

Resilience to coastal erosion for people and nature

Coupling citizen engagement with environmental characterisation to empower informed decision-making

ADAPTIVE

Nature-Based Solutions (NbS)

- Dynamic Buffers
- Living Shorelines
- Iterative Management

COLLECTIVE

Community-Led Management

- Maptionnaire Engagement
- Citizen Observations
- Co-Designed Policy

INFORMED

Data-Driven Intelligence

- Remote Sensing
- AI-Driven Analytics
- Predictive Modeling





Key Message

- Coastal erosion is a natural process, but human activity and climate change are worsening its impacts.
- Empowering communities and managers with data and awareness is critical.

Policy Relevance

- **E.U. Strategy on Adaptation to Climate Change (2021):** The strategy calls on Member States to incorporate climate adaptation into flood risk management plans and to use NbS to reduce vulnerability and enhance ecosystem health.
- **E.U. Floods Directive (2007/60/EC):** Real-time monitoring, early warning systems, and community literacy aligns with the directive's requirements for proactive risk assessment and public engagement. The use of video monitoring and deep learning for shoreline detection is a direct response to the need for data-driven, adaptive flood and erosion management
- **E.U. Biodiversity Strategy for 2030:** Nature literacy, ecosystem-based solutions, and community involvement in coastal restoration mirrors the strategy's goals. The strategy supports projects that integrate scientific monitoring with public participation, much like the beach profiling and citizen engagement campaigns detailed here.
- **These policies** provide a regulatory and funding framework for the activities outlined in this brief, encouraging the shift from hard infrastructure to adaptive, nature-inclusive approaches that may be more appropriate in some areas.



What is the Challenge

Coastal erosion is a natural process that affects our coastal environment. However, as human activity changes the physical nature of our coasts and Climate Change progresses, the system is increasingly out of balance, with coastal erosion threatening homes, infrastructure, and farmland, forcing relocations and economic losses, while destroying those coastal ecosystems we rely on to protect us from extreme events and the advance of Climate Change.

Existing hard infrastructure approaches to coastal erosion are sub-optimal or expensive, yet local authorities and coastal managers must implement solutions that are socially acceptable. Citizens also need to be empowered to protect themselves, to work alongside coastal managers and design better solutions that work for them, and with natural coastal processes. Citizens and managers must be enabled by scientific evidence on the reality of this natural process, so they can consider new solutions, such as those based on ecosystems and nature's dynamism.

An Innovative Solution

This solution enhances awareness of coastal erosion, fosters new mindsets and understanding, while establishing baselines of fact to inform management and responses to change.

The solution has four key components:

1. Dedicated beach profiling campaigns to establish beach character baselines, and demonstrate existing option performance.
2. Automated, robust and replicable monitoring systems such

as video monitoring, that create databases of imagery with high temporal coverage, and enable the use of deep learning segmentation techniques for real-time shoreline detection and warning system support.

3. Coupled scientific data collection and outreach campaigns to increase awareness and change narratives concerning coastal erosion.
4. Technology-based awareness campaigns and alert systems that encourage local citizens to engage, learn, and consider coastal erosion as a natural process, while empowering them to know when action is really needed.

The Benefits the solution produces

- **Enhanced fluency of local communities in the coastal erosion topic**, enabling more productive engagement with local authorities.
- **Established monitoring baselines**, coupled with the local knowledge on how to monitor autonomously and cost effectively.
- **Enhanced fact-based knowledge of changes that occur**, when a change can be considered extreme enough to require a management response, and predictive/response capacity.
- **Scientifically evidenced information on existing management interventions** and whether or not they exacerbate, or alleviate, the erosion issue that has arisen.
- **Coastal erosion warning systems** to support planned and pre-emptive rapid management responses.



How developed is the solution

This solution is being tested at small scale in real-world societal contexts in Ireland and Portugal. On the Social Readiness Scale, the overall solution could be considered SRL 5. Note that the coupling of video monitoring into a coastal warning system is currently between SRL-6 and SRL-7, with a first prototype already implemented in the Praia de Mira (NW Portuguese Coast) and the implemented algorithms being validated.

Where could also be applied to?

