POLICY BRIEF

Blue Adapt

Protecting human health from climate change and pollution in coastal environments

Using a One Health framework to support effective, equitable policymaking across Europe



What is the situation?

Coastal environments are vital ecosystems for human societies. Around one third of the EU population lives within 50km of the coast.[1] These environments are transitional zones between land and sea. They offer diverse benefits, from supporting livelihoods to recreational activities, but they are under significant pressure from pollution, and they are vulnerable to climate change. This impacts human health.

- Climate change-related events such as increased rainfall and flooding as well as environmental pollution from both inland and marine sources are exacerbating natural and anthropogenic sources of waterborne pathogens. They are also creating conditions in which pathogens can survive for longer and spread in coastal waters.

- Waterborne pathogens include bacteria, viruses, fungi and parasites. They pose risks to human health, as they can cause infections and diseases.

- Some people are more at risk than others. Socio-economic factors and underlying health issues can influence exposure, susceptibility, and ability to recover from infections.

- These health risks are likely to increase under the growing pressure from a complex interaction of climate change, increasing pollution, and socio-economic factors.

What can policymakers do?

Policymakers need to take **urgent action to protect human health by mitigating and adapting to the impacts of climate change and pollution** in coastal environments. This falls within broader efforts to guarantee **water security and resilience in Europe** and beyond.[2] Ensuring water security and resilience will help to reduce risks to human health and allow communities to fully benefit from coastal areas. It will also protect key economic activities, such as those related to tourism, water sports, and fisheries. Coastal areas generate over 30% of EU GDP.[3]

The increasing spread of infectious diseases due to climate impacts could have repercussions across our entire society, putting a strain on our health systems and triggering economic impacts through loss of productivity. **Taking measures to improve overall population health** will increase people's resilience and ability to recover from all infections, including those impacted by climate change, while improving wellbeing and achieving socio-economic co-benefits.

Policy actions need to be based on a holistic framework that considers the links between human health, ecosystems, and socio-economic inequalities.

BlueAdapt is an EU Horizon Europe and UKRI-funded research project focusing on reducing health risks from coastal pathogens. Its researchers have developed a **One Health conceptual framework and policy recommendations** to support evidence-based decision-making aimed at improving the health and wellbeing of people and ecosystems.



How can the BlueAdapt One Health framework help develop policies that improve health and wellbeing?

What is One Health?

The One Health High-Level Expert Panel[4] defines One Health as "an integrated, unifying approach that aims to sustainably balance and optimise the health of people, animals and ecosystems. It inherently recognises that the health of humans, domestic and wild animals, plants and the wider environment (including ecosystems) are closely linked and inter-dependent".[5]

How does BlueAdapt approach One Health?

The BlueAdapt One Health framework demonstrates how this definition can be **concretely applied to the case of coastal pathogens**. It further integrates social sciences, with a strong focus on **equity and on contextual social and economic factors**, and adopts a **systems approach** to issues of health, climate change and pollution.

This novel framework enables policymakers to understand the interactions between climate change, pollution and the social context, and how these influence coastal pathogens and the "host's" health status. BlueAdapt primarily examines human health, but this understanding can also be extended to other health domains such as animal health. The framework is applicable across the broad area around coastal zones (watershed).

How can policymakers use the BlueAdapt One Health framework to better understand changing coastal environments and their impacts on human health?

When considering the impact of coastal pathogens on human health, policymakers should consider the following, as highlighted in the framework:

- **exposure** to pathogens;
- **susceptibility** – the propensity to become infected once exposed; and
- ability to **recover** from the infection.

Each of these elements is influenced by **climate change, pollution, and the social context.**



Climate change and pollution impact on the virulence, spread and resistance of coastal pathogens, increasing risk of **exposure** to infection. Likewise, community lifestyles and behavioural patterns, such as an increased use of beaches during heatwaves, can create further pressure on **exposure** to coastal pathogens.

