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# European climate risk assessment Executive summary

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# Executive summary

This assessment identifies 36 climate risks with potentially severe consequences across Europe. The risks are evaluated in the contexts of risk severity, policy horizon (lead time and decision horizon), policy readiness and risk ownership. It further identifies priorities for EU policy action, based on a structured risk assessment united with qualitative aspects, such as considering social justice.

## Key takeaways

- Human-induced climate change is affecting the planet; globally, 2023 was the warmest year on record, and the average global temperature in the 12-month period between February 2023 and January 2024 exceeded pre-industrial levels by 1.5°C.
- Europe is the fastest-warming continent in the world. Extreme heat, once relatively rare, is becoming more frequent while precipitation patterns are changing. Downpours and other precipitation extremes are increasing in severity, and recent years have seen catastrophic floods in various regions. At the same time, southern Europe can expect considerable declines in overall rainfall and more severe droughts.
- These events, combined with environmental and social risk drivers, pose major challenges throughout Europe. Specifically, they compromise food and water security, energy security and financial stability, and the health of the general population and of outdoor workers; in turn, this affects social cohesion and stability. In tandem, climate change is impacting terrestrial, freshwater and marine ecosystems.
- Climate change is a risk multiplier that can exacerbate existing risks and crises. Climate risks can cascade from one system or region to another, including from the outside world to Europe. Cascading climate risks can lead to system-wide challenges affecting whole societies, with vulnerable social groups particularly affected. Examples include mega-droughts leading to water and food insecurity, disruptions of critical infrastructure, and threats to financial markets and stability.
- When applying the scales of severity used in the European climate risk assessment, several climate risks have already reached critical levels. If decisive action is not taken now, most climate risks identified could reach critical or catastrophic levels by the end of this century. Hundreds of thousands of people would die from heatwaves, and economic losses from coastal floods alone could exceed EUR 1 trillion per year.

- Climate risks to ecosystems, people and the economy depend on non-climatic risk drivers as much as on the climate-related hazards themselves. Effective policies and action at European and national levels can therefore help reduce these risks to a very significant degree. The extent to which we can avoid damages will largely depend on how quickly we can reduce global greenhouse gas emissions, and how fast and effectively we can prepare our societies and adapt to the unavoidable impacts of climate change.
- The EU and its Member States have made considerable progress in understanding the climate risks they are facing and preparing for them. National climate risk assessments are increasingly used to inform adaptation policy development. However, societal preparedness is still low, as policy implementation is lagging substantially behind quickly-increasing risk levels. Most of the climate risks are co-owned by the EU and its Member States; therefore, coordinated and urgent additional action is required at all governance levels.
- Most policies and actions to strengthen Europe's resilience to climate change are made for the long term, and some actions have long lead times. Urgent action is needed now to prevent rigid choices that are not fit for the future in a changing climate, such as in land-use planning and long-lived infrastructure. We must prevent locking ourselves into maladaptive pathways and avoid potentially catastrophic risks.
- Adaptation policies can both support and conflict with other environmental, social and economic policy objectives. Thus, an integrated policy approach considering multiple policy objectives is essential for ensuring efficient adaptation.