This approach can be replicated in other coastal and river basin regions globally. It is adaptable to different cultural, environmental and educational settings, making it suitable for schools, community organisations, ecotourism and citizen science initiatives working toward cleaner waters.

Area characteristics

Communities that may not yet be fully informed about the complexities of coastal erosion and the limitations of different type of coastal interventions.

Areas where soft sediment coastal ecosystems—and their use by local communities—face heightened vulnerability due to increasing coastal erosion rates and extreme events, like storms. Areas that are low-lying and exposed to storm wave action are particularly applicable.

Areas where decision-makers acknowledge the vulnerability to coastal erosion and are actively seeking solutions, yet recognize that current approaches may not be sufficient to effectively reduce risk.

Areas of soft sediment coastal systems where scientific data is limited, creating challenges for decision-makers in developing informed, effective responses.

Coastal areas in which the sand starvation is a coastal reality (e.g. in coastal areas downdrift of rivers where the sediments are retained by dams).

Intention for applying this solution

There is an unrealised opportunity to raise awareness about the natural dynamics of soft sediment coastal systems and the benefits of integrating natural processes into coastal management, maintenance, and sustainable use.

These challenges highlight the need for adaptive strategies to protect both natural systems and community livelihoods, and improve responses and awareness.

This creates an opportunity to explore innovative, evidence-based strategies for long-term resilience.

Addressing these data gaps could empower more targeted and sustainable coastal management solutions.

Improve awareness of land-sea connectivity by providing data on the impacts of sediment retention, and the potential negative consequences (both environmental and financial) of upstream development



What do you need to have in place:

Before you dive into implementing this solution, it is worth having, or establishing, the following key things in your area:

- **Resources** to implement data gathering and engagement, and literacy activities, as well as response activities such as beach nourishment and nature-based interventions.
- **Guidelines/links** to protocols, to ensure robust and replicable implementation of solution components.
- **Links to local authorities** for advice, permissions, activity prioritisation and joint opportunities.
- **GPS survey** equipment, and option to purchase, install and maintain a camera monitoring system.
- **An online survey** asset such as Maptionnaire.
- **Strategy**, permissions and resources to undertake targeted interventions (with a bid to restore natural processes and reduce intervention-need over time).
- **Expertise** in: Graphic design and signage, science-public and science-policy communications, data analysis, coastal processes, GPS surveying and Geo-informatics, local coastal processes and communities.
- **Coastal warning system components:** Video monitoring cameras, local infrastructures (master with electric power and internet connection).
- **A public policy framework** that allows for activities such as artificial beach nourishment, more subtle coastal restoration interventions (e.g. dune stabilisation), hard infrastructure removal (to restore coastal processes), and decision-making based on data gathered using new monitoring techniques and analysis systems.

Who is this relevant to?

- Municipal authorities.
- Researchers in coastal processes, shoreline dynamics, and coastal community education.
- Coastal advocacy groups and NGOs.
- Coastal communities.
- Policy makers specialising in coastal adaptation and resilience.



Key components of implementation:

Coastal monitoring:

You will need to observe and characterise the dynamics occurring in the target coastline, understanding the goal of your restoration intervention. This may involve developing beach character baselines using GPS surveying (collecting representative beach profiles), setting up video monitoring of the coastline in question, or engaging citizens in the data collection process through the use of Public Participatory Geographical Systems. Characterising the dynamics of your coastline will help you identify when extremes are experienced, and rationalise when interventions are needed. Video monitoring can also support coastal warning systems where appropriate (see below). Key elements are:

- GPS surveying to develop a beach character baseline
- Establish video monitoring
- Public data gathering / citizen science

Nature literacy

A critical part of this solution is raising awareness and understanding of coastal processes during the scientific data gathering. This is done by ensuring researchers in the field are supplied with key messaging and awareness supports (flyers), actively engaging citizens in the data gathering process (e.g through use of a Public Participatory Geographical System such as Maptionnaire, or using a CoastSnap stand), while ensuring that researchers and online tools are equipped with a means to gauge and record public perceptions and report on them. **Key elements are:**

- Nature literacy - Materials preparation
- Nature literacy - Citizen engagement while surveying
- Nature literacy - Citizen science

