

The logo for iDAlert, featuring the letters 'iD' in white and 'Alert' in a light blue color. The 'i' has a small blue arc above it, resembling a signal or Wi-Fi icon.

iDAlert

Infectious Disease decision-support
tools and Alert systems

D2.2 Scoping review of key climate policy and health impact pathways

May 2024

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Deliverable lead	London School of Economics and Political Science (LSE)
Author(s)	Elizabeth J.Z. Robinson, Katie Johnson, Sara Mehryar, Camile Oliveira, Shouro Dasgupta Contributors: Jan C. Semenza, Joacim Rocklöv, Rachel Lowe
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1 Introduction

On a global scale, climate change is altering the incidence, prevalence, and distribution of infectious diseases (Semenza and Paz, 2021). This carries significant consequences for human health in Europe, where the climate is becoming more suitable for the emergence and transmission of some climate-sensitive infectious diseases (Dasgupta et al., 2024; EEA, 2022b). Climatic stressors, specifically temperature and precipitation, constrain the geographical and temporal distribution, seasonality, and transmission intensity of infectious diseases, whereas extreme weather events such as heatwaves, storms, droughts, precipitation, floods, and wildfires can affect the timing and intensity of disease outbreaks by exposing more humans to the possibility of disease transmission (Semenza and Paz, 2021). Non-climatic factors related to globalization and the environment, sociodemographic characteristics, and the quality and capacity of public health systems are also important factors influencing the transmission and spread of infectious diseases (Rocklöv and Dubrow, 2020).

The increasing risk of infectious disease in Europe is addressed in climate policy at various governance levels. European (EU) policies recognize infectious diseases as a growing climate-related risk to health that requires better understanding and capacity to act, yet the EU has limited competences in areas relevant to the development and implementation of many solutions (Dasgupta et al., 2024; EEA, 2022b), so actionable measures are often introduced in national level climate policy.

Climate change mitigation and adaptation measures, both within and outside of the health sector, can have positive or negative impacts on infectious disease outcomes. Reduced infectious disease risk is a potential co-benefit of adaptation measures implemented with the aim of reducing exposure or vulnerability to climate impacts; conversely, increased disease risk can be a trade-off. Climate mitigation policies can similarly affect infectious disease risk through mechanisms independent of those related to modifying climate risk. For example, reducing emissions by reducing meat consumption can decrease infectious disease risk, as animal farming contributes to the loss of biodiversity, which is associated with greater disease risks (Espinosa et al., 2020). In many cases, climate adaptation policies and measures are positive and mutually beneficial for human health and infectious disease, especially those aimed at enhancing social capital by organizing networks of resources and strengthening social linkages to help reduce vulnerability and increase community resilience (Confalonieri et al., 2015). For infectious diseases, which are affected by a range of individual, social, and environmental determinants, climate strategies taken in non-health sectors, such as water and wastewater management, and civil protection, could both reduce the environmental risks of infection and improve the efficacy of public services for the protection of the population (Confalonieri et al., 2015). Conversely, some dimensions of infectious disease outcomes could be worsened rather than benefit from climate policies. In the case of adaptation to extreme heat or flooding in highly populated areas, for example, the use of nature-based solutions (NBS), which also provide mitigation benefits, could unintentionally create more mosquito breeding sites, potentially increasing human exposure to and transmission of infectious disease (Fournet et al., 2024).

While some EU policies already address the impacts of climate change on infectious disease (Dasgupta et al., 2024), most policies are yet to take into consideration the impacts of climate adaptation and mitigation-driven transformations on infectious disease outcomes (Rocklöv et al., 2023). To support policy makers in limiting unintended negative consequences and promoting health co-benefits, more evidence about the health effects of climate action is needed (Luyten et al., 2023). This scoping study intends to help fill this gap by identifying and mapping pathways through which European and national level climate policies can potentially affect climate-sensitive infectious disease outcomes. In section 2, we explore infectious disease risk and measures to adapt to infectious disease, to conceptualize the impact

pathways through which climate measures can influence the transmission of infectious disease to humans, or human exposure or vulnerability to infectious disease. In section 3, we introduce the methodology used to screen European and national climate policies for relevant adaptation and mitigation measures. In section 4, we present the findings of the scoping review, first, on the coverage of infectious disease in policies, then, on the co-benefits and unintended consequences of climate policies and measures on infectious disease. Section 5 provides a discussion of findings and conclusions.

2 Links between climate change and infectious disease risk

Climate-related health impacts are often mediated through complex ecological and social processes, where direct and indirect effects of climate change interact with social dynamics to influence health outcomes (Watts et al., 2015). In the case of climate-sensitive infectious disease, weather and climatic conditions may influence the reproduction and survival of animals, disease vectors, and pathogens, which affect the geographic range, subsequent human exposure, and transmission potential of pathogens. In parallel, biological, ecological, demographic, social, and structural factors may influence human vulnerability (Rocklöv et al., 2023). Infectious disease transmission is sensitive to changing climate conditions and can be influenced by altered contact rates between human and pathogen, human and vector, or human and host, depending on the presence of people in areas where they could be exposed to the disease, as well as underlying vulnerabilities in society (Semenza et al., 2022).

Numerous studies have shown that variations in temperature, precipitation, and humidity affect the distribution and transmission of infectious diseases (Van de Vuurst and Escobar, 2023), in part because the ecosystem habitats where vectors or non-human hosts may thrive or fail can be altered by climate change (Rocklöv and Dubrow, 2020). An increase in extreme events can also increase disease transmission to humans, influencing the timing and intensity of disease outbreaks and hindering response efforts (IPCC, 2023). Further, climate hazards such as temperature extremes, heavy precipitation, and severe droughts, can cause cascading impacts, where secondary events in natural and human systems lead to physical, natural, social, or economic disruptions due to existing vulnerabilities, or activate cascading risk pathways (Dasgupta et al., 2024). Cascading risks from infectious disease arise due to a nexus of hazard, vulnerability, and exposure, where climate hazards amplified by societal vulnerabilities can trigger new hazards, for example, stagnant water that serve as breeding ground for mosquitoes after a flood, contamination of drinking water after a storm surge, breakdown of vector control programs after a hurricane (Semenza et al., 2022), or dengue outbreak following a drought (Lowe et al., 2021).

While climate change may increase diseases in nature, transmission to humans depends upon a range of societal, infrastructural and medical barriers protecting humans (IPCC, 2023). Economic, technological, demographic, and governance structures shape health outcomes (Watts et al., 2015) and alter the landscape of infectious disease risk (Baker et al., 2022). At the individual-level, the risk of infectious disease risk relates to the frequency and intensity of a person's exposure to an infectious pathogen, where contact occurs primarily in the household, the neighbourhood, and the work environment (Noppert et al., 2022). In Europe, the non-climate drivers for the transmission (Semenza et al., 2016).

All humans are potentially susceptible to infectious diseases, yet social, economic, political, and health inequalities can exacerbate vulnerabilities (Jeleff et al., 2022). Vulnerabilities arise from the interaction of climatic and social processes; direct (e.g., storms, drought, floods, heatwaves) and indirect (e.g., water quality, air pollution, land use change, ecological change)

effects of climate change interact with social dynamics (e.g., age and gender, health status, socioeconomic status, social capital, public health infrastructure, mobility and conflict status). Underlying vulnerabilities affecting disease transmission include biomedical, demographic, geographic, socioeconomic, socio-political factors, as well as access to preventative measures (Semenza et al., 2022). Collectively, social development, existing public health systems and infrastructures, the programs and measures in place to reduce burdens of climate-sensitive health determinants and outcomes, and the success of traditional public-health practices determine levels of human vulnerability (Wu et al., 2016). Vulnerability inequalities could however increase if the response to infectious disease risk is not carefully considered, for example, if bottom-up community responses are working out well in high income settings and less so in low-income settings. Table A1 in Annex I provides an overview of climate hazard, exposure and vulnerability factors that have an impact on infectious disease, and how infectious disease risk factors are influenced by climate.

Infectious disease risk in Europe is addressed explicitly in Chapter 14 of the [European Climate Risk Assessment](#) (Dasgupta et al., 2024). Specific diseases of concern and observed and projected changes are reported based on the latest scientific knowledge and findings. Table A2 in Appendix I compiles information on how climate is affecting each of the diseases referred to in the chapter.

More than half of infectious diseases that impact humans globally can be aggravated by climate hazards (Mora et al., 2022), so it follows that there are climate adaptation measures designed and implemented specifically to address the increasing risk of infectious disease. Some examples include surveillance of climate variables (i.e. temperature, rainfall, humidity) to predict disease outbreaks, design of early warning systems for extreme events that can exacerbate disease spreading (Colón-González et al., 2021; Lotto Batista et al., 2023; Lowe et al., 2014), implementation of vector control strategies, vaccination programs, promotion of public health campaigns to raise awareness and educate health professionals and communities on climate-related disease risk, specifically training the medical community to recognize and treat potential new diseases in their region, and improvements in public health services. Measures resulting in changes to geographic spread of people, land use, water and sewer systems, diets, or outdoor workers/working hours can affect human exposure to infectious disease; on the other hand, measures resulting in changes to the resilience or capacity of health systems, general health and well-being, inequality, population dynamics, social dynamics, or availability of individual protection/safeguards (e.g. mosquito net) can affect human vulnerability to infectious disease.

In particular, early warning systems based on forecasts of spatial-temporal changes in infectious disease risk have proven effective in helping societies take proactive measures to prevent or alleviate the possible health impacts (Wu et al., 2016). See Table A3 in Annex I for an overview of factors influencing the transmission of several key diseases in Europe, including different types of preventative measures can be used to reduce human exposure and vulnerability. In all cases, prevention should include raising public awareness and development of early warning systems (EEA, 2022b). Many of the measures for disease prevention and response are focused more generally on the level of improving community health and well-being and building the resilience of the health care system and facilities. Education, food security, proper sanitation of water and waste, high-quality housing, disease surveillance and alarm systems, and high-quality medical and veterinary systems dramatically reduce disease risk and improve health (IPCC, 2023).

According to the Intergovernmental Panel on Climate Change (IPCC), the highest level of evidence and agreement on adaptation measures to reduce risks of climate change impact on water- and vector-borne diseases are for improving warning systems, diagnostic abilities, and infrastructure (IPCC, 2023). Measures that support the conservation, protection, and restoration of wild habitats, including the use of nature-based solutions, contribute to healthier

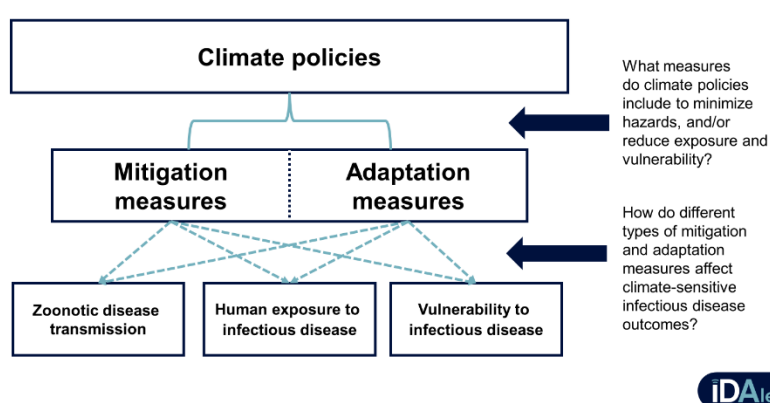
ecosystems which can provide services such as reduced disease spill-over. Changes in food production and diets to include less meat limits direct human contact with the hosts of food-borne pathogens. See Table A4 in Annex I for European relevant examples of adaptation from the IPCC.

Many of the factors that reduce human exposure or vulnerability to infectious disease can also be achieved as outcomes of measures taken mitigate or adapt to climate change in other sectors; in some cases, these can also result in negative outcomes for infectious disease risk. This scoping review focuses on exploring the extent to which these types of measures are included in European and national climate policy and how they can provide co-benefits or trade-offs for infectious disease.

3 Methodology and scope

The purpose of this scoping review is to identify and map the pathways through which European and national level climate policies are likely to affect climate-sensitive infectious disease outcomes. Countries and regions pursue their goals through policy instruments (Capano and Howlett, 2020); in the case of climate policies these instruments are mitigation and adaptation measures. The policies are screened to select adaptation measures with a potential link to the disease transmission, human exposure or vulnerability to infectious disease (Figure 1) based on the conceptual framework developed in section 2. Mitigation measures are only considered insofar as they are addressed in policies with an adaptation focus. In section 3.1, we explain the screening process to select climate-relevant European policies, and in section 3.2, the process for selecting national climate policy. Section 4 presents the findings on how climate policies may directly and indirectly affect infectious disease outcomes. The coverage of climate-sensitive infectious disease types is limited to vector-, food- and water-borne diseases in Europe.