# Overarching findings of this report

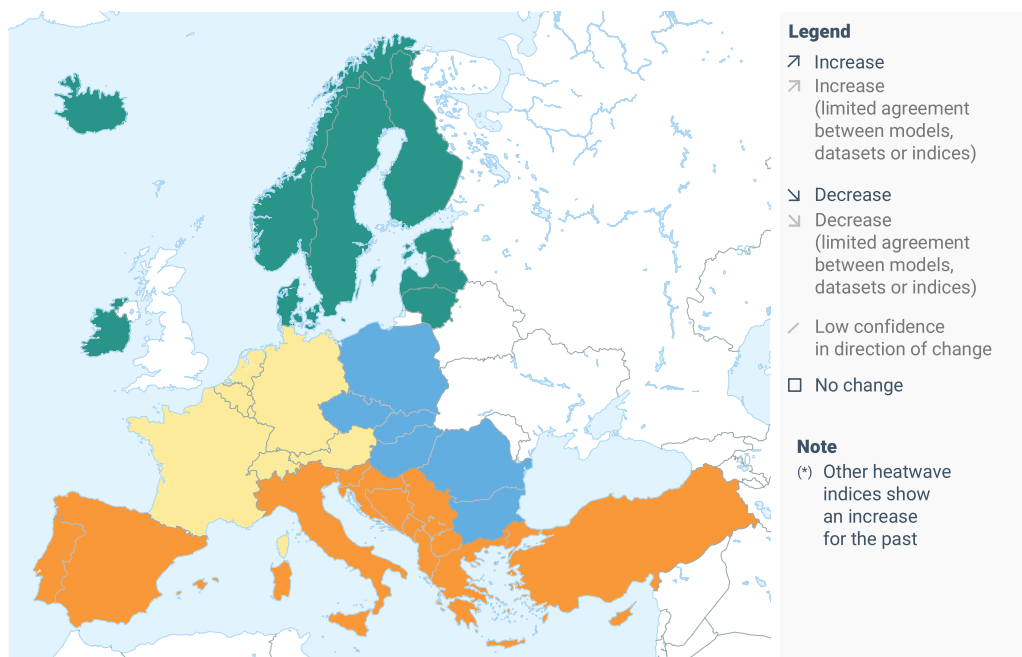
## Europe's climate is changing rapidly

Human activities have led to unprecedented global warming. The average global temperature in the 12-month period between February 2023 and January 2024 exceeded pre-industrial levels by 1.5°C. 2023 was the warmest year on record over more than 100,000 years globally, at 1.48°C above pre-industrial levels, with the world's ocean temperature also reaching new heights. Europe is the fastest-warming continent; since the 1980s, warming on the continent was about twice the global rate.

Recent years have seen many long-time climate records broken in Europe. Europe is also facing more and stronger climate hazards, including heatwaves and prolonged droughts, heavy precipitation leading to pluvial and fluvial floods, and sea level rise leading to coastal floods (see Figure ES.1).

**Figure ES.1 Observed and projected trends in key climatic risk drivers in different European regions**

Land regions	Northern Europe		Western Europe			Central-eastern Europe			Southern Europe			European regional seas	Past	Future
	Past	Future	Past	Future	Past	Future	Past	Future	Past	Future				
		Low	High	Low	High	Low	High	Low	High	Low	High			
Mean temperature	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗
Heatwave days	☐(*)	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗
Total precipitation	↗	↗	↗	↗	↘	↘	↗	↗	↘	↘	↘	↘	↘	↘
Heavy precipitation	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗
Drought	↗	↘	↘	↗	↘	↗	↗	↘	↗	↗	↗	↗	↗	↗



**Notes:** Underlying climate variables are: heatwaves (days with maximum temperatures above 35°C), heavy precipitation (maximum 1-day precipitation), and drought (using a standardised precipitation evapotranspiration index over 6 months (SPEI-6, Hargreaves' method)). Time periods and scenarios are past (1952-2021); future until the end of the century (2081-2100 relative to 1995-2014); low scenario (SSP1-2.6); and high scenario (SSP3-7.0).

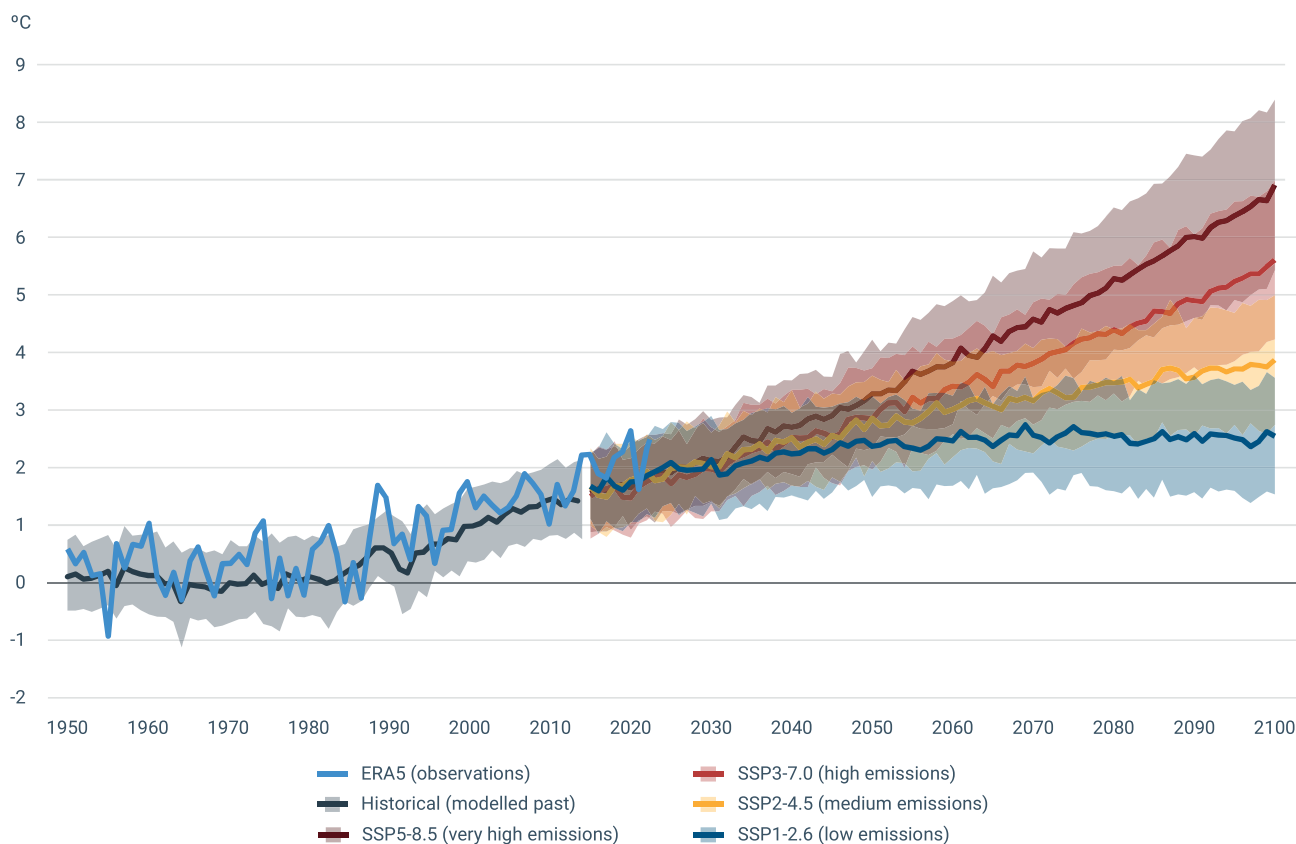
**Source:** Copernicus Climate Change Service (C3S).