Engagement

Engagement concerns multiple sectors of society. Not only are you promoting literacy and involvement in the public sphere, you also need to ensure that you are engaging with all relevant decision-making bodies, such as local authorities and relevant coastal managers and decision-making stakeholders. This can yield a wealth of advice, permissions and help you identify areas of particular concern to begin with. In particular, local authorities are often the recipients of citizens local concerns, and are well placed to direct and advise. As concerns coastal erosion hotspots that require more response-requiring management, decision-makers at national, regional, and local levels can benefit from the coastal warning systems outlined here. Here, it is important to consider engagement beyond the surveying timeframe. Particularly where citizens have contributed and engaged in the literacy aspect, it is worthwhile rewarding their engagement with information on what has been achieved, or learned about their local environment. This could be achieved by simply issuing an infographic online through social media channels, or providing communities with a chance to connect around the subject by hosting an information event to tell them about the results and findings, and say thank you.

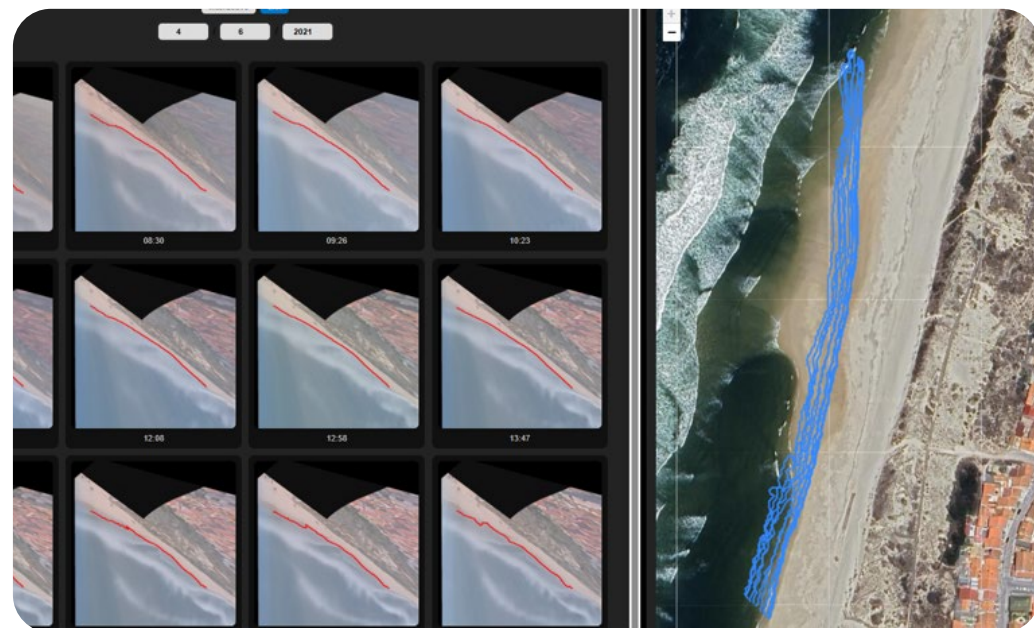


Monitoring your success

While implementing this socio-scientifically coupled solution, it is important you to monitor your system to help you gauge progress, and tailor to local realities. Key metrics to monitor include:

- Evidence of the uptake of alternative approaches to manage erosion;
- Evidence of the scientific integration into decision-making;
- Levels of citizen awareness of coastal erosion as a natural process, which cannot be improved/solved by hard engineering solutions;
- Levels of citizen awareness regarding alternatives such as ecosystem-based solutions to reduce risk from extreme erosive processes;
- Positive versus negative citizen perceptions of the full range of potential hard and ecosystem-based solutions.

Methodologies to help implement such monitoring can be found in the A-AAGORA Learning and Evaluation Methods toolbox, and include: participatory evaluation, design thinking, focus groups, participatory workshops, pre- and post-Intervention questionnaires, community-centred pressures and solutions prioritisation, and scenario building. Use of these approaches will support both communities and authorities to learn, explore options and design effective solutions for implementation.