Figure 1 How climate policies influence infectious disease outcomes



We used the [European Climate Adaptation Platform Climate-ADAPT](#) to identify European level climate policies and climate-relevant policies to include in the scoping review. We screened the EU policy pages of the Climate-ADAPT platform, grouped as EU Adaptation Policy, Adaptation in EU policy sectors, EU regional policy, and Key EU actions, to compile a list of relevant policies. The policy sectors of the Adaptation in EU policy sectors pages are grouped and used to structure our findings in section 4 of the scoping review. Criteria used to narrow

the scope of policies reviewed include relevance to adaptation, the link between the policy subject and climate change, and the type of legislation (binding legislative acts vs evaluations, commentary or explanations of action-programs or brief outlines on future policies or arrangements concerning details of current policy). The most relevant European level policy documents were then screened to compile a set of adaptation measures with a potential link to climate-sensitive infectious disease outcomes.

Five European countries were used as case studies to further investigate climate measures in national level climate policy: Germany, Greece, the Netherlands, Spain, and Sweden¹. As the initial step in the review of national level policy, we conducted a keyword search of terms relevant to infectious diseases among all climate policy documents of the five case studies. This was done to examine whether and how infectious diseases are recognized in these policies, as well as the co-benefits and trade-offs of such policies on infectious diseases. We utilized a variety of keywords including 'infectious disease', 'zoonotic', 'vector', and 'pathogen' in this search. This search was performed using [Climate Change Laws of the World](#), a comprehensive dataset encompassing national-level climate change legislation and policies worldwide. This dataset includes adaptation and mitigation laws, policies, and United Nations Framework Convention on Climate Change submissions. The online tool enables keyword searches and identifies exact matches and related phrases highlighted in the text. Additionally, it offers live translations of documents from all languages to English.

Then, we conducted a deeper analysis of the five countries' national climate change adaptation policies to identify the most relevant measures included in such policies with a potential link to infectious disease outcomes. To do this, we used the Country Profiles² pages of the [European Climate Adaptation Platform Climate-ADAPT](#) for an overview of available resources for the five countries and to determine the country-level documents that would provide the most consistent analysis of adaptation action across a variety of contexts. The availability and specificity of such plans vary across sectors and across countries (See Box A1 in Appendix I Mapping the climate adaptation policy landscape in case study countries); as such, we chose to conduct a review of national adaptation plans for Germany, Greece, the Netherlands, and Spain, and of several sectoral adaptation plans for Sweden as the country does not have a national adaptation plan. Following the same approach used with the European policy documents, the national climate adaptation policy documents were then screened to compile a set of adaptation measures with a potential link to climate-sensitive infectious disease outcomes.

4 Findings

Climate measures introduced at both European and national levels can have various direct and indirect impacts on infectious diseases. While some of these impacts are acknowledged in policies, many remain overlooked. Additionally, many of these measures have the potential to create both co-benefits and trade-offs for infectious diseases, simultaneously. In section 4.1, we analyse how the EU and the five case study countries acknowledge infectious diseases in their climate policies, thus outlining the direct impact of these policies on infectious diseases. In section 4.2, we explore how different categories of climate measure, included in EU policies and the national adaptation policies of the five case studies can affect infectious diseases,

¹ These are the five European case study countries in the IDAlert project.

² In March 2023, EU Member States were mandated for the second time to report their national adaptation actions under the [Regulation on the Governance](#) of the Energy Union and Climate Action and in line with the requirements of the first [implementing regulation](#). This information is accessible on Climate-ADAPT.

thereby highlighting the indirect impacts of climate policies as co-benefits and trade-offs for infectious diseases. **Error! Reference source not found.**

4.1 Infectious disease in climate policy

The threat of infectious disease and the need to address this threat is touched upon in several European climate-relevant policies (Appendix I Table A5). The Communication on the [EU Health Union \(COM/2020/724 final\)](#) (EC, 2020b) identifies the need to better anticipate health risks and prevent the spread of new infectious diseases and associated disorders. Highlighting the importance of biodiversity and well-functioning ecosystems in doing this, [the EU Biodiversity Strategy \(COM/2020/380 final\)](#) (EC, 2020c) states that biodiversity and well-functioning ecosystems need to be protected and restored to build resilience and decrease the risk of emergence and spread of infectious diseases. As a key element of the Biodiversity Strategy, the proposal for the [Nature Restoration Law \(COM/2022/304 final\)](#)³ (EC, 2022a) calls for binding targets to restore degraded ecosystems, stating that ecosystem restoration will help reduce the potential for future communicable diseases with zoonotic potential and contribute to efforts to apply the One Health approach

The [Communication on the European Health Emergency preparedness and Response \(HERA\) Authority \(COM/2021/576 final\)](#) (EC, 2021c) names infectious disease outbreaks as an outcome of driving the rise and increasing the frequency of emerging pathogens due to global population growth, climate change and the consequential pressure on land use, food production and animal health, with modern travel facilitating the quick spread of viruses and other pathogens across the world. The [Regulation on Serious Cross-Border Threats to Health \(\(EU\) 2022/2371\)](#) (EU, 2022b) maintains and further strengthens, [The European Surveillance System \(TESSy\)](#) for Infectious Diseases, operated and coordinated by the European centre for disease prevention and control (ECDC), established under [Regulation \(EC\) 815/2004](#) (EC, 2022b), and introduced a legal mandate for the establishment of EU reference laboratories (EURLs) in public health, including EURLs covering infectious disease.

The [European Strategy on Adaptation to Climate Change \(COM/2021/82 final\)](#) (EC, 2021a) brings infectious disease into the context of European climate policy, noting that the emergence and spread of infectious diseases linked to geographical shifts in vectors and pathogens is a growing climate-related health threat that requires greater understanding and capacity to respond (smarter adaptation). The [European Climate Law \(\(EU\) 2021/1119\)](#) (EU, 2021b) further highlights the need to address the emergence and spread of infectious diseases as a growing climate-related risk to health.

[Managing climate risks - protecting people and prosperity \(COM/2024/91 final\)](#) (EC, 2024), the Commission's response to the first-ever [European Climate Risk Assessment](#), calls attention to the increasing incidence of infectious disease and current lack of effective medical countermeasures to respond to these diseases. However, it not only identifies the problem, but also takes the next step by presenting ongoing existing work and key actions that the Commission will take forward to address the risks for health. The Commission will strengthen its actions and commitments on climate and health by securing access to and development of critical medical countermeasures, including the development of new vaccines and therapeutics for infectious disease.

At the national level, the Netherlands is the only one of the five case study countries that has policies that explicitly recognize the co-benefits and trade-offs of climate-related interventions on infectious diseases (see Appendix I Table A6 for examples from policies). While all five countries' climate policies highlight 'infectious disease' as a major impact of climate change or

a consequence of inaction, they do not go beyond that to identify changes in the transmission and spread of infectious disease as a potential outcome of some climate mitigation or adaptation interventions. The [National Climate Strategy of the Netherlands](#) (Netherlands Ministry of Infrastructure and the Environment, 2016), however, calls for attention and further research to comprehend the connections between heat, infectious diseases, urban development, and natural environments. This policy explicitly mentions the negative impact of natural environments, noting that “while outdoor recreational activities have positive health effects, they also increase the risk of exposure to pathogens and vectors like ticks and Lyme disease”. The strategy also recognizes the co-benefits of enhancing water quality, which can reduce infectious diseases. Climate policies in the other four countries discuss infectious disease as one of the main impacts of climate change due to changes in the ecosystem. They also recognise the increased vulnerability and human exposure to infectious diseases due to climate change and certain measures that should be taken to control and reduce the transmission and spread of infectious diseases. However, very few if any specific infectious diseases are mentioned.

The growth and expansion of infectious diseases as a result of climate change, along with the need for measures to reduce their risks, are addressed in the national policies of all five countries. Specifically, infectious disease-relevant actions outlined in the National Adaptation Plans of the countries follow three overarching themes: strengthening research on infectious disease; developing continuous data collection and evaluation; and creating systems of prevention and preparedness (see Appendix I Table A6 for examples from each country).

In terms of strengthening research on infectious disease, all five countries in this review suggest that more knowledge development is key in both understanding the complex relationship between changes in the environment and disease spread, but also in understanding how infectious disease can spread not only through the environment, but also water, food, and a variety of vectors. Countries also outlined the need for continuous monitoring of disease vectors. Depending on the country, this task is found within different sectors. For instance, Germany and Spain attribute this action to the public health sector, whereas Sweden identifies the need for active monitoring of vectors to fall under the Swedish Veterinary Institute sectoral actions.

As part of creating systems of preparedness, the development of early warning systems was specifically mentioned by Greece, Germany, Sweden, and Spain. Netherlands indicated that there is already a monitoring and screening system for infectious disease. Germany, Sweden and Spain also recognize the need to communicate to the wider population around infectious disease risks and hot spots, guided by the data.

Interestingly, Spain and Sweden outlined the need to integrate animal and human surveillance when it comes to infectious diseases. More specifically, Sweden’s main coverage of infectious disease was through the country’s Veterinary Institute. Both countries seem to take a wider approach to infectious disease illnesses that acknowledges the impact on both human and animals and the way both will interact and be impacted by climate change as well. Greece also mentions disease vectors in relation to the context of potential threats to productive animals and the effects of climate change on livestock production.

4.2 Co-benefits and trade-offs of climate policies on infectious disease

Climate policies focus on mitigating greenhouse gas emissions and adapting to the impacts of climate change, but many sectoral policies also have climate-related objectives or measures integrated into their plans. Mainstreaming climate change adaptation in EU policies is called for as a critical step towards more systemic adaptation in the [EU Adaptation Strategy](#) (EC,

2021a) and named as a priority objective in [Europe's 8th Environment Action Programme](#) (EU, 2022a).

We use the Climate-ADAPT sectoral categories of climate change adaptation to outline climate measures and their co-benefits and trade-offs on infectious disease risk. These are agriculture, biodiversity, buildings, coastal areas, cultural heritage, disaster risk reduction, energy, financial, forestry, health, information and communications technology, land use planning, marine & fisheries, mountain areas, tourism, transport, urban, and water management. We only include those sectors for which we have identified relevant measures with potential impacts on infectious disease.

4.2.1 Water management

European climate policies on water management tend to address ensuring sustainable freshwater availability, reducing water use, preserving water quality, and addressing the risks of extreme weather events such as droughts and floods. These policies aim to integrate climate change considerations into water management strategies, such as through river and flood management plans, and encourage measures like water reuse and efficiency, sustainable soil management, and land-use practices. Additionally, climate change impacts are increasingly being considered in risk assessments for water supply systems to secure water availability, including for drinking and sanitation.

The [EU Strategy on Adaptation to Climate Change](#) (EC, 2021a) emphasizes (1) sustainable freshwater management by implementing mechanisms such as water resource allocation and water permits, (2) reduced water use by implementing stricter water-saving requirements for products, promoting water efficiency, and encouraging the adoption of drought management plans and sustainable soil management, and (3) preserved water quality in light of increasing extreme weather events by incorporating climate change risks into water management risk analyses. While the [Water Framework Directive](#) (EC, 2000) does not explicitly mention climate change adaptation, it requires EU member states to integrate climate-related threats and adaptation planning into River Basin Management Plans. Similarly, the [EU Floods Directive](#) (EC, 2007b) addresses flood management with consideration for climate change impacts. In addition, the [Regulation on minimum requirements for water reuse](#) (EU, 2020) establishes minimum standards for treating and reusing urban wastewater in agriculture, aimed at addressing droughts and water insecurity exacerbated by climate change. It outlines key rules for water reuse risk management plans, mandates member states to develop these plans with additional water quality requirements and preventive/corrective measures, and requires information campaigns to promote the benefits of water reuse and ensure safe reclaimed water use. Member states must conduct information campaigns promoting the benefits of water reuse and ensuring safe reclaimed water use, with relevant information accessible to the public online or through other means, as specified in the regulation.

At the national level, [Greece's National Adaptation Strategy](#) (Greek Ministry of Environment & Energy, 2016) focuses on sustainable water resources management measures including rationalizing irrigation, adopting efficient irrigation systems, minimizing water transport losses, and investigating limitations on water-bearing plant species. [Spain's National Climate Change Adaptation Plan](#) (Spanish Ministry for the Ecological Transition and the Demographic Challenge, 2021) emphasizes integrating drought risk management into water planning, monitoring climate change effects on water bodies, and maintaining water quality information systems. The [Netherlands' National Climate Adaptation Implementation Program](#) (Netherlands Ministry of Infrastructure and Water Management, 2023) prioritizes groundwater protection, long-term drinking water source availability research, duty of care clarification, and freshwater supply increase. [Germany's Adaptation Action Plan](#) (German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection, 2022) involves renaturing watercourses, developing quality standards for water reuse, ensuring ecological

continuity in waterways, and implementing rainwater management measures to address climate change impacts.