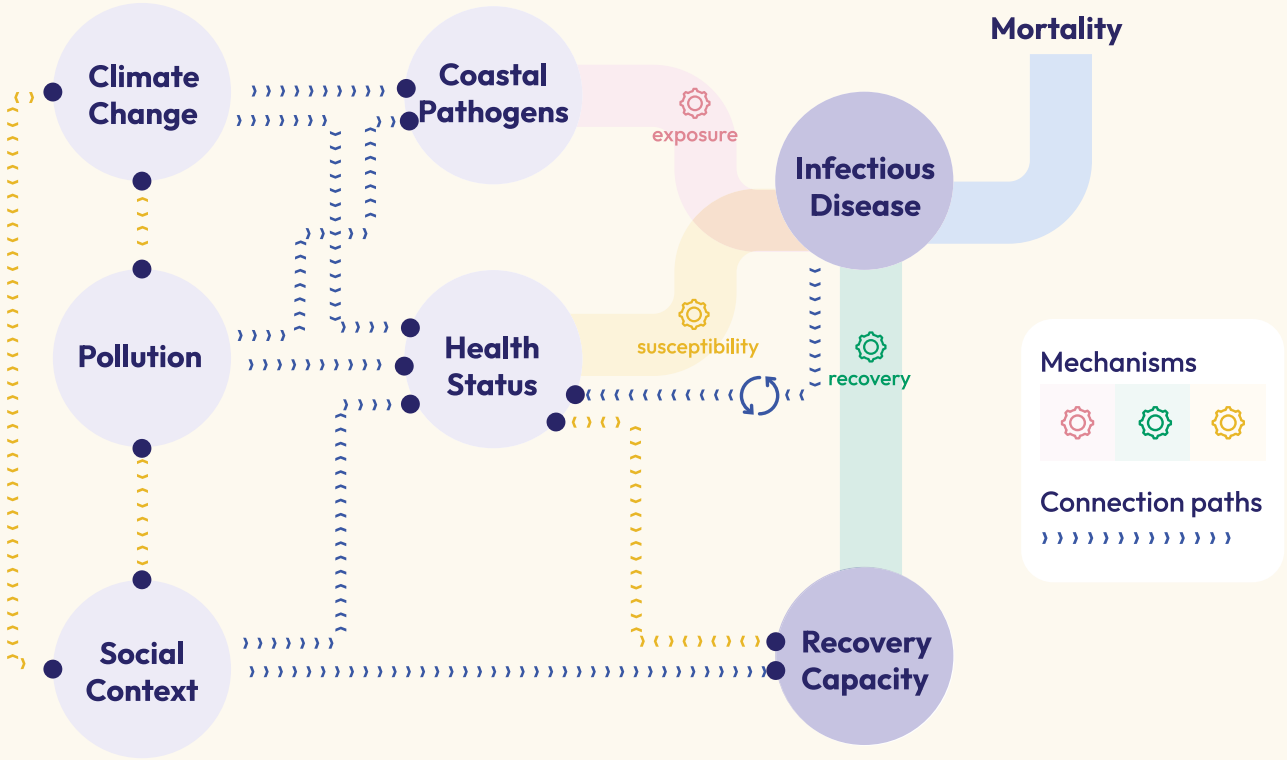
Structural social disadvantages such as poverty and social exclusion increase the risk of poor health, leading to underlying chronic diseases and a weakened immune system. This increases **susceptibility** to certain infectious diseases and slows down the **recovery** process following an infection. Climate change and pollution can cause both physical and mental health conditions such as stress and cardiovascular diseases, increasing people's **susceptibility** to infections.

The framework uncovers the complex pathways by which climate change, pollution and social context influence the disease dynamics experienced from coastal pathogens. It provides a basis for locating **promising areas for intervention** to reduce exposure, improve resilience and enhance recovery processes.

Want to know more?

The BlueAdapt One Health framework is included on the following page. An infographic further explaining the different parts of the framework can be found here. In the following pages, this policy brief provides evidence in support of the framework and four key policy recommendations.

The BlueAdapt One Health Framework



Feedback loops highlight the nonlinear dynamics, showing that infectious diseases also have reciprocal effects, for example further weakening or improving the host's health status and impacting various social aspects such as income and work productivity

The bidirectional relationships between these factors indicate that these elements actively reinforce each other.



The evidence: how human health, climate change, pollution, and socio-economic factors interact in coastal zones

Coastal zones are complex systems. They are transitional zones, influenced by both the sea as well as the inland environment. **Human health, climate change, and pollution all interact with and influence each other in coastal zones.** These elements are also interlinked with human behaviour. **Socio-economic factors**, in turn, influence a person's underlying behaviours (their capacity, opportunity and motivation to act[7]) as well as their health status (influencing people's exposure and susceptibility to infections, as well as their ability to adapt and recover).

Examples include:



Changes in precipitation, such as increased heavy rainfall, can cause sewage overflow, leading to the discharge of untreated urban wastewater and the spread of pathogens in coastal zones.