Costs and Timeframes

Short term: less than a year | Medium Term: 2-5 years | Long Term: years | High cost: 10000+ EUR | Medium cost: 1000-10000 EUR | Low cost: less than 1000 EUR

	Approximate cost	Cost range*	Approximate timeframe	Timeframe ranges
Coastal monitoring - GPS surveying to develop a beach character baseline	High cost	Medium to high cost range	Long-term investment	Medium – long-term range
Coastal monitoring - Establish video monitoring	High cost	Medium to high cost range	Short term investment	Short to medium term range
Coastal monitoring - Public data gathering / citizen science	Medium cost	Medium cost range	Medium term investment	Short to medium term range
Nature literacy - Materials preparation	Low cost	Low cost range	Short term investment	Short term range
Nature literacy - Citizen engagement while surveying	Low cost range	Low cost range	Short term investment	Short term range
Nature literacy - Citizen science	Medium cost	Low to medium cost range	Short term investment	Short term range
Societal Engagement outside surveying	Medium cost	Medium cost range	Short term investment	Short term range

*Cost ranges are relative to each other within this blueprint document, and have been developed by looking at the demonstration sites the activities were undertaken in. Please contact the authors for more information on how they could translate in your region.

The challenges you may encounter

List two challenges per activity area that people may encounter implementing the solution elements.

Activity	Challenge 1	Challenge 2
Coastal monitoring - GPS surveying to develop a beach character baseline	Costs can magnify with the length of time over which the shoreline mapping takes, and the survey frequency. At a minimum the shoreline character should be quantified over all four seasons. Greater numbers of surveys also magnify the data volume to be analysed.	Rental or purchase costs for GPS surveying equipment can be expensive. More recently in addition to purchasing the equipment, a repeat licence is needed to operate the bespoke software on the devices. This can add to costs, particularly if the monitoring is more medium to long term in nature.
Coastal monitoring - Establish video monitoring	Obtaining permissions, and co-designing the installation with planning and administrative authorities is essential. This takes time, but ensures that the installation is suitable for the site, and it is robust enough to survive the conditions (local operators are a wealth of knowledge on what will and will not survive).	Pay careful attention to the privacy considerations of the camera feed. This requires an investment of time in considering resolution, and field of view. This is particularly important in the case of beaches, which are typically high use areas by the public.
Coastal monitoring - Public data gathering / citizen science	Engagement by local communities. If there are not yet local community interest groups to connect with and advocate for data gathering, you may need to invest in wider engagement and publicity. You can also use technologies such as social media to reach out to specific demographics, noting that this is an additional cost and investment of time.	
Nature literacy - Materials preparation	The scale and timeframe of literacy campaign can have a considerable impact on costs. It is worth investing from the start in clarifying who the target audience is, and how to communicate with them effectively. Then design your literacy materials to align with their needs as curious citizens.	



Activity

Challenge 1

Challenge 2

Nature literacy - Citizen engagement while surveying

You may need to resource the survey staff-wise to account for citizen engagement. Have a member of the team tasked specifically with engagement, to allow the member doing the measuring to continue with the surveying.

It is highly recommended to prepare and have flyers and a study website to hand to direct people to further information. While the design of such content is an investment of time and resource, it is a good use in terms of magnifying engagement and sustaining community interest beyond the initial encounter.

Nature literacy - Citizen science

The scale and timeframe of a citizen science campaign can have a considerable impact on costs. This is shaped by how engaged the target communities are already in the issue, how receptive they are to information of use to them, and the numbers of people the target communities constitute. Advice here is to connect to and support key community champions and connect to local community hubs such as interest groups, sports clubs and local action groups. You can also use technologies such as social media to reach out to specific demographics, noting that this is an additional cost and investment of time. Making an engaging and long-lasting science point (such as the CoastSnap camera stands and Maptionnaire) can provide a long-lasting feed of scientifically-harmonised data, once the initial installation is complete.

Societal Engagement outside surveying

Depending on the rationale for gathering the data it can be useful to prepare to engage the community and disseminate information on the study outputs. Again, the scale and timeframe of your engagement activity here will influence the cost investment in terms of time and resources. The nature of engagement will also have an influence – would you prefer a light-touch dissemination of information online through social media channels, or are you seeking to foster community champions through a local info-event that requires catering, a venue and some dedicated content for people to take home with them? Your engagement outside surveying will be location specific, and it is good to have some ideas on this before you finish your surveying and data analysis so the engaged community can see what their efforts and curiosity have helped produce.