Co-benefits

- **Reduced water-borne diseases:** ensuring the minimum quality of water can control water-borne diseases. Proper treatment processes such as filtration, disinfection, and advanced oxidation can effectively remove or inactivate pathogens, reducing the risk of waterborne diseases.
- **Reducing impacts of flood and drought events:** If properly maintained, measures to store, infiltrate, and reuse rainwater (as suggested in Germany's Adaptation Action Plan) can provide access to clean water for hygiene practices such as handwashing during drought, reducing the transmission of waterborne diseases. However, efforts must be taken to ensure water storage containers do not become mosquito breeding sites.
- **Behaviour change:** educating the public about the importance of water quality and hygiene can lead to behavioural changes, reducing the exposure to and transmission of infectious diseases.
- **Enhanced ecosystem health:** Management of natural ecosystems to optimize water production can contribute to healthier ecosystems, which may indirectly support biodiversity and ecological balance, potentially reducing the prevalence of disease vectors.
- **Reducing combined sewer overflows** reduces the risk not only to the drinking water supply but also to beaches, freshwater ecosystems, and shellfish aquaculture, minimising the risk of gastrointestinal illness (Semenza, 2024).

Trade-offs

- **Improper storage or contaminated water harvesting systems** is a known risk factor for mosquito breeding, and probably also related to waterborne diseases in some settings.
- **Inadequate implementation of measures to monitor water quality** and manage water resources could lead to outbreaks of waterborne diseases due to contamination of drinking water sources, posing significant public health risks. Testing for microbial agents (bacterial, viral, and parasitic) in potable water sources and wastewater, identified in real-time through polymerase chain reaction, next generation sequencing, enzyme-linked immunosorbent assay, and biosensors testing methods are essential to prevent such outbreaks.
- **Ecological disruptions:** Construction of dams and underground water enrichment projects may disrupt natural habitats and alter ecosystems, potentially leading to unintended consequences such as changes in disease vector populations or displacement of species that play a role in disease regulation. For example, both hydropower and irrigation dams create large reservoirs of stagnant water, which serve as breeding grounds for mosquitoes, increasing the risk of mosquito-borne diseases such as malaria, dengue fever, and West Nile virus (Kibret, 2018; Kyei-Baafour et al., 2020; Johansen et al., 2023). In addition, dams and water projects can alter habitats, displacing predators such as birds of prey and bats (Rebelo and Rainho, 2009; Abreu et al., 2020) that keep rodent and insect populations, respectively, in control. An increase in rodents and insects can lead to higher transmission rates of rodent-borne diseases (e.g., hantavirus and leptospirosis) and insect-borne diseases. In addition, creation of ecological continuity and renaturation of watercourses and floodplains, while

beneficial for ecosystem health, could alter the distribution of disease vectors and their habitats, potentially leading to shifts in disease patterns and transmission dynamics.

- **Unforeseen consequences of rainwater management:** While rainwater management measures such as sustainable drainage system, and retention and infiltration measures can help mitigate flooding and preserve natural water regimes, improper implementation or reliance on certain technologies may inadvertently create breeding grounds for disease vectors like mosquitoes, increasing the risk of vector-borne diseases.

4.2.2 Buildings, Urban, and Land use planning

European climate policies tend to promote the integration of climate change adaptation in building standards to increase energy efficiency and performance of buildings, particularly during extreme weather events. At the urban level, the EU has strategies like the Adaptation Strategy (EC, 2021a) and Biodiversity Strategy 2030 (EC, 2020c) to make cities more resilient. Tools like the European Environment Agency's [Urban Adaptation Map Viewer](#) and Copernicus' [Urban Atlas](#) help assess urban vulnerability. Financial and technical support is available through programs like Horizon Europe and the [Urban Adaptation Support Tool](#).

[The EU strategy on Adaptation to climate change](#) (EC, 2021a) includes several actions addressing climate vulnerabilities in the built environment, emphasizing preparedness and the role of buildings and urban planning in large-scale adaptation. It promotes nature-based solutions in buildings such as green roofs and walls and green infrastructure in cities such as green corridors, green urban areas, and trees to reduce reliance on air conditioning and address the urban heat island effect. The integration of this strategy and the [Renovation Wave Communication](#) (EC, 2020a) aims to improve energy efficiency and standards for heating and cooling in renovation of buildings, including considerations for vulnerable populations. [Green Public Procurement Criteria for Office Buildings](#) and the [European framework for Sustainable Building](#) support these goals on improving buildings' climate resilience. Directives like the [Energy Performance of Buildings](#) and the [Energy Efficiency Directive](#) (EU, 2018) guide policies on heating and cooling of buildings. The [EU Biodiversity Strategy 2030](#) (EC, 2020c) promotes integrating healthy ecosystems, green infrastructure, and nature-based solutions into urban planning, including public spaces and buildings. The European Commission calls on European cities of at least 20,000 inhabitants to develop ambitious Urban Greening Plans, supported by the [EU Urban Greening Platform](#) and the [Green City Accord](#).

In contrast, land-use decisions are typically made at the local or regional level, but the European Commission ensures that Member States consider environmental concerns and practice integrated land management. This involves directives such as the [Strategic Environmental Assessment Directive](#) (EC, 2001) and the [Environmental Impact Assessment Directive](#) (EU, 2014), along with sector regulations such as the Water Framework Directive and the Common Agricultural Policy.

Land use has a significant impact on greenhouse gas emissions, with over half of land use sector emissions coming from agriculture. The EU aims for climate neutrality by 2050, with an interim goal of a 55% net reduction in emissions by 2030 – a Green Deal objective made a binding target by the EU Climate Law. The [LULUCF Regulation](#) (EU, 2018) implements the agreement made between EU leaders in October 2014 that all sectors should contribute to the EU's 2030 emission reduction target, including the land use sector.

Similarly, all five countries' policies promote increasing urban greenery to adapt cities to the impacts of climate change. The [Greece's National Strategy for Adaptation](#) promotes enhancing urban greenery through utilizing underutilized areas, redistributing and restoring greenery in the built environment, and prioritizing the integration of greenery into existing structures such as ceilings and vertical surfaces. [Spain's National Climate Adaptation Plan](#) proposes

increasing green infrastructure and applying innovations in building materials and solutions, including permeable road surfaces, timber constructions, bioclimatic architecture, green facades or roofs, and strategies like seasonal shading and night cooling. The [Netherlands' National Climate Adaptation Implementation Program](#) emphasizes considering health effects of heat in the design of the physical living environment to better protect vulnerable people, exploring extending green built environment standards to existing construction as well as exploring measures to increase the city's sponge effects, such as more rainwater infiltration, minimizing paving, increasing green and cool places, and natural drainage systems.

Co-benefits

- **Stormwater and flood management:** Urban green infrastructure, including green roofs, permeable surfaces, and rainwater harvesting systems can help manage stormwater runoff, reducing the risk of urban flooding and protecting water quality, thus reducing the transmission of water-borne diseases.
- **Heat management:** Green infrastructure and bioclimatic architecture can mitigate the urban heat island effect, lowering temperatures in urban areas. This can decrease the incidence of heat-related illnesses such as heatstroke and dehydration, thus reducing the burden on healthcare systems. In addition, lowering urban heat island effects and urban temperatures can reduce impacts of extreme heatwaves during summer which is one of the main extreme climate events accelerating spread of infectious diseases (Lian et al., 2023; Mora et al., 2022). Urban heat islands are areas with minimal vegetation cover and large man-made surfaces (e.g., dark roofs, asphalt lots, and roads) that absorb sunlight, re-radiate heat, and retain less water compared to natural land-cover. These are characterized by high land surface temperature, low humidity, and poor vegetation, and considered to favour the transmission of the mosquito-borne dengue fever (Araujo et al., 2015).
- **Improved indoor air quality:** The promotion of energy-efficient buildings and regular inspection of heating, ventilation and AC systems may also include measures to improve hygiene practices. Proper maintenance can help reduce the buildup of contaminants and improve overall indoor air quality, thereby reducing the risk of indoor transmission of infectious diseases.
- **Improved outdoor air quality:** Urban green infrastructure, such as green roofs and green walls, can help reduce air pollution by absorbing pollutants and particulate matter. Cleaner air can lead to reduced respiratory illnesses and lower the transmission rates of respiratory infections. This can also lead to fewer transmission of respiratory viruses and bacteria among building occupants, thus reducing general health vulnerability.
- **Enhanced Mental Health and Physical Activity:** Access to green spaces and natural environments in cities has been linked to improved mental well-being and stress reduction. Reduced stress levels can strengthen the immune system, making individuals less susceptible to infectious diseases (Segerstrom and Miller, 2004; Godbout and Glaser, 2006). In addition, green infrastructure in urban areas encourages outdoor activities and physical exercise, which can contribute to overall health and immune system function. Regular physical activity reduces the risk of chronic diseases and strengthens the body's ability to fight off infections.
- **Reduced Greenhouse Gas Emissions (GHGs):** Improving energy efficiency and transitioning to renewable energy sources reduces the emission of greenhouse gases and air pollutants. This contributes to cleaner outdoor air and reduces the burden of respiratory and cardiovascular diseases. Reduction in GHGs also lowers the probability and severity of extreme weather events and negative environmental changes

caused/exacerbated by climate change and therefore water, food and vector borne diseases caused by these events.

Trade-offs

- **Poor indoor air quality from insufficient ventilation:** Conversely, energy-efficient buildings with tightly sealed envelopes and inadequate ventilations can result in indoor air stagnation and the buildup of pollutants and pathogens. Pollutants such as dust, mould, pet dander, and chemicals may develop or worsen respiratory diseases (Domingo and Rovira, 2020) which weaken the immune system, making individuals more susceptible to food-borne, water-borne, and vector-borne infectious diseases.
- **New breeding grounds from green infrastructure:** Improperly designed or maintained green infrastructure, such as poorly drained green roofs or stagnant water features, can create breeding grounds for disease vectors like mosquitoes and ticks, and water-borne diseases (due to lack of proper sewage system). Without adequate management, this can lead to increased transmission of vector-borne diseases. In addition, increased contact between humans and wildlife, such as birds, in green urban areas can raise the risk of zoonotic disease transmission.
- **Allergies and Respiratory Issues:** While green spaces can improve air quality, they may also introduce allergens, exacerbating allergies and respiratory conditions in susceptible individuals.

4.2.3 Tourism and Cultural heritage

In June 2010, the European Commission adopted a new political framework for tourism called "[Europe, the world's No. 1 tourist destination](#)" (EC, 2010). This framework aims to stimulate competitiveness, promote sustainable tourism, enhance Europe's image, and utilize EU financial policies. A regularly updated implementation plan outlines major initiatives to be carried out collaboratively with public authorities, tourism associations, and other stakeholders.

Among the five countries' policies analysed, Spain and Greece have a specific focus on tourism. [Greece's National Adaptation Strategy](#) includes measures to expand the tourist season, improve infrastructure related to water and energy to support tourism activities, and develop a plan to manage the displacement of the tourism seasonal period towards spring and autumn. It also emphasizes necessary investments in infrastructure and technologies to better address challenges such as high temperatures and water scarcity. [Spain's National Climate Change Adaptation Plan](#) suggests measures to diversify economic activities in tourist areas, such as shifting from ski tourism to mountain tourism, redistributing tourist flows to untapped inland destinations, and reducing the average length of stay to de-seasonalize sun and beach destinations. It also promotes alternative tourism models including gastronomical, sports, cultural, leisure, and rural tourism; other economic options such as agriculture; and sustainable tourist destinations.

Co-benefits

- **Reduced overcrowding:** Diversifying tourist activities, redistributing tourist flows to untapped destinations, and de-seasonalizing sun and beach destinations, as suggested in Spain's policy, can help reduce overcrowding in popular tourist spots and spread-out tourist flows throughout the year. This can lower the risk of infectious disease transmission due to overcrowded conditions during peak periods. Expanding the tourist season, as suggested in Greece's Strategy, can also distribute tourist flows more evenly throughout the year, reducing overcrowding during peak seasons. This can lower the risk of infectious disease transmission in crowded tourist destinations. In addition, smoother tourism flows allow for better management of public health measures and reduces the risk of disease outbreaks during high seasons.

- **Improved hygiene practices:** Promoting alternative tourism models such as gastronomic, sports, cultural, and rural tourism (suggested in Spain's policy) often involves smaller-scale, niche activities that can prioritize hygiene and safety. This can lead to better sanitation practices and reduced transmission of infectious diseases. In addition, infrastructure projects related to water and energy reserves, suggested in Greece's Strategy, can improve access to clean water and sanitation facilities in tourist areas. This promotes better hygiene practices and reduces the risk of waterborne diseases. Investments in technologies to address high temperatures and water scarcity can also enhance public health by reducing the risk of heat-related illnesses and waterborne diseases.
- **Improved economic stability and reduced short-term migration:** Extending the tourist season and redistributing tourist flow can provide more consistent income for businesses in tourist-dependent areas, reducing the need for seasonal layoffs and labour migration, which results in enhancing economic stability for local communities and reducing short-term migrations of workers.
- **Enhanced health services:** Investments in infrastructure for tourism can strengthen healthcare systems, providing better medical facilities and services for tourists and local communities. This improves the capacity to respond to infectious disease outbreaks and medical emergencies.