Most climate hazards in Europe will further increase during the 21st century, even under optimistic scenarios compatible with the Paris Agreement, but the magnitude and pace of change depend on global efforts to reduce greenhouse gas emissions (see Figure ES.2). A pessimistic scenario without additional policy action suggests that economic damages related to coastal floods alone might exceed EUR 1 trillion per year by the end of the century in the EU.

The climate risks Europe is facing are driven not only by increases in climate hazards, but also by how prepared societies are for them. Figure ES.1 only shows the general direction of travel. Climate adaptation policies need to consider a wider range of plausible scenarios for those risk drivers that they cannot directly influence, including plausible low probability events with high impacts (wildcards), compounding hazards occurring at the same time or after each other, and risk cascades that stretch across national borders or sector boundaries.

Extreme heat is becoming increasingly common, exposing a large share of the population to heat stress, particularly in southern and western Europe. The record-hot summer of 2022 has been linked to between 60,000 and 70,000 premature deaths in Europe, despite considerable investments in heat-health action plans. Warmer temperatures also facilitate the northward movement of disease vectors and their spread to higher elevations. Southern Europe is now warm enough for mosquitoes to transmit formerly tropical diseases.

**Figure ES.2** Observed and projected temperature increase over European land area



**Notes:** Temperatures are expressed relative to pre-industrial levels. The model projections show the mean and uncertainty interval. The two scenarios assessed are SSP1-2.6: low warming, and SSP3-7.0: high warming.

**Source:** Copernicus Climate Change Service (C3S).

Heatwaves and prolonged droughts are growing with climate change. This can lead to acute crises, such as widespread wildfires, critical infrastructure failures, blackouts, and major health and economic impacts. Europe faces a growing risk of megadroughts that span large regions and last for several years, and that are even more severe than recent drought events in Europe. Prolonged droughts cause large economic damage across many sectors and can severely degrade the water resources that people, agriculture, industry, power plants, river transport and ecosystems depend on.

Extreme precipitation has increased in large parts of Europe, leading to growing flood risks and devastating floods in recent years. This trend is expected to rise further in a warming climate.

Sea level in Europe is rising higher every year at an accelerating pace. Rising sea levels increase the risk of coastal floods and storm surges, coastal erosion and saltwater intrusion into groundwater. This presents an important threat to many coastal cities, regions and ecosystems in Europe. Sea level will continue to rise for centuries or even millennia after global temperatures have stabilised.

Various extreme climate events in recent years have severely impacted ecosystems, populations and the economy in Europe. All of these events are consistent with a changing climate, and attribution studies have shown that some of them become more likely and/or severe as a result of human-caused climate change. These events have also demonstrated how the impacts of a single event can cascade to multiple systems and sectors, thus affecting several policy areas simultaneously. These connections can lead to risk cascades where a risk originating in one system is transmitted to others (Box ES.1).

**Box ES.1 Examples of extreme climate events in 2021, 2022 and 2023 with severe societal consequences**

- Extreme precipitation and large-scale floods took place in Germany and Belgium in 2021 (EUR 44 billion damage and more than 200 deaths), Slovenia in 2023 (damage estimated at around 16% of national GDP), and Greece in 2023 (submerging its breadbasket region). These events caused severe, direct impacts on settlements, infrastructure, agriculture and human health. They also led to wider economic impacts in the affected regions and major fiscal challenges at national levels, and stretched the limits of the existing EU Solidarity Fund.
- Extreme heat in combination with prolonged drought, such as the record drought in 2022, have caused severe, direct impacts on ecosystems, forestry, agriculture, water supply and human health. More indirect impacts affected energy security, transport services, tourism and the wider economy.
- Large wildfires are facilitated by extreme heat in combination with prolonged drought, even though humans play the dominant role in their ignition. Extreme wildfires in 2022 and again in 2023 have had severe, direct impacts on ecosystems, carbon storage and human settlements. They also led to wider impacts on human health, critical infrastