Using nature and data to weather coastal storms

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As extreme weather events become more common, seaside regions are particularly vulnerable. Credit: James Peacock via Unsplash

Extreme weather events are becoming more frequent and intense, sometimes with tragic consequences. Europe's coastal cities are

preparing to meet the challenges with help from nature and data from outer space.

As the people of La Faute-Sur-Mer—a small French coastal town in the Vendée north of La Rochelle—tucked into bed on the night of 27 February 2010, a violent storm was raging out at sea.

Swirling, cyclonic winds, high waves and heavy rain blown up across the Bay of Biscay combined with a high spring tide to wreak havoc as it battered the coastline of western France. Residents awoke to a scene of utter devastation.

Perched perilously between the Atlantic Ocean on one side and the river Lay on the other, the town was completely inundated by flooding from the storm surge. Homes, property and businesses were ruined.

Of the 53 people in France who died as a result of Storm Xynthia, 29 were from La Faute.

In a town with a population of just 1,000 people, it was a devastating tragedy.

Extreme weather

Such extreme weather events are becoming more common and seaside regions are particularly vulnerable, says Dr. Clara Armaroli, a coastal geomorphologist who specializes in coastal dynamics (how coastlines evolve).

In response, the University School for Advanced Studies (IUSS) in Pavia, Italy, is leading a pan-European project to develop an early-warning system to increase coastal resilience. Armaroli coordinates the project, called the European Copernicus Coastal Flood Awareness

System (ECFAS).

"Given climate change and sea-level rise, we know there will be an increase in the tendency and the magnitude of coastal storms," Dr. Armaroli said.

"What's needed is an awareness system at a European level to inform decisions."

ECFAS has been set up to develop a proof-of-concept for an early-warning system for coastal flooding. It will develop a functional and operational design.

It draws on data and uses tools from the EU's Copernicus Earth observation satellites and from the Copernicus Services.

Central to this is how data about storm surges, magnitude of flooding and potential impact could be incorporated into the EU's Copernicus Emergency Management Service (Copernicus EMS).

Copernicus EMS is a space-based monitoring service for Europe and the globe that uses satellite data to spot signs of impending disaster, whether from forest fires, droughts or river flooding.

Coastal flooding is not yet part of the Copernicus emergency management mix so ECFAS wants to "plug the gap" says Armaroli.

This will ensure that coastal flooding is monitored in future and that such vulnerabilities become part of its watching brief.

In addition to charting the progression of storms that break on Europe's coastlines, the ECFAS team is integrating data about the changes to shorelines caused by coastal erosion. It's a growing concern as sea-levels

rise across the globe.

Boundary erosion

"The vulnerability and exposure of our coastal areas are also increasing due to erosion, which is narrowing the boundary between the land and the sea," said Dr. Armaroli.

The early-warning system will gather data from an array of sources, all of which impact flood risk. This includes geographic factors such as land use and cover, soil type, tidal changes, wave components and sea levels.

It is being designed to provide forecasts for coastal storm hazards up to five days out. Potentially, it could work in tandem with pre-existing regional and national systems to improve local defenses.

Looking beyond the proof-of-concept stage, Armaroli hopes ECFAS-Warning for coastal awareness can play a critical role in helping areas better prepare for when disaster strikes.

"Our work has started a process, but in the future, we hope this can really help increase the resilience of our coastal areas to the coming extreme weather events," she said.

On the west coast of Ireland, in the Atlantic seaport town of Sligo, an environmental engineer named Dr. Salem Gharbia is taking the challenges faced by coastal cities to the next level.

With the project—SCORE—Smart Control of the Climate Resilience in European Cities—Dr. Gharbia's team is building a network of "living labs" to rapidly and sustainably enhance local resilience to coastal damage.

"Coastal cities face major challenges currently because they are so densely populated and because their location makes them vulnerable to sea-level rise and climate change," he said.

With SCORE's network of 10 coastal cities—from Sligo to Benidorm, Dublin to Gdańsk—Dr. Gharbia intends to create an integrated solution that should help coastal centers to mitigate the risks.

"The main idea behind the concept is that we have coastal cities learning from each other," he said.

Co-created solutions

"Each living lab faces different local challenges," he said, "But each has been established to include citizens, local stakeholders, engineers, and scientists to co-create solutions that can increase local resilience."

Through the network, SCORE wants to pioneer nature-based solutions such as the restoration of floodplains or wetlands that reduce the risk of flooding in coastal regions. It's a model that is already proving effective.

One example, a project to bio-engineer sand dunes in Sligo for stronger natural defenses, is also being tested in Portugal.

The team is developing smart technologies to monitor and evaluate emerging coastal risks. In addition to using existing Earth observation data, this means the community can become involved through new citizen science projects aimed at expanding local data collection.

In Sligo, locals are already getting involved in the monitoring of coastal erosion using what Dr. Gharbia terms "DIY sensors"—drone kites—equipped with cameras, to survey local topography.

Elsewhere, citizens are helping to monitor and record water levels and quality, as well as wind speed and direction with a variety of other sensors.

Sustaining local citizen involvement in this way is crucial to SCORE's success, said Gharbia.

"It's essential that this is two-way for citizens," he said. "Without engaging them fully in the process of co-design and co-creation of ideas to mitigate risks, you will never get them committed to the types of solution proposed."

Data sources

All of this, of course, is creating a wealth of new data from a multitude of sources. But Dr. Gharbia is adamant that an integrated approach is critical.

"The main reason we're developing this system is," he said, "We've realized that to increase climate resilience we have to utilize all the information coming in from different sources."

Ultimately, the goal behind the work is for a real-time, early warning system that could be used by local and regional policy makers to test a range of "what if" scenarios.

Currently, the team are categorizing the data and optimizing the systems and models. In time, they hope other regions can learn from the approach and develop similar living labs.

Dr. Gharbia said the impact of his research project should be "to create an integrated solution that can be used in multiple different locations and can make a big impact in increasing local coastal resilience."

Resilience like it should spread far and wide. "The main purpose is a solution that can be replicated and scaled up," said Dr. Gharbia. The tragic consequences of more frequent and more intense coastal storms must be averted.

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