Sewage spills from storm overflows – caused by pressure from flooding, rainfall or snowmelt – recorded in 2023 by water companies in England totaled 3.6 million hours of spills. This was double the amount experienced in 2022, illustrating the difference in impact between a wetter and drier than average year. Many of these spills were legal, the result of a struggling sewer network.[6]



Agricultural and industrial production, urbanisation, wastewater treatment, and tourism, can cause pollution in coastal waters. Release of nutrients, usually from agriculture, into waterways, can enhance the growth of harmful algal blooms, occurring when algae grow out of control and produce toxins.[8] The consumption of contaminated fish and seafood is a key pathway in which humans can come into contact with harmful algal bloom toxins, chemical pollutants, microplastics and microbial contamination from water.

Pollution from toxic metals, industrial chemicals and plastic waste is at problematic levels in 96% of the Baltic Sea, 91% of the Black Sea, 87% of the Mediterranean Sea and 75% of the North-East Atlantic Ocean.[9]



Climate change can contribute to the spread of antimicrobial resistance (AMR). AMR occurs when certain microorganisms such as bacteria, viruses, fungi or parasites evolve to produce different mechanisms that render them non-susceptible to specific antimicrobial medicines. For instance, common treatments like antibiotics become ineffective against AMR bacterial infections. This poses a significant public health concern. Rising temperatures can trigger self-protection mechanisms in bacteria that promote the development of AMR. At the same time, hot weather leads to the proliferation and spread of bacteria, as well as more frequent use of recreational waters, increasing people's potential exposure to these microorganisms.[10]

Every year, over 35,000 people in the EU/EEA die as a consequence of an infection due to bacteria resistant to antibiotics. The estimated number of infections and deaths is increasing.[11]



AMR occurs naturally. However, misuse, overuse and improper disposal of antibiotics and the release of pollutants such as heavy metals, pesticides, disinfectants, and microplastic into the environment augment the emergence and spread of resistant bacteria.

Almost one in ten citizens in the EU are taking antibiotics without prescription.[27] Up to 75% of antibiotics used in aquaculture may be lost into the surrounding environment.[28]



Climate change hazards such as flooding and heat stress, as well as pollution, can cause direct and indirect physical and mental health impacts, affecting lives and livelihoods, and making people more vulnerable to the risk of infectious diseases.

The frequency of 1-in-100 years historical extreme flooding events is expected to increase by a factor of at least ten before 2050 in many communities along the Mediterranean and Atlantic coasts.[29] Flooding can cause fatalities and injuries, it can damage infrastructure, health facilities, food and water supplies (increasing the risk of subsequent infectious diseases), and affect mental health.[30]



Being in worse health can increase people's susceptibility to infectious diseases caused by coastal pathogens. Individuals' and communities' health is influenced by the conditions in which they are born, live, work, grow and age. Disadvantaged and poor communities are more at risk of underlying physical and mental health issues and may also face difficulties accessing healthcare and affording medicines. They are also more at risk of being affected by the health impacts of climate change and pollution. Other factors such as gender, age and ethnicity also contribute to health inequalities.[31]

Chronic health problems are more prevalent amongst people on the lowest incomes in almost all countries in Europe.[32] Several chronic diseases are key factors in susceptibility to certain infectious diseases caused by coastal pathogens, for instance chronic liver disease (for Vibrio vulnificus), lung disease (for Legionella pneumophila), or diabetes, chronic lung disease, cirrhosis and heart disease (for E. coli).[33]



Low health literacy – defined as a person's ability to find, understand, and use health-related information – alongside insufficient accessibility to adequate information may lead to poor food hygiene or food handling practices. In addition, disadvantaged and poor communities may struggle to access and enjoy the benefits of high-quality blue spaces such as the ocean, for instance due to limited public transport options.

Communities with a high proportion of immigrants and ethnic minorities often have less access to high-quality blue spaces.[34] Homes near high-quality blue spaces tend to be more costly.[35] Coastal environments encourage activities like walking, particularly for low-income households, and possibly contribute to reducing health inequalities.[36]

Policy recommendations: protecting human health from the impacts of climate change and pollution in coastal environments

Drawing on the BlueAdapt One Health framework, BlueAdapt has developed a set of principles to guide policymaking in support of promoting health and wellbeing. The following table includes key principles, related implications for policymaking, and suggested actions that can help protect and improve human health in coastal environments.