Trade-offs

- **Shift in disease patterns:** Redistributing tourist flows to new destinations may introduce infectious diseases to areas with lower immunity or less developed healthcare infrastructure. This can lead to outbreaks of diseases that were previously uncommon in those regions.
- **Reduced capacity in healthcare systems:** A surge in tourism at untapped destinations can strain local healthcare systems, which may be ill-equipped to handle sudden increases in tourist-related healthcare demands. An influx of tourists may overwhelm hospitals and clinics, leading to delays in treatment and the spread of infectious diseases if not managed properly.
- **Difficulty of detecting exotic tropical diseases in returning travellers:** Returning travellers can pose a significant challenge for the detection of exotic tropical diseases in their home countries due to several factors: lack of familiarity of healthcare providers with the symptoms of tropical diseases; similarity between the symptoms of some tropical diseases and the symptoms of common illness like the flu; the long incubation period of some tropical diseases; and the lack of specialized tests for tropical diseases.
- **Increased disease transmission:** Extending the tourist season, as suggested in Greece's policy, may increase the duration of exposure to infectious diseases for both tourists and local residents. This could lead to higher transmission rates of respiratory infections (thus increasing vulnerability to infectious diseases) and vector-borne diseases.
- **Environmental degradation:** Infrastructure projects implemented to support expansion of tourism activities may lead to environmental degradation, such as deforestation or water pollution, increasing the risk of infectious diseases. Changes in ecosystems can alter disease transmission patterns and introduce new pathogens into the environment.
- **Social unrest and displacement of local communities:** Large-scale infrastructure projects may displace local communities or disrupt traditional livelihoods, leading to social unrest and increased exposure and vulnerability to infectious diseases among affected populations.

4.2.4 Disaster Risk Reduction

The [EU Strategy on Adaptation to Climate Change](#) (EC, 2021a) enhances synergies between disaster risk reduction and climate change adaptation, focusing on water-related disaster risks and critical infrastructure. It also emphasizes disaster risk financing and integrates climate resilience into fiscal policies. Disaster prevention and preparedness are addressed at the EU level through the [Union Civil Protection Mechanism](#) (EU, 2013). Disaster Risk Management is integrated into key EU policy areas such as the [Floods Directive](#) (EC, 2007b), [Action on Water Scarcity and Drought](#), and [proposal for a directive on European critical infrastructure](#) (EC, 2020d).

The national adaptation policies of the five countries largely focus on flood risk reduction, followed by measures addressing heat, drought, and air pollution. [Greece's National Strategy for Adaptation](#) promotes building flood protection structures in areas near rivers or lakes, and water dams and dikes to regulate water runoff, limit erosion, reduce flooding, and protect infrastructures. It discourages development in erosion-prone coastal areas and suggests relocating buildings to safer locations if necessary. In response to air pollution, this strategy promotes installing air pollution monitoring systems to assess ozone and suspended particle levels and taking measures to reduce pollution exposure as well as encouraging individuals to avoid outdoor activities, keep windows closed, and exercise during times of lower pollution levels. The health sector is also advised to be prepared for increased cases during summer months and promote self-protection measures like seeking shade and staying hydrated. In [Spain's National Climate Change Adaptation Plan](#), priority is given to actions aimed at the recovery of natural morphology and dynamics of watercourses and the promotion of nature-based solutions to address flood risk. The plan recognized that such solutions also benefit other objectives such as ecosystem conservation, water quality protection, aquifer recharge, and ecological connectivity. In the [Netherlands' National Climate Adaptation Implementation Program](#), future building in floodplains is prohibited. It includes strengthening flood defences and a reassessment of areas around primary flood defences to be free of constructions. It also requires the volume for sand and coastal nourishments to be periodically adjusted to current sea level rise. In addition, this program includes developing heat maps for vulnerable people, neighbourhoods, and buildings, along with standards for building cooling. Similarly, Germany's Adaptation Action Plan requires the production of flood hazard maps for all water bodies to provide information on potential flooding, which should be updated every six years. This plan also promotes development of an integrated forecasting and early warning system for severe weather, particularly in relation to different target groups and users. Finally, [Sweden's National Board of Health and Welfare](#) (Swedish National Board of Health and Welfare, 2022) suggests that equipment and working methods may need to be adapted so that personnel do not risk being affected by negative health effects when working during, e.g., heat waves.

Co-benefits

- **Reduced waterborne diseases:** Flood protection measures such as strengthening flood defences (walls, dams, and dikes) as well as prohibiting building in floodplains can reduce exposure of population to floods and the risk of waterborne diseases caused by contaminated water during floods. These measures can also reduce the vulnerability of populations to flooding and erosion, thereby increasing their capacity for infectious disease risk reduction and protection.
- **Improved community health awareness:** Improving communication and raising awareness on individual protection actions after disasters such as floods and heatwaves can include messages on infectious diseases caused during extreme events and precautionary health measures to prevent them. These efforts can enhance community awareness about infectious diseases, leading to better prevention practices and early detection.

- **Reduced human exposure to the natural environment:** Discouraging development in flood-prone and erosion-prone coastal areas can protect natural habitats and reduce the exposure of humans to nature and thus the risk of diseases transmitted by vectors like mosquitoes breeding in stagnant water.
- **Vulnerability assessment and targeted health support:** Developing heat and flood maps for vulnerable populations and buildings allows for targeted interventions to protect those most at risk, improving public health and safety. Developing flood hazard maps can also increase public awareness of flood risks, helping communities and authorities understand vulnerability and plan appropriate flood risk reduction and preparedness measures.
- **Enhanced disaster preparedness:** Development of an integrated forecasting and early warning system for severe weather improves disaster preparedness, enabling timely response actions and reducing the impact of extreme events on communities. An effective early warning system can also help early preparation for infectious disease hazards that may be caused by extreme weather events (e.g., communicating precautionary measures for post-flood drinking water).
- **Worker health and safety:** Adapting premises, equipment, and working methods to mitigate negative health effects during extreme events like heatwaves improves worker safety and well-being, thereby reducing their exposure and vulnerability to infectious diseases.

Trade-offs

- **Disruption of ecosystems:** Construction of anti-flood barriers and retaining dams may disrupt ecosystems, altering habitats and potentially leading to ecological imbalances that could indirectly affect infectious disease dynamics.
- **Displacement and overcrowding:** Relocating communities to safer locations, if not planned properly, may lead to overcrowded living conditions, which can facilitate the spread of otherwise non-climate sensitive infectious diseases (McMichael, 2015).
- **Social displacement, mental health risks, and increased transmission and exposure:** Relocating communities to safer locations may lead to social disruption and health risks, including increased stress and mental health issues among displaced populations, increasing the vulnerability of these populations to a wider range of health issues including infectious diseases. Displacement measures may also lead to social conflict/unrest and economic challenges for businesses and residents. In addition, emergency evacuation and sheltering measures taken in response to extreme events results into sheltering large number of people in one place which can increase the transmission of and exposure to infectious diseases, particularly if the extreme event occurs during a pandemic.
- **Impact on livelihoods and economic situation of community:** Prohibiting construction in flood and erosion-prone coastal areas, especially in areas with limited land availability, could negatively impact livelihoods dependent on coastal activities, potentially leading to economic hardships that indirectly affect health outcomes.

4.2.5 Agriculture, Biodiversity, Forestry

The [EU Strategy on Adaptation to Climate Change](#) (EC, 2021a) focuses on sustainable water use for agriculture. Proposed adjustments to the [LULUCF regulation](#) (EU, 2018) aim to increase carbon capture in agriculture and forestry, while measures like maintaining grasslands, carbon farming, and peatland restoration help prevent soil erosion and reduce flood risk. Adaptation measures in agriculture are primarily supported through the [Common Agriculture Policy](#) (CAP), which emphasizes sustainability and climate action. The CAP

includes obligatory measures and funding opportunities for environmental protection, forest management, and eco-schemes.

The [EU Biodiversity Strategy to 2030](#) (EC, 2020c), part of the [European Green Deal](#) (EC, 2019) emphasizes nature-based solutions and recognizes the importance of [Natura 2000](#), established under the EU Birds and Habitats Directive, sites for climate adaptation. The proposed [Nature Restoration Law](#) (EC, 2022a) aims to ensure resilient ecosystems, habitats and species in the face of climate change threats, and to contribute to climate mitigation and adaptation as a key nature-based solution. The [EU Strategy on Green Infrastructure](#) (EC, 2013) promotes ecosystem-based approaches for adaptation.

The new [EU Forest Strategy for 2030](#) (EC, 2021b) aims to protect and restore forests, combat climate change and biodiversity loss. It focuses on effective monitoring, forest protection and restoration, incentives for forest owners, sustainable forest use and management, skills development, and planting 3 billion trees by 2030.

[Greece National Strategy for Climate Change Adaptation](#) includes measures to study the reaction mechanisms of animals to extreme temperatures (for example, food consumption, liver function, immune system response, mortality, infectious diseases, resistance to thermal stress), as well as their reproductive and productive capacity (for example, milk production, milk chemical composition, growth rate) and measures to deal with them. The [Swedish Agency for Agriculture's Adaptation Plan](#) (Swedish Board of Agriculture, 2022) promotes managing agricultural soil drainage to facilitate increased production and climate/environmental adaptation and increasing the establishment of wetlands and small water bodies for irrigation. Sweden's Forest and Forestry Adaptation Plan emphasizes the widening protection zones around moisture-dependent habitats, restoring wetlands to improve water supply for forest diversity during dry summers, and reducing large clearings (due to constructions) to mitigate harmful runoff. The [Netherlands' National Climate Adaptation Implementation Program](#) includes measures to stimulate sustainable soil management based on the National Agricultural Soils Program. This leads to vital soil that improves rainwater infiltration, retains moisture better, reduces crop drying during droughts, and replenishes groundwater. [Spain's National Climate Change Adaptation Plan](#) includes measures to assess the conservation status of habitat types locally considering climate change impacts, implement measures to mitigate non-climate pressures on habitat types and enhance their resilience, and improve knowledge of soil parameters to understand climate change impacts on forestry, hunting, and inland fisheries.

Co-benefits

- **Habitat protection and reduced exposure to infectious disease:** Creation of riparian buffer zones, and conservation and restoration of natural ecosystems can reduce habitat destruction and fragmentation, and limit human-wildlife interaction, reducing the transmission of zoonotic diseases.
- **Pathogen dilution and reduced risk of emerging infectious diseases:** Conservation and ecosystem re-stabilization measures can lead to healthy biodiverse ecosystems. In a diverse ecosystem, there are many different species of plants and animals, reducing the density of any single host species that a pathogen relies on for transmission (host-virus dilution). When a pathogen's primary host is less abundant or diluted among a wider range of species, the likelihood of the pathogen encountering a susceptible host decrease (Keesing and Ostfeld, 2021).
- **Reduced food-borne and water-borne diseases:** Sustainable soil management practices improve soil structure and fertility, leading to healthier soils that support better crop growth and resilience to diseases. In addition, soil conservation measures minimize erosion and prevent sedimentation in water bodies, which can contribute to waterborne diseases.

- **Resilient Ecosystems:** Improving habitat resilience, optimizing habitats for climate-sensitive and endangered species, and maintaining abiotic conditions can enhance ecosystem health, making them more resistant to disease outbreaks and climate-related stressors.
- **Improved water supply:** Wider protection zones around moisture-dependent environments and wetland restoration can enhance water supply during dry periods, benefiting water availability, improving hygiene practices, and preventing the consumption of low-quality water during these periods.

Trade-offs

- **Increased vector-borne diseases:** Enhanced ecosystems and vegetation and creating large areas for habitat and ecosystem may inadvertently provide breeding grounds for disease vectors such as mosquitoes, increasing the risk of vector-borne diseases.
- **Increased human activity:** Conservation measures may attract more human activity to these areas, leading to greater disturbance of wildlife habitats, human and wildlife interactions, and potential disease transmission between humans and wildlife.
- **Overuse of land and soil:** In some cases, efforts to improve soil management may lead to overuse of fertilizers or pesticides, which can have unintended environmental consequences and potentially contribute to pesticide resistance or water contamination.
- **Disruption of ecosystem balance:** Intensifying development measures to promote greater natural environment and ecosystems and create wider protection zones and restore wetlands may inadvertently disrupt existing ecosystem balances or lead to unintended consequences, such as invasive species encroachment or habitat degradation.
- **Land use conflicts:** Creating large areas for habitat protection and natural ecosystem development may conflict with other land uses, such as agriculture or urban development, leading to social and economic tensions.

4.2.6 Coastal areas, Marine & fisheries

The [EU Strategy on Adaptation to Climate Change](#) (EC, 2021a) strengthens ocean measurements and observations and promotes nature-based solutions. New funding initiatives like Horizon Europe will speed up adaptation efforts. The EU's sustainable blue economy approach, endorsed in May 2021, emphasizes renewable resource use, marine ecosystem preservation, pollution reduction, and climate resilience. Policies like the [Integrated Maritime Policy](#) (EC, 2007a) and the [Common Fisheries Policy](#) (EU, 2023) support sustainable management of marine resources and climate adaptation.

[Greece's National Adaptation Strategy](#) includes measures to examine the necessity of relocation, redesign and strengthening of breakwaters to protect ports and maritime transport infrastructure in general from larger waves and to examine the necessity of building dams-dykes for the protection of infrastructure at coastal airports from flooding. The [Spain's National Climate Change Adaptation Plan](#) focuses on restoration of natural coastal areas, such as beaches, dune systems and marshes and prioritizing adaptation projects based on the use of green infrastructure in the coastal areas. [Sweden's Sea and Water Authority Climate Action Plan](#) (Swedish Agency for Marine and Water Management, 2018) requires the Swedish Agency for Marine and Water Management to develop a knowledge base and measures regarding ocean acidification and evaluate its impact on fish health and spread of infection. The Agency is also required to adapt the fishing rules to the new climate and ensure that fish management and protected areas are based on the changed climate.

While the impacts of nature-based solutions and flood and sea level rise protection structures on infectious diseases are discussed in previous sections, here we focus solely on the impacts of measures related to ocean acidification and fisheries.

Co-benefits

- **Reduced infectious disease transmission:** Developing measures for reducing ocean acidification can indirectly benefit human health by preserving marine ecosystems, which play a role in regulating disease transmission. The infectious disease via ocean acidification can be water-borne diseases (via changes in microbial communities impacting distribution of waterborne pathogens), food borne (via seafood), and vector-borne (via the impact of ocean acidification on coral reefs and biodiversity).
- **Increased fish health:** Evaluating risks for impacts on fish health and the spread of infection can lead to improved management practices in aquaculture and wild fisheries, reducing the risk of zoonotic disease transmission caused by seafood.

Trade-offs

- **Ecosystem disruption:** Measures to address ocean acidification may inadvertently disrupt marine ecosystems, potentially altering disease dynamics among marine species and affecting human health through changes in seafood safety and availability. In addition, adapting fishing rules and management strategies to address ocean acidification and climate change may have unforeseen consequences for infectious diseases. For instance, altering fishing practices or establishing new protected areas could inadvertently create conditions that favour the spread of certain pathogens or disrupt disease regulation mechanisms in marine ecosystems.
- **Shifts in human exposure risks:** Changes in fish health and distribution resulting from adaptation measures may affect human exposure to waterborne or foodborne pathogens. Consuming fish from altered ecosystems or with compromised health status may increase the risk of foodborne illnesses or zoonotic infections.

4.2.7 Energy

The [European Climate Law](#) (EU, 2021b) legally binds the EU to achieve climate neutrality by 2050 for the first time. It introduces the concept of carbon budgets, setting limits on the total amount of greenhouse gases that can be emitted over specific periods to ensure a steady reduction trajectory. It also defines the rules to monitor and assess the progress of the Union and the national measures and acknowledges the need to provide support for workers and vulnerable population that may be disproportionately affected by the transition. The latter may include reskilling and upskilling programs, as well as investment in new economic activities to replace declining industries. Member States are encouraged to develop and implement fair and inclusive transition plans that address social and economic vulnerabilities associated with the climate transition.

Although the 2020 [European Green Deal](#) (EC, 2019) is expected to substantially decarbonize the EU energy sector, the [EU Strategy on Adaptation to Climate Change](#) (EC, 2021a) lacks a specific section on energy but includes relevant recommendations. For instance, it suggests actions for water management adaptation and integrating adaptation strategies within energy governance. The energy sector is indirectly addressed in various EU and national policies related to land use, buildings (energy efficiency), water management, and agriculture.

Co-benefits

- **Reduced extreme weather events:** Efforts to reduce greenhouse gas emissions such as energy efficiency, renewable energy, and decarbonization efforts can limit climate change, thereby reducing the probability and severity of extreme weather events, and

therefore, infectious diseases spread by such events. Better air quality (as a result of the transition to cleaner energy) may also lead to a reduction in respiratory illnesses and certain infectious diseases.

- **Reducing general vulnerability and exposure:** Reducing extreme events can reduce vulnerability and exposure caused or exacerbated by such events among humans and ecosystems, improving vulnerability to infectious diseases.

Trade-offs

- **Human migration pattern:** Energy policies can also influence human migration and displacement patterns. Forced migrations due to environmental changes (such as economic shift, unemployment, and job displacement) may lead to overcrowded living conditions, which can facilitate the spread of infectious diseases.
- **Socio-economic inequality:** Certain energy policies, if not implemented with a focus on social equity, could disproportionately affect vulnerable populations. For example, policies that increase energy costs might disproportionately burden low-income communities, potentially impacting their access to healthcare resources and ability to cope with infectious diseases.
- **Inadvertent impact on transmission of infectious disease:** While decarbonization and promoting renewable energy can reduce the extreme weather events, they may also lead to changes in temperature, precipitation patterns, and land use, altering the geographic range of disease-carrying vectors (e.g., mosquitoes carrying diseases like malaria or Zika virus) and affecting the spread of infectious diseases. Large-scale land use changes can also impact ecosystems, potentially affecting the prevalence of vector-borne diseases transmitted between animals and humans.

4.2.8 Health

European level health policy coordinates transboundary activities, enhancing preparedness and response to health threats, including those linked to climate change. The [European Climate and Health Observatory](#) was launched as part of this effort to track and prevent climate change's impacts on human health. The [European Green Deal](#) (EC, 2019) and the [8th Environment Action Program](#) (EU, 2022a) emphasize tackling climate-related challenges and strengthening links between environmental and health policies. The [EU4Health vision \(2021-2027\)](#) (EU, 2021a) aims to strengthen health security, including addressing climate change's negative impacts. The [European Health Union](#) (EC, 2020b) intends to improve coordination against cross-border threats, including those related to the environment and climate.

In plant health, the [Regulation on protective measures against plant pests](#) (EU, 2016b) aims to mitigate climate change impacts on crops and forests. Similarly, the [Regulation on transmissible animal diseases](#) (EU, 2016a) supports early detection and control of diseases, including those influenced by climate change. The One Health approach emphasizes the interconnectedness of human, animal, and environmental health, pooling data, tools, and expertise to prevent climate change effects on human health. It ensures a comprehensive approach involving all relevant sectors and disciplines.

[Sweden's National Board of Health and Welfare](#) proposes developing indicators and monitoring the effects of climate change impacts such as increasing temperature and adaptation measures on morbidity as well as raising awareness and communication about impacts of climate change on health and improving collaboration between health and other sectors. In the [Netherlands' National Adaptation Strategy](#), health and active living are emphasized, along with initiatives under "heat-resistant cities" to improve the physical living environment and protect vulnerable populations from heat. Additionally, there's a focus on reducing disease burden from allergies and strengthening zoonoses policy. [Greece's National Strategy](#) includes actions to address the health of livestock during extreme temperatures,

training and informing patients about self-protection measures, monitoring air pollution and infectious diseases, and tracking allergen levels. [Germany's Adaptation Action Plan](#) involves protecting health through various measures such as water reuse, hazard maps, and safety measures against work-related hazards like heat. There is an emphasis on training health sector professionals, education, and monitoring activities for disease vectors, allergens, and the impacts of climate change on the health system. Information is also provided to local authorities for local adaptation.

All climate-related measures to improve health have co-benefits for reducing infectious diseases transmission, exposure, and/or vulnerability.

Co-Benefits

- **Enhanced preparedness:** Strengthening coordination and response to health threats in general can improve preparedness against infectious diseases too, including those exacerbated by climate change.
- **Improved surveillance:** Initiatives like the European Climate and Health Observatory can enhance disease surveillance, aiding in early detection and response to infectious disease outbreaks.
- **Healthier environments:** Efforts to mitigate climate change can lead to cleaner air and water, reducing the transmission of infectious diseases like respiratory infections and waterborne diseases. In addition, the focus on health as a part of climate change adaptation can lead to initiatives promoting healthier lifestyles and habitats, reducing the spread of diseases.
- **Reduced vulnerability:** Improving human health reduces pressure on the public health system and infrastructure and on the vulnerable population with underlying health conditions.

Trade-offs

- **Diversion of resources from more pressing needs:** Resources and attention might be diverted from other pressing health issues to address climate change impacts, potentially leading to neglect of routine healthcare services and infectious disease control. Increased funding for climate-related health initiatives may reduce the budget available for controlling existing infectious diseases, compromising surveillance and response efforts.

Table 1 Summary of potential co-benefits and trade-offs of climate policies on infectious disease outcomes (ID = infectious disease)

Adaptation Measure/Intervention		Co-benefits (positive impacts)	Trade-offs (negative impacts)
water management	improving water supply management	Reduced water-borne diseases by improving water quality (ID transmission)	Contaminated water storage/harvesting system leading to water-borne diseases (ID transmission and exposure) Inadequate implementation of water quality monitoring leading to an outbreak of water-borne diseases (ID transmission) Ecological disruption due to the construction of dams, create ecological continuity, and renaturation of watercourses and floodplains leading to changes in disease vectors (ID transmission and exposure)
	improving and monitoring water quality	Reduced impacts of drought and flood on access to clean water (ID exposure)	
	raising awareness and information sharing	Behaviour change by raising awareness on water quality and hygiene (ID transmission & exposure)	
	improving resilience of water resources to extreme weather events	Enhanced ecosystem health by managing/protecting natural water and ecosystems (ID transmission)	
Building, urban, and land use planning	buildings' energy performance	Stormwater and flood management through urban green infrastructure (ID exposure and transmission)	Increased vector-borne diseases caused by green and blue infrastructure (ID transmission and exposure) Allergies and respiratory issues caused by increased green spaces (ID vulnerability) Poor indoor air quality due to insufficient ventilation in energy-efficient buildings (ID transmission and exposure)
	improving the resilience of buildings against extreme weather	Heat management through NBS and urban/building cooling solutions (ID transmission and vulnerability)	
	NBS in buildings	Improved indoor and outdoor air quality through NBS and building ventilation (ID transmission and vulnerability)	
	NBS in cities	Enhanced mental health and physical activity because of increased outdoor green spaces (ID vulnerability) Reduced greenhouse gas emissions (ID transmission and exposure)	
Tourism	Expanding tourism seasons and destinations	Reduced overcrowding (ID exposure and vulnerability)	Shift in Disease Patterns due to redistribution of tourists to new locations (ID exposure) Reduced Capacity in Healthcare Systems (ID vulnerability) Increased Disease Transmission due to extending tourism duration (ID exposure) Difficulty of detecting exotic tropical diseases in returning travellers (ID exposure and vulnerability) Environmental Degradation due to new constructions (ID transmission) Social Unrest and Displacement of Local Communities (ID vulnerability)
	improving required infrastructures and resources for tourists	Improved hygiene practice (ID transmission and vulnerability)	
	introducing alternative tourism models in new locations	Improved economic stability and reduced short-term migrations (ID vulnerability and exposure)	
	improving the resilience of the tourism sector against the impacts of climate change	Enhanced health services (ID vulnerability)	
Disaster Risk Reduction	Flood risk reduction measures	Reduced Waterborne Diseases due to flood risk reduction measures (ID transmission and exposure)	Disruption of Ecosystems due to anti-flood constructions (ID transmission) Displacement and overcrowding (ID exposure) Social displacement and mental
	Heat risk reduction measures	Improved Community Health Awareness (ID exposure and vulnerability)	

	Air pollution risk reduction through increasing NBS and ventilation Raising awareness among communities on disaster protection measures Improving weather forecasting, early warning systems	Reduced human exposure to the natural environment as a result of limiting construction on flood plains (ID exposure) Vulnerability Assessment and targeted health support (ID vulnerability) Enhanced Disaster Preparedness (ID exposure and vulnerability) Worker Health and Safety (ID exposure and vulnerability)	health risks due to relocation measures (ID vulnerability) Impact on Livelihoods and economic situation of community (ID vulnerability)
Agriculture, biodiversity, and Forestry	Improving the resilience of animals to extreme events and changing climate Improving irrigation systems Improving soil productivity, protecting biodiversity	Habitat protection and reduced exposure to infectious disease due to the preservation and restoration of natural ecosystems (ID exposure) Pathogen dilution and reduced risk of emerging infectious diseases (ID transmission) Reduced food-borne and water-borne diseases (ID transmission) Resilient Ecosystems (ID transmission and vulnerability) Improved water supply (ID transmission and exposure)	Increased vector-borne diseases due to enhanced ecosystem and vegetation (ID transmission) Increased Human Activity in conversation areas (ID vulnerability) Overuse of land and soil (ID transmission and exposure) Disruption of Ecosystem Balance (ID transmission and exposure) Land Use Conflicts (ID vulnerability)
Coastal areas, marine, and fisheries	Protecting coastal areas from over-construction and flood Preserving marine systems Reducing ocean acidification Adopting fishing rules to the new climate and improving fish health	Reduced infectious disease transmission caused by ocean acidification (ID transmission) Increased Fish Health (ID transmission)	Ecosystem Disruption due to measures to reduce ocean acidification and improve fishery (ID transmission) Shifts in Human Exposure Risks due to changes in fishery, increasing NBS and changes in natural coastal areas and marine systems (ID exposure)
Energy	Decarbonization measures	Reduced extreme weather events (ID transmission and exposure) Reducing general vulnerability and exposure caused/exacerbated by extreme events (ID vulnerability and exposure)	Human migration pattern (ID exposure) Socio-economic inequality (ID Vulnerability) Inadvertent impact on transmission of infectious disease (ID transmission)
Health	Multiple measures to enhance healthcare capacity and health-related research and knowledge	Enhanced preparedness (ID vulnerability) Improved Surveillance (ID transmission and exposure) Healthier Environment (ID transmission, exposure, and vulnerability) Reduced Vulnerability (ID vulnerability)	Diversion of resources from more pressing needs (ID vulnerability)

5 Discussion and conclusions

Our analysis shows that climate policies generally do not consider the direct or indirect impact of climate change adaptation or mitigation measures on infectious diseases. Typically, infectious diseases are recognized in policies as one of the main negative health impacts of climate change on societies and ecosystems, due to alterations in climate variables and the natural environment. These policies emphasize health-related interventions such as enhancing research, monitoring, and early warning and disease surveillance systems for infectious diseases, and increasing health capacity for the response phase. However, there is

little, if any, mention of the negative or positive impacts that climate adaptation and mitigation measures, interventions, strategies, and approaches may have on infectious diseases.