Key Contact who to talk to about your application idea

Emma Verling, Rory Scarrott

(University College Cork)

For information on the potential of advanced warning systems founded on video monitoring contact:

Paulo Baptista, Carlos Coelho

(University of Aveiro)

Diogo Oliveira, Francisco Cerda,

André Cardoso, Bruno Rocha (R5

Marine Solutions)

Further information

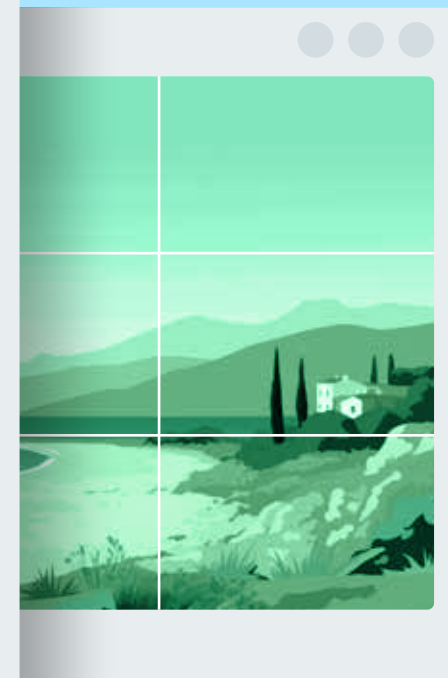
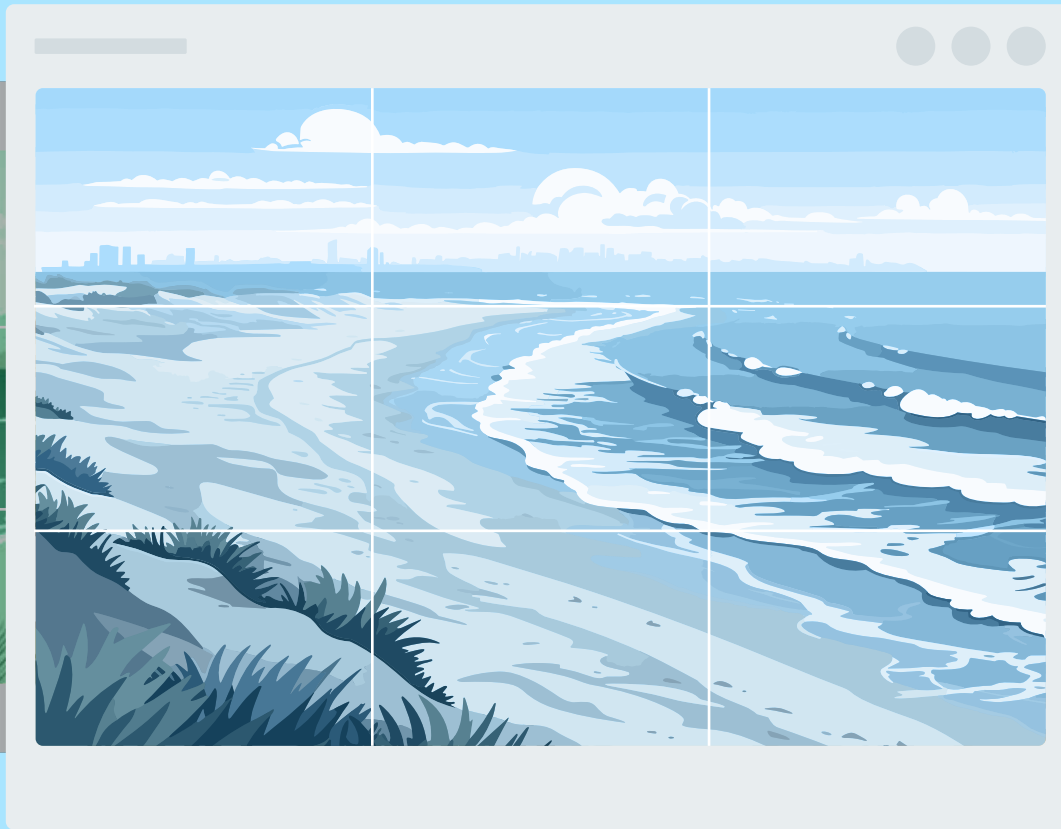
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