Principle	Overarching policy recommendation	Possible actions
Interconnectedness and interdependence Multiple pressures interact on human health through interconnected pathways – environmental, social, economic – increasing the risk of infections from coastal pathogens 	Adopt an intersectoral and systemic approach, such as the BlueAdapt One Health framework, to better understand and act on the drivers and multiple risks to health, looking at climate change, pollution, and socio-economic factors	• Engage and collaborate with experts working across different departments (health, environmental, social, economic) to identify integrated, effective actions to reduce negative health impacts from climate change, pollution and coastal pathogens. • When designing policies for coastal zones, consider influences from both inland areas (watershed), as well as from the open ocean. • In line with recommendations from the EU's Scientific Advice Mechanism,[37] expand existing public health surveillance infrastructures to better integrate One Health considerations and ensure capacity for early warning systems to reduce pathogen and pollution spread. Surveillance should go hand-in-hand with strong health promotion policies to improve population health and resilience, for instance by linking health promotion interventions with programmes on AMR. • Coordinate current funding initiatives across sectoral approaches.
Source control The presence of coastal pathogens is amplified by two key drivers: climate change and pollution 	Act on the root causes of the issue by taking measures to reduce greenhouse gas emissions, adapt to climate change and reduce environmental pollution. Reducing the pressures at source is typically associated with the largest co-benefits in other areas such as human health and equity.	• Engage with *water utilities* to support more effective and resilient wastewater systems that are better adapted to climate change risks. • Engage with *businesses, civil society and communities* to address issues of pollution, for instance acting on plastic pollution by promoting initiatives to reduce, reuse and repair, implementing higher restrictions on agricultural discharge, etc. • Design measures to mitigate and adapt to climate change with equity in mind, to ensure that people in vulnerable situations, who are often less responsible for climate change, can benefit from them.[38]

Community engagement Inclusive engagement with communities builds trust and reduces health inequalities, leading to policies that better serve the health and wellbeing of everyone	Involve relevant actors across different sectors from the local community throughout the decision-making process, from individuals to researchers, health practitioners, urban planners, educators and local companies. Effective interventions need to be community-driven and context-specific.	• Meaningfully involve local coastal communities from the beginning when planning actions to improve health and wellbeing, through a bottom-up approach. This will help identify the issues and solutions, gather perspectives, ensure actions are appropriate and targeted, and ensure sustainability over time.[39] • Investigate the potential for local initiatives such as One Health Living Labs[40] that serve to co-produce knowledge and develop community-driven policy advocacy and narratives, empowering coastal communities to manage their own health. • Involve coastal communities in the uptake and use of early warning systems for safe beach use.
Equity Access to a clean environment and to health are fundamental human rights. Fair access as well as health literacy help to address underlying health determinants and promote good health and wellbeing for all people and the ecosystem	Mainstream equity throughout all policy processes and decisions. Policies should strive to achieve a fair distribution of resources and opportunities for all, both for current and future generations.	• Raise awareness of risks and benefits of accessing coastal environments and possible exposure routes to pathogens through training and education, as well as campaigns using language and formats that are accessible to all and tailored to different communities: improving health literacy can help to avoid or reduce exposure. • Ensure that high-quality blue spaces are accessible and affordable. • Conduct Health Impact Assessments with an equity focus when considering new initiatives in coastal areas to ensure that programmes and policies aiming to adapt to climate change reduce rather than exacerbate health inequalities. • Promote research and approaches that recognise that multiple social, economic, cultural and biological vulnerabilities intersect in the most disadvantaged groups and that exposure, susceptibility and recovery are very heterogeneous.



Looking ahead

Across the world, the health of people and of our ecosystems are at risk, including in coastal environments. **Policymakers need to protect human health, wellbeing and our ecosystems from the challenges posed by climate change and pollution in coastal environments and beyond.** The imperative to protect health provides a strong argument on which to base actions to mitigate and adapt to climate change and can serve as a compass to chart the path ahead.

BlueAdapt is ready to support policymakers in their journey. In the coming years, we will continue to provide evidence on how climate change and pollution are impacting coastal pathogens and the risks to human health. Our findings aim to help inform the most effective ways for Europe to adapt through policy and innovation.

To find out more about our work and stay in touch, you can find us on:

Our website, https://blueadapt.eu/

@BlueAdaptEU on LinkedIn

More about the BlueAdapt One Health framework can be found in:

A video

An infographic

A research report
(This report will be made available on the CORDIS website in the autumn of 2025)



Endnotes

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