Our sectorial analysis of European and national level policies indicates that **nature-based solutions** are a cross-cutting theme being adopted and promoted in almost all sectorial policies. Despite the adaptation, mitigation, and health co-benefits, nature-based solutions can facilitate the spread of vector-borne and food-borne diseases as well as zoonotic diseases, leading to unintended consequences for transmission and exposure of infectious diseases (Sharifi et al., 2021). Nature-based solutions have the potential to induce health risks by hosting infectious pathogens and contributing to the spread of vector-borne, water-borne, and food-borne diseases. For example, in urban areas a connected network of green elements may increase the spread of infectious diseases by allowing for the movement and presence of rats and ticks, or blue elements such as lakes, streams, wetlands, and other types of water bodies may increase the presence of mosquitoes and lead to harmful algal blooms (Sharifi et al., 2021). The climate measures promoted in the policies range from natural measures to protect communities against floods and reduce heat and air pollution in cities and buildings, to measures aimed at protecting water resources, agriculture, and biodiversity from the impacts of climate change, as well as green measures to enhance physical and mental health. While there are growing efforts in policy and practice to promote and increase investments in nature-based solutions as a cross-cutting solution for multi-hazard and adaptation-mitigation challenges, it is important to recognize their potential trade-offs on health, particularly at the policy level, before implementing them in practice.

Measures to enhance **food and water security** can have significant co-benefits for preventing infectious disease risks. Policies causing changes in food production and diets (shifting towards plant-based diets and reducing meat consumption) can reduce emissions from livestock production while reducing the potential for exposure to food-borne diseases. Relying less on meat, including non-domesticated meat and animal products, will decrease direct human contact with these (potentially affected) animals and limit food contamination from the improper preparation or storage of meat. In addition, European and national policies place significant focus on improving the quality and quantity of water resources, as well as enhancing access to clean drinking water. Managing water resources effectively, including sanitation practices and water quality monitoring, can help prevent waterborne diseases and reduce the spread of infectious diseases linked to water sources affected by climate change. Improved access to clean water and awareness about water quality can also reduce exposure to polluted water during floods and droughts.

Mitigation measures focused on **agriculture, forestry, and other land use** are also closely linked to infectious disease outcomes as they affect biodiversity and ecosystems. While expansion of natural spaces may increase transmission of infectious diseases, maintaining forests as carbon sinks can help to prevent the emergence of *novel* zoonotic diseases and reduce the risk of vector-borne disease transmission. Climate adaptation policies promoting the protection and restoration of ecosystems, notably forest protection, indigenous peoples' land tenure, temperate forest restoration, tropical forest restoration, grassland protection, and peatland protection and rewetting are known to reduce risks of emerging infectious disease, as well as reduce exposure to environmental extremes and improve water quality (Mailloux et al., 2021). In addition, mitigation measures that focus on conserving and restoring natural ecosystems, such as forests and wetlands, can also help control vector habitats, reduce the risk of vector-borne diseases, and reduce exposure to infectious diseases by controlling human-environment interactions. By conserving, protecting and restoring wild habitats, healthier ecosystems can provide many services, including reduced disease spill-over (IPCC, 2023).

Policies on **tourism** are among those that, if not well designed and implemented, may have significant negative impacts on all three aspects of transmission, exposure, and vulnerability

to infectious diseases. Particularly, policies on expanding tourist seasons and diversifying tourist activities may result in overcrowding and redistributing tourists to new areas, introducing infectious diseases to regions with less developed healthcare. They can also add pressure to the local health, food, and water systems.

Inherently, all policies and measures taken to adapt the **health sector** to climate change by promoting community health and climate-resilient health systems have co-benefits for infectious disease. Health sector adaptation measures focus on primary prevention - reduction of exposure to infection, or secondary prevention - health care (Confalonieri et al., 2015). Adaptation efforts that invest in improving health infrastructure, surveillance, and response capabilities can strengthen health systems by enhancing the capacity to prevent, detect, and manage outbreaks of infectious diseases. Strengthening the health system is important for responding to the direct health impacts resulting from extreme weather events such as storms, floods, droughts, and heatwaves, however, adaptation is needed in other sectors too (Watts et al., 2015).

Similarly, adaptation measures implemented in any sector to **decrease human vulnerability** have co-benefits for human health and infectious disease. Enhancing social capital by organizing a network of resources and strengthening social linkages can help to reduce vulnerability and increase community resilience (Confalonieri et al., 2015). Adaptation strategies that address social determinants by tackling the social, demographic, and economic drivers of infectious disease vulnerability can have co-benefits for reducing vulnerability to infectious disease.

The knowledge generated in this report will feed into the process of developing a decision support tool that enables decision makers to understand the impact that their climate policies and selection of mitigation and adaptation measures can have on the transmission of infectious disease, human exposure, or human vulnerability to infectious disease (final deliverable of IDAAlert Task 2 in Work Package 2).

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Appendices

Table A1 Factors influencing climate change and infectious disease risk (selected examples)

	Hazard	Exposure	Vulnerability
Climate <i>with impact on infectious disease</i>	Extreme weather events: floods, storms, heatwaves, wildfires Slow onset events: increasing temperature, drought, sea level rise, warming oceans, increasing coastal water salinity, ocean acidification, changes in precipitation and humidity, glacial retreat, extended hot seasons	Land cover and land use (change) Urbanization Global mobility (trade, travel, tourism) Population displacement Residential and occupational exposure to extreme events	General vulnerability: Population demographic composition Level of economic development Socio-economic inequality Capacity of health sector, access to and quality of healthcare Population health status, including underlying health conditions
Infectious disease <i>affected by climate</i>	Geographic expansion (and contraction) of vectors and pathogens Increase in number of native vectors and pathogens Emergence of invasive vector species Emergence of new pathogens Evolution of more pathogenic strains	Residential and occupational exposure to vectors due to the expansion of hazard zones and expansion (and contraction) of infectious disease Deforestation, mining, and dams Ecosystem degradation/change Contamination of water treatment and distribution systems Exposure to flood water contaminated with pathogens Exposure to food contaminated with pathogens Food preparation and storage	Climate-specific vulnerability: Awareness and access to disaster risk reduction, protection, preparedness, response, and recovery measures Infectious disease-specific vulnerability: Availability and adequacy of infectious disease protection measures (e.g., repellent, window screens, air conditioning) Baseline incidence of disease

Table A2 Observed and projected changes for infectious diseases, extracted from EUCRA chapter 14 (Dasgupta et al., 2024) and updated by IDAAlert consortium members

Disease	Status in Europe
Dengue	- Climate in Southern Europe is increasingly suitable for mosquitoes to transmit tropical diseases - Central and Eastern Europe observe strong trends of new emergence of the (<i>Aedes albopictus</i>) capable of transmitting dengue - Dengue has been on the rise in recent decades due to travel, trade, urbanisation and climate change, and dengue is estimated to lead to around 100 million symptomatic infections a year. - Southern Europe is becoming increasingly warm enough for longer periods of the year for <i>Aedes albopictus</i> to transmit dengue virus. - Floods and heavy rainfall can result in standing water where mosquitoes can quickly reproduce and then transmit diseases like Zika, malaria and dengue. - Droughts can lead to water storage in temporary/artificial containers. If not covered/well maintained can lead to additional mosquito breeding sites (Lowe et al., 2018) Projected changes: “the potential length of the dengue transmission season could increase by about 1- 2 months by 2080 over south-eastern Europe, leading to an additional population at risk of about 150-250 million, depending on the emission scenario . Such future changes mostly occur at low altitudes (<500m).”
Malaria	- Changes in land use and agricultural practices can sometimes enable disease vectors to proliferate (Perring et al., 2016). For example, <i>An. labranchiae</i> is found in rice paddies, and this mosquito is competent to transmit malaria Projected changes in EUCRA: “moderate increase in the length of malaria transmission season (1-2 months) is simulated over south-eastern Europe by the 2080s over low population density areas. Such changes could lead to an additional population at risk of 200-250 million (Colón-González et al., 2021). However, there are large uncertainties depending on the selected malaria model, the emission-population scenario and the climate model considered. A systematic review estimates that the malaria transmission season could be extended by 6 months over southern Europe in future (Fischer et al., 2011).”
Chikungunya	- Southern Europe is increasingly warm enough for mosquitoes to transmit tropical diseases - Central and Easter Europe observe strong trends of new emergence of the tiger mosquito capable of transmitting Chikungunya - Large insecticide campaigns eradicated <i>Aedes aegypti</i> mosquitoes after World War II, but it is now established on eastern coasts of the Black Sea and in north-eastern Turkey Projected changes: “temperature projections under climate change scenarios for Europe indicate a moderate increase in the climatic suitability, particularly in central Europe, especially over France and Italy and areas surrounding the Rhine and Rhone rivers, but a decline in northern Italy near the Adriatic coast (Tjaden et al., 2017).”
Tick-borne diseases	Three tick-borne pathogens are of concern in Europe: tick-borne encephalitis (TBE), which can cause life-threatening swelling of the brain and lingering neurological problems, and Lyme disease (neuroborreliosis), which can have lasting debilitating effects, and Crimean Congo Haemorrhagic fever transmitted primarily by the

	more southern European prevalent tick <i>Hymaloma Marginatum</i> (listed as one of the WHO top 10 priority diseases) • Tick-borne diseases are most common in northern and central Europe, are on the rise as climate change favours tick survival and development (Daalen et al., 2024). • Ticks may survive on their hosts during mild winters, and early spring can accelerate tick development • High incidence of both Lyme borreliosis and tick-borne encephalitis is correlated with mild winters and warm, humid summers • Temperature-related range expansion of certain vector-borne diseases such as Lyme disease already occurs and is projected to continue • Projected changes: “Lyme disease risk in future shows a nonlinear response to the emission-population scenario. Under SSP1-RCP2.6, a reduced risk in Lyme disease is estimated, while the largest risk increase is simulated over northern Europe under a 2.4°C global warming level. Future droughts and conversion of forests to agriculture might limit the risk over southern Europe (Li et al., forthcoming).”
Campylobacter	• More frequent and severe floods and droughts are increasingly favouring the spread of water- and foodborne diseases • Floods can contaminate water sources and distribution systems, too, and lead to waterborne disease outbreaks • Warming has been linked with elevated incidence of campylobacteriosis outbreaks in various European countries • <i>Campylobacter</i> is the most reported cause of human bacterial gastroenteritis throughout the EU
Salmonella	• More frequent and severe floods and droughts are increasingly favouring the spread of water- and foodborne diseases • Floods can contaminate water sources and distribution systems, too, and lead to waterborne disease outbreaks • Foodborne disease outbreaks led to the highest numbers of cases when they occurred in schools or kindergartens, and caused a disproportionate number of deaths when they occurred in healthcare and residential facilities • <i>Salmonella</i> is climate sensitive, too, and grows in a narrow temperature envelope, with more frequent infections in the summer months in Europe • The incidence of human <i>Salmonella</i> infections is higher in summer than in winter and is thus highly seasonal • Projected changes: “Microbial foodborne illness is typically a seasonal phenomenon. Therefore, if summers are longer and hotter, anticipate an increase in illnesses from bacteria such as <i>Salmonella</i> is anticipated.”
Leptospirosis	• More frequent and severe floods increase the risk of leptospirosis • Contamination of floodwater with pathogens such as leptospirosis can cause population exposure to pathogens and then trigger a leptospirosis outbreak
Vibrio	• Warming oceans may accelerate the replication of pathogenic bacteria • Marine bacteria, like <i>Vibrio</i>, thrive under elevated sea surface temperature and low salinity, such as is found in the Baltic Sea
West Nile Virus	• Most infections in Europe occurring in the summer and early autumn • Temperature strongly predicts the <i>Culex</i> mosquitoes' ability to transmit WNV virus

	• Rainfall can also affect WNV transmission by enabling mosquitoes to proliferate • Recent outbreaks, however, are likely to be related to drought conditions that led birds carrying WNV and mosquitoes to concentrate around water bodies, leading to more contacts. Infected birds may also have travelled farther during the drought searching for water and food • Limited water resources can prompt mosquitoes and birds to gather around water bodies, increasing the chances of disease transmission and spreading the prevalence of WNV. • Projected changes: “climate change projections predict an expansion of areas affected by WNV, particularly in western Europe (Farooq et al., 2022). In the medium term (2050s), the risk of WNV transmission is simulated to increase mostly over south-eastern Europe, north-eastern Italy and south-eastern France (Semenza et al., 2016).”
Rift Valley Fever	• Zoonotic vector-borne disease transmitted by different <i>Culex</i> and <i>Aedes</i> mosquitoes • Epidemics are characterised by a storm of abortions in livestock with large economic impacts. Humans can be infected by mosquito bites, but more often by contact with viraemic animal materials (blood, meat, foetus). • The risk of RVF introduction into the EU through movement of infected animals is low, given strict veterinary and health safety policies on animal imports
Leishmaniasis	• Projected changes: “The development of <i>Leishmania</i> parasites into the infectious form in the sandfly vector is accelerated by ambient temperature. It extends the infectious period in the vector’s life cycle. Sandfly vectors can occupy new ecological niches if the long-term temperature and precipitation constraints become more suitable. Projecting the climatic conditions, from where the vectors are at present, forward in time under climate change scenarios and taking landscape features into account can delineate the vector’s expansion (Fischer et al., 2011; Koch et al., 2017; Chalhaf et al., 2018; Erguler et al., 2019). For example, <i>P. ariasi</i> is currently restricted to south-western Europe but is projected to expand eastwards towards western Germany and western Switzerland by 2040. By 2100, <i>P. ariasi</i> is projected to reach south-eastern Germany and eastern and north-eastern Austria (Farooq et al., 2022).”

