to be made by the respective authority. As decision-support tools, climate services go beyond providing data: they deliver actionable information and knowledge to guide strategic choices. However, the ultimate responsibility and accountability for these decisions rest with the decision-makers.

Other enablers of coastal adaptation include adequate governance, accessible and long-term finance, and a transparent and inclusive public debate. CoCliCo's research reveals progress and setbacks in these areas. Governance and regulatory frameworks have advanced in many European countries. Yet, challenges persist, including unclear strategic objectives in many countries, regions and sectors, and the lack of short-term options to address emerging risks such as chronic flooding at high tides. In the context of budgetary and democratic crises, the institutionalisation of participatory approaches and the allocation of financing have been slow to develop or were even hindered. Coastal adaptation will require significant investment, especially for costly measures such as protection or relocation. In this context, climate services must be carefully assessed to ensure they effectively support development pathways and achieve the intended outcomes.

Multiple adaptation pathways are available, but current choices are strongly constrained by past ones such as the implementation of hard coastal protection infrastructures, developments in the coastal flood plain and past emissions inevitably leading to more future sea-level rise (called committed sea-level rise). Research conducted in CoCliCo and PROTECT has reinforced the understanding that, at multi-centennial timescales, sea-level rise can exceed meters, leaving large-scale protection measures or relocation as the only effective responses. Economically, the optimal response involves early decisions on whether protection or retreat will be implemented at each location. Such early decisions would prevent further urbanisation and lock-ins in areas that could be ultimately abandoned. From a social perspective, postponing the retreat decision has the advantage of postponing social conflicts, but this may also favour the development of lock-ins. Regardless of the approach, implementing additional adaptation measures this decade is essential in most locations to maintain safety levels during storms and prevent chronic flooding at high tide. These measures could include accommodation measures to minimise costs while avoiding lock-ins in the short term.

Coastal adaptation offers a unique opportunity to improve coastal zone management while addressing climate change mitigation, adaptation to its impacts, and achieving social, environmental, and sustainable development goals. Many research projects and experiments in Europe have demonstrated the feasibility and effectiveness of introducing coastal restoration in climate services and the adaptation practice, including through European projects such as REST-COAST, SCORE, PROTECT and CoCliCo. Successful adaptation that also supports climate mitigation, environmental protection, and biodiversity conservation – key pillars for economic stability – requires allocating space for sediments and ecosystems to thrive. Substantial knowledge already exists on achieving climate-resilient development in coastal areas, with scientific organisations like the IPCC and IPBES outlining actionable pathways.

Glossary

CoCliCo: Coastal Climate Core Services. **https://coclicoservices.eu**

Protect: Projecting Sea-Level Rise: from Ice Sheets to Local Implications. **https://protect-slr.eu**

Score: Smart control of the climate resilience in European coastal cities. **https://score-eu-project.eu**

Rest-Coast: Large scale restoration of coastal ecosystems through rivers to sea connectivity**.** **https://rest-coast.eu**

Climate service: "Climate services involve the provision of climate information in such a way as to assist decision-making. The service includes appropriate engagement from users and providers, is based on scientifically credible information and expertise, has an effective access mechanism and responds to user needs". (IPCC, 2022)

Core Climate Service: a core service is an essential service that provides standardised, authoritative, and multi-purpose information that can support a broad range of applications and users. It is not as specialised as a local-centric, application-centric service.

Copernicus: Europe's Earth Observation programme. **https://www.copernicus.eu/en**

Adaptation: "In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects." (IPCC, 2022)

Transformational adaptation: "Adaptation that changes the fundamental attributes of a social-ecological system in anticipation of climate change and its impacts." (IPCC, 2022)

IPCC: Intergovernmental Panel on Climate Change.

IPBES: Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

Suggested citation

Gonéri Le Cozannet, Paul Sayers, Robert J. Nicholls, Jochen Hinkel, Iñigo Losada, Angélique Melet, Arjen Luijendijk, Elco Koks, Daniel Lincke, Eva Loukogeorgaki, Gianmaria Sannino, Athanasios Vafeidis, Carme Machí Castañer, Etienne Kras, Melisa Menendez, Alexandra Toimil, Vanessa Voelz, Rémi Thiéblemont, Vincent Bascoul, Hedda Bonatz, Edmund Penning-Rowsell. Next generation Coastal Climate Core Service - A policy brief. Published by the CoCliCo project.

Creation: Guerilla Creative, Susana Romao, Pauline Douillac.

Salzspeicher, Lübeck, Germany. Credits: Athanasios Vafeidis

Further reading:

This policy brief is based on the outcomes of the CoCliCo project. More details about CoCliCo, the demonstrator developed within this project and the scientific publications can be found here:

https://coclicoservices.eu/

CoCliCo

coastal climate core services

In association with

Protect CRYOSPHERE & SEA LEVEL

score

REST-COAST

Partnership

The following organisations participate in the CoCliCo project:

brgm Geoscience for a sustainable Earth

CAU Kiel University Christian-Albrechts-Universität zu Kiel

cnrs

GCF

Deltares

ENEA

federlogistica

Guerilla Creative Think • Create • Do

ICLEI Local Governments for Sustainability EUROPE

IH cantabria

VU VRIJE UNIVERSITEIT AMSTERDAM

LGi sustainable innovation

MERCATOR OCEAN INTERNATIONAL

SAYERS AND PARTNERS

UEA University of East Anglia

vizzuality.

CoCliCo has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 101003598