Table A3 Overview of factors influencing infectious disease transmission in Europe (information extracted from Overview of the key climate-, weather- and flooding-sensitive infectious diseases in Europe table in (EEA, 2022b))

Disease	Climate factor	Mode of transmission	Prevention
Chikungunya	Higher temperatures Heavy precipitation Extended warm season	Mosquito Substance of human origin (SOHO)	Individual protection against mosquito bites; vector control.
Dengue	Higher temperatures Heavy precipitation Extended warm season Drought	Mosquito SOHO	Individual protection against mosquito bites; vector control; limited vaccine use.
Tick-borne encephalitis	Higher temperatures Heavy precipitation Extended warm season	Tick Food	Vaccines; avoidance of tick-infested areas individual protection against ticks; pasteurisation of milk.
West Nile fever	Higher temperatures Heavy precipitation Extended warm season Drought	Mosquito SOHO	Individual protection against mosquito bites; vector control; virus surveillance in other vertebrate hosts and vectors; testing for viral agents in the blood of organ donors.
Campylobacteriosis	Higher temperatures Heavy precipitation	Animals Food Bathing water	Vaccine; clean drinking water; enhanced biosecurity; improved sanitary conditions.
Legionnaires' disease	Higher temperatures Heavy precipitation Extended warm season Drought	Water	High flow in hot- and cold-water systems; control of rainwater harvesting systems; drinking water quality; biofilm prevention.
Leptospirosis	Higher temperatures Heavy precipitation Flooding	Animals Food Bathing water Water	Flood risk reduction; rodent control; protective clothing; avoidance of swimming and wading in contaminated waters; avoidance of contact with infected animals.
Lyme disease	Higher temperatures Extended warm season	Tick	Avoidance of tick-infested areas; individual protection against tick bites.
Salmonellosis	Higher temperatures	Animals Food Water	Control measures for food-producing animals; good hygiene practices around animals and food.
Shigellosis	Higher temperatures Heavy precipitation Flooding	Food Water Human contact	Good hygiene practices to prevent faecal-oral transmission.

STEC/VTEC (toxin-producing Escherichia coli)	Heatwaves Flooding	Food Water Animals	Good hygiene in household and premises dealing with animals. Adequate cooking of food. Milk pasteurisation, avoiding cross-contamination.
Vibriosis	Higher temperatures Heatwaves	Food Bathing water	Avoidance of raw or undercooked seafood; avoidance of swimming in salt- or brackish water with wounds.
Cryptosporidiosis	Higher temperatures Heavy precipitation Flooding Drought	Food Water Animals Bathing water	Vaccination programmes; protective technologies; improved sanitary conditions.
Giardiasis	Higher temperatures Heavy precipitation Flooding	Food Water Animals Human contact Bathing water	Good hand hygiene; avoidance of contaminated food and water; good hygiene.
Malaria	Higher temperatures Heavy precipitation Extended warm season	Mosquito Organ, blood donor	Individual protection against mosquito bites; vector control; prophylactic drugs; limited vaccine use.

Table A4

Table A4 European relevant examples from the IPCC of adaptation measures to reduce risks of climate change impact on water- and vector-borne diseases (adapted from IPCC AR6 WG2 Figure Cross-Chapter Box ILLNESS.1 (IPCC, 2023)) and how they influence infectious disease transmission in Europe

Types of measures	Examples of measures to reduce exposure and vulnerability
Warning and surveillance systems	Pathogen surveillance, seasonal, and dynamic forecasts of disease outbreaks with risk mapping, and early warning systems target at the appropriate scale
Diagnostic abilities	Technological and lab capacity and personnel trained to rapidly diagnose and raise case awareness, near real-time case reporting for efficient response and resource mobilization, and adequate public health and medical resources
Infrastructure	Urban forests and green spaces with vector control integrated in the design, improved and maintained drinking water and sewage/drainage systems, and high-quality homes that prevent vectors from entering
Capacity building	Health and environmental officials trained on newly emerging diseases, public awareness of health risks from pathogens and vectors, and robust healthcare systems and facilities
Public policy	Public health programs for disease/vector eradication, and vaccination campaigns
Nature-based solutions	Managed habitat restoration: Habitats restored and conserved, habitat fragmentation decreased and human proximity to risky environments limited, and ecosystem-based management to regulate pathogen and vector populations
Changes in practices	Diets diversified and more resilient food systems created

Box A1 Mapping the climate adaptation policy landscape in case study countries

All EU member states have a dedicated adaptation policy in place since 2019 (Leitner et al., 2023). In some countries, climate laws are playing a role in institutionalising national adaptation policies and embedding adaptation strategies and plans in binding regulatory frameworks, however, adaptation strategies and plans remain soft, non-binding policies in most countries. The adopted policy instruments addressing climate change adaptation reflect each country's specific (national) circumstances in terms of governance structure and institutional frameworks (EEA, 2022a). This is reflected in each of the case study countries climate adaptation policy.

Germany

Germany's first overarching strategy focused on reducing GHG emissions was called the National Climate Protection Programme, released in 2000. This plan primarily dealt with mitigation measures, and lacked adaptation methods.

In 2008, Germany focused on adaptation planning through the [German Strategy for Adaptation to Climate Change](#), which created a national framework for increasing climate resilience and provided the basis for climate adaptation policy in Germany. Since 2008, once every five years, the government publishes Progress Reports on the Adaptation plan. [The Adaptation Action Plan III](#), for instance, the main document analysed in this review, outlines measures that the federal government will or has been implementing in the years 2020 to 2024 to adapt to climate change.

In mid-2023, the German government adopted the [Climate Adaptation Law](#), which creates the first strategic framework for climate adaptation in Germany. The framework is aimed at integrating climate adaptation at all levels of government. Although the plan requires action plans to be drawn up based on local threats of climate change, an updated federal climate adaptation strategy with measurable targets will also be developed.

Greece

Greece established a National Climate Change Program in 2002, which was an early high-level strategy that outlined actions across sectors to mitigate GHG. These sectors included energy, industry, and transport. The 2002 program did not demand that a national adaptation strategy be developed.

The first official mandate for a national climate adaptation plan appeared in Greece in 2016. This law specifically called for a [National Strategy for Adaptation for Climate Change](#) for Greece. This national strategy is the main document that was included in the analysis for Greece, and it identifies priorities across sectors such as water management, biodiversity, as well as civil engagement and public awareness. However, this strategy is currently under review to address criticisms that it lacked specific adaptation actions and was too broad.

Recently, there were further developments in Greece's climate laws. The [National Climate Law](#) was implemented in 2022 and sets binding targets to achieve climate neutrality by 2050, and it calls for an updated National Climate Change Adaptation Plan by 2023. However, as of April 2024, the Greek government has not officially released or published the updated document yet.

The Netherlands

The Netherlands adopted its first dedicated national climate law in 1992. As early pioneers in the climate sphere, the Netherlands continues to set ambitious goals on climate change. Given the Netherlands's high vulnerability to climate change impacts like sea level rise and extreme rainfall, the country has a long history of adapting to rising climate risks. For instance, the [Delta Programme](#) was created in 2008, focusing on flood risk management and fresh water supply. This programme laid the foundations for climate adaptation planning in the Netherlands.

In 2016, the Netherlands published its first overarching [National Climate Adaptation Strategy](#), which lists the impacts of climate change on sectors such as agriculture, health, and infrastructure. The plan outlined the strategic vision and key priorities for adaptation such as flooding, drought, and heat stress.

The Netherlands developed a [National Climate Agreement](#) in 2019, which set targets to reduce GHG emissions by 49% by 2030 and 95% by 2050. This Agreement provides the basis for climate laws

within the countries, including the [Climate Act \(2019\)](#) that broadly outlines the government's view on climate and energy, and regulates government climate plans on how targets will be met. The Act also cemented adaptation as a required element of all future policymaking.

Recently, in 2023, the [National Climate Adaptation Implementation Programme](#) was launched. It operationalises the priorities and objectives laid out in the 2016 Strategy, outlining specific programs and measures for 2023-2027. The 2023 Programme is the main document analysed in this review, as it is a key instrument to implement and provide the financial resources for the adaptation of the 2016 Plan, the Delta Programme and Climate Act.

Spain

In May 2021, Spain approved Law [7/2021 on Climate Change and Energy Transition](#). This law outlines the actions to be taken across Spain to meet the objectives of the 2015 Paris Agreement to reach climate neutrality by 2050 at the latest. These actions include setting Greenhouse Gas (GHG) emission goals for 2030 and 2050; generating of electricity from renewable sources; promoting zero-emission mobility and transportation; mobilising resources to finance the energy transition; among others. In our analysis, we considered the high-level objectives of the Climate Change and Energy Transition law and took note of the mitigation targets of each section. Notably, Title V of this law focuses on adaptation measures against the impacts of climate change. The law establishes the development of the [National Plan for Adaptation to Climate Change \(PNACC\)](#) as the basis for adaptation action for Spain. The National Plan is intended to promote coordinate action that will promote resilience and adaptation across various areas of work which include water sources, biodiversity, forestry, agriculture, urban planning, energy, tourism, human health, and more. The [Climate Change Adaptation: Work Programme 2021-2025](#) is the 5-year work plan for implementing the PNACC. The Work Programme is the main document reviewed for this analysis.

Sweden

In 2017, Sweden established the [Climate Act](#), a legal framework with binding targets for Sweden to have net-zero emissions by 2045. Complementary to the Act, the [Climate Policy framework \(2017\)](#) sets Sweden's overall strategy for transitioning to an environmentally sustainable society, and emphasises integration of climate considerations across all policy domains.

Sweden released its [National Adaptation Strategy in 2018](#). It outlines the most urgent climate risks in Sweden like flooding, erosion, drought, and heatwaves. While the strategy outlines the general direction and guidance for adaptation measures, it guides sectoral agencies to develop and implement adaptation actions for areas under their purview. This aspect differs from the other countries, which do include sectoral actions in their National Strategies. Although the list is not exhaustive, the Strategy listed 13 national authorities that had produced or were in the process of producing action plans for adaptation. These included: , Sea and Water Authority (HaV), National Antiquities Authority, t, Forestry Agency, State Geotechnical Institute (SGI), State Agricultural Agency, State Veterinary Institute (SVA), Geological Survey of Sweden (SGU), Agency for Growth, The Swedish Transport Agency, the Swedish Transport Agency and the Public Health Agency.), National Antiquities Authority, t, Forestry Agency, State Geotechnical Institute (SGI), State Agricultural Agency, State Veterinary Institute (SVA), Geological Survey of Sweden (SGU), Agency for Growth, The Swedish Transport Agency, the Swedish Transport Agency and the Public Health Agency.

In this review, we focused on the most relevant plans for tracking infectious disease impacts. The plans chosen also mostly align with the sectors identified in other countries' plans, so that the areas for comparison are similar. The plans that were reviewed are by the following authorities: [National Board of Housing, Building and Planning](#); [National Board of Health and Welfare](#); [Agency for Marine and Water Management](#); [the Land Survey](#); [Swedish Food Agency](#); [Swedish Environmental Protection Agency](#); [Saami Livelihoods and Culture](#); Sea and [Water .Authority](#); [Swedish Agency for Agriculture](#); [Forest and Forestry](#) and the [State Veterinary Medical institute](#)

Table A5 Infectious disease in European policy

Policy	Reference to infectious disease
Communication on the EU Health Union	"The 2020 Annual Strategic Foresight Report showed that there is a need to better anticipate health risks and prevent the spread of new infectious diseases and associated disorders. Embedding foresight in health policies will therefore contribute to better preparedness and resilience."
EU Biodiversity Strategy for 2030	"This reflects the fact that the risk of emergence and spread of infectious diseases increases as nature is destroyed. Protecting and restoring biodiversity and well-functioning ecosystems is therefore key to boost our resilience and prevent the emergence and spread of future diseases."
Communication on the European Health Emergency preparedness and Response (HERA) Authority	"Over the last decade, the world has experienced some of the most devastating outbreaks of infectious diseases ever, including Influenza, Ebola and the Zika epidemics . Global population growth, climate change and the consequential pressure on land use, food production, and animal health are driving the rise and increasing the frequency of emerging pathogens. Modern travel allows viruses and other pathogens to spread across the world in a matter of hours. These factors made a major health crisis almost inevitable. Nonetheless, nations across the globe were under-prepared for a pandemic when COVID-19 struck and brought the world to a near halt in 2020."
Regulation on serious cross-border threats to health	"For the purposes of this Regulation, the following definitions apply: ...'communicable disease' means an infectious disease caused by a contagious agent which is transmitted from person to person by direct contact with an infected individual or by indirect means such as exposure to a vector, animal, fomite, product or environment, or exchange of fluid, which is contaminated with the contagious agent;" "The information communicated by the national competent authorities referred to in paragraph 3, point (a), may be, when available, reported at least at NUTS II level to the European Surveillance Portal for Infectious Diseases operated by the ECDC, on a timely basis." Within the limits of the Union's competences, such agreements could include, where appropriate, the participation of such third countries or international organisations in the relevant epidemiological surveillance monitoring network, such as the European Surveillance Portal for Infectious Diseases, operated by the ECDC, and the EWRS, exchange of good practice in the areas of preparedness and response capacity and planning, public health risk-assessment and collaboration on response coordination, including the research response."
European Strategy on Adaptation	"We need a deeper understanding of the climate-related risks for health and greater capacity to counter them. Climate change related health threats are increasing; they are serious and can only be addressed across borders. They include death and injury from heat, floods or forest fires; and the emergence and spread of infectious diseases and allergens linked to geographical shifts in vectors and pathogens. Climate change will also increasingly challenge the ability of public health systems to function effectively, e.g. to develop

	capacities to deal with diseases previously unknown in Europe. The Commission will pool and connect data, tools and expertise to communicate, monitor, analyse and prevent the effects of climate change on human health, based on a 'One Health' approach.”
European Climate Law	“It is necessary to address the growing climate-related risks to health, including more frequent and intense heatwaves, wildfires and floods, food and water safety and security threats, and the emergence and spread of infectious diseases .”
Managing climate risks - protecting people and prosperity	“The incidence of climate-sensitive infectious diseases is set to increase, with diseases such as the West Nile virus, dengue and chikungunya becoming endemic in parts of Europe and foodborne and water-borne pathogens spreading more easily. However, in most cases, effective medical countermeasures to respond to these diseases are scarce or yet to be developed.” “To reduce the vulnerabilities, the Commission will assess the relevant risks and further develop strategic stockpiles for key countermeasures. Under Horizon Europe and EU4Health, the Commission has been supporting development of new vaccines and therapeutics against neglected tropical and emerging infectious diseases. This has, for instance, enabled recent progress on a vaccine against chikungunya virus.”

Table A6 Infectious disease in national climate policy

Published jurisdiction	Policy	Link with infectious diseases
Sweden	Sweden's long-term strategy for reducing greenhouse gas emissions - 2020	Only one mention of infectious diseases, describing it as an impact of increasing temperatures: “Negative impacts such as higher death rates due to heatwaves, greater spread of infectious diseases, shorter snow seasons, higher risks for flooding, landslides, rockfalls and erosion, lower quality drinking water and a higher risk of drought, forest fires and insect infestation”
	Sweden's Adaptation communication - 2022	Only two mentions of infectious disease, describing it as an impact of climate change mainly due to ecosystem change and animal's vulnerability to heat ⁴ , but not clear how to reduce such impacts. “Climate change increases the risk of outbreaks of infectious animal diseases, mainly due to ecosystem changes and an increased presence of ticks and insect vectors . Many vector-borne diseases are zoonotic and may spread between animals and humans. It is difficult to distinguish the impact of climate change on infectious diseases from the influence of other anthropogenic factors. In a warmer climate, animal husbandry may benefit from an extended grazing season as well as from possibilities for new feed crops. However, drought may cause water scarcity and reduced harvests of feed crops. Farm animals housed indoors may suffer from heat stress, increasing the risks of mortality and disease. Stables in Sweden are in general built to protect animals from wind and low temperatures, not from heat.”
	Sweden. Biennial Reports (BR). BR 3. National Communication (NC). NC 7. - 2017 (has same content as above)	Same content as above
	Climate Action Plan - all the way to net zero - 2023	Only one mention of infectious diseases, describing it as an impact of increasing temperatures: “Climate change also brings an increased risk of infectious diseases and other negative health consequences” [Translated by google cloud translate]
Netherlands	The Netherlands' Global Climate Strategy - 2022	
	National Climate Adaptation Strategy (NAS) - 2016	15 mentions of infectious diseases, describing it as a likely impact of climate change in short-time (2010-2020) due to deterioration of water quality. It also introduces infectious disease as one of the 6 climate effects requiring urgent actions due to: (1) Possible increase in exposure to waterborne pathogens due to growth in water recreation and deterioration of water quality, and (2) Possible increase in vector-borne infectious diseases. In addition, unlike other

⁴ As buildings in which farm animals are kept in Sweden are built to protect animals from wind and low temperature but not heat

		policies, this policy recognizes the co-benefits of improving water quality for infectious disease reduction, the negative impact of natural environment “an attractive environment which invites outdoor recreational activity has a positive health effect. However, recreation also increases the change of exposure to pathogens and vectors (such as ticks and Lyme disease)”, and the impacts of increasing infectious disease on wider health issues, health care costs and lost productivity “The increasing popularity of recreation on and in the water means that more people will be exposed to water of poor quality (e.g. containing cyanobacteria, also known as blue-green algae) and the associated health problems.” Under “flood safety”, “Disaster response (Level 3) forms the final safety net, regardless of the nature of the crisis: floods, extreme weather, an outbreak of some infectious disease or the failure of vital functions due to heat or drought.” Under “health”: “A policy on indigenous mosquitoes (and other <i>culcidae</i>) is currently in preparation. It is possible that in time they too will become vectors of disease, or that the exotic species will gradually extend their habitat into the Netherlands. Developments with regard to infectious diseases will be reported using the existing mechanisms which allow for targeted communication and the amendment of existing guidelines as necessary.” And “Municipal health departments provide various forms of support in the prevention of climate-related infectious diseases and exposure to allergens. They are responsible for monitoring risks in and around open water used for recreational purposes (in association with the water management authority) and for public information concerning these risks. They are also responsible for pest control and will arrange for the extermination of rats and other vermin (which are potential carriers of leptospirosis) and will respond to outbreaks of the oak processionary moth (<i>Thaumetopoea processionea</i>) whose caterpillars provoke an extreme allergic skin reaction. The municipal health departments also provide advice on other allergens, including pollens, spores and mites, to members of the public and to the departments responsible for parks and recreation.” “The problem of heat stress has not yet attracted adequate attention. Further knowledge development is required, and countermeasures must be improved. This is also true of the response to infectious diseases and allergies, whereby attention must also be devoted to the interrelationship between these health conditions, the urban environment and developments in nature.” “Infectious diseases due to deterioration in water quality”
	National Climate Agenda: Resilient, Prosperous and Green - 2013	As an impact of climate change
	Netherlands. National Communication	Five mentions of infectious disease: Recognizing the unintended consequences of growing recreational areas and introducing measures to reduce risk of ID: “Municipal health departments provide various forms of support

	(NC). NC 7. - 2018	to prevent climate-related infectious diseases and exposure to allergens. They are responsible for monitoring risks in and around open water that is used for recreational purposes (in association with the water management authorities) as well as for public information about these risks." Recognizing impact of infectious disease on health and productivity: "greater health burden and loss of productivity due to a possible increase in infectious diseases or allergic respiratory conditions such as hay fever." Identifying infectious disease as one of the 6 climate effects requiring urgent actions to be included in the National Climate Adaptation Strategy Mentioning that " there is already a monitoring and screening system in place for infectious diseases."
	Netherlands. National Communication (NC). NC 8. Biennial Reports (BR). BR 5. - 2022	As above
Spain	Spanish Strategy for Science, Technology and Innovation 2021-2027 (2020)	Four mentions of infectious disease, describing it as an impact of climate change.
	Spain's integrated National Energy and Climate Plan for 2021-2030 (2020)	Four mentions of infectious disease, describing infectious disease as an impact of climate change: "Climate change is prolonging the seasons in which vector transmission of numerous infectious diseases occurs and is altering their geographical distribution, favouring their development even in territories where they did not previously exist." "Both episodes of torrential rains and floods and droughts will affect the quality and availability of water, and will modify the conditions of agricultural and livestock production, potentially increasing the risk of infectious diseases transmitted by water and food."
	National Climate Change Adaptation Plan 2021-2030 (2020)	As above
	Spain's recovery and resilience plan (Plan de Recuperación, Transformación y Resiliencia) - 2021	Two mentions of infectious disease, requiring "more research by the Instituto de Salud Carlos III, in particular the National Centre for Microbiology, the National Centre for Epidemiology and the National School of Occupational Medicine and National School of Health to fight infectious diseases and global threats." Introducing the "creation of a new Network Biomedical Research Center (CIBER) for Infectious Diseases."

Greece	Greece. National Communication (NC). NC 8. Biennial Reports (BR). BR 5. - 2022	Three mentions of infectious disease, describing it as an impact of climate change: “greater frequency of infectious disease epidemics due to floods and extreme weather events” and “indirect impacts, as a result of environmental changes and ecological disruptions due to climate change (e.g. higher risk of vector-borne or rodent-borne infectious diseases).” and “The impact of climate change on infectious diseases varies, as both the reproductive rate of the transmitters and their activity are affected. Some important examples are analyzed in the NAS concerning: Extreme weather conditions, air pollution, diseases transmitted via transmitters and increased incidents of allergies due to climate change”
	Greece. Biennial Reports (BR). BR 3. National Communication (NC). NC 7. - 2017	As above
	Second National Climate Change Programme (approved by Act of the Ministerial Council 5/27.02.2003, amended in 2007) - 2003	Two mentions of infectious disease, introducing a measure on studying “the reaction mechanisms of animals to extreme temperatures in terms of their metabolism, physiology in general and their health (e.g. food consumption, liver function, immune system response, mortality, infectious diseases, resistance to heat stress, etc.).” And “The Center for Disease Control and Prevention (KEELPNO), in the matter of dealing with climate change, focuses on diseases that can be transmitted by transmitters, diseases that are directly linked to climate change. The way climate change affects infectious diseases varies, as both the reproductive rate of the transmitters and their activity are affected.”
	The National Strategy for Climate Change Adaptation - 2016	As above
Germany	Future Strategy Research and Innovation - 2023	Two mentions of infectious diseases, requiring new vaccines and medication as well as technical protective measures and research. “Climate change is also expected to cause the spread of vector-borne infectious diseases. In addition to the development of new vaccines and medications, there is also a need to develop technical protective measures.” “In addition to non-communicable chronic diseases, infectious diseases are again increasingly threatening our health. The development of appropriate safe and effective medicines and vaccines, but also diagnostics, is a crucial prerequisite for combating them worldwide. The sharp decline in newly approved drugs against infectious diseases as well as the increasing development of resistance of pathogens to anti-infective agents represent a serious threat to the global health situation. Research and development for effective drugs must be strengthened as well as vaccine development as part of pandemic prevention to move forward. We will also advance activities to combat antimicrobial resistance (AMR), the so-called “silent pandemic,” at national, European and international levels, including through

		product development initiatives. After product development, manufacturing plays the crucial role. We want to strengthen Germany as a pharmaceutical location in the areas of research, development and production.” “With a view to pandemic preparedness, we will further expand our modeling expertise on the spread of serious infectious diseases and the effects of possible intervention measures by networking relevant disciplines” “We want to improve the protection of humans and animals from vector-borne infectious diseases through research.”
	German Strategy for Adaptation to Climate Change (DAS) - 2008	As an impact of climate change due to extreme events and impacts of rising temperature on spoiled food ID to be increased in future
	Germany. National Communication (NC). NC 8. Biennial Reports (BR). BR 5. - 2023	Evaluating surveillance data on imported vector-transmitted infectious diseases
	Federal Climate Adaptation Act (KAnG) - 2023	As an impact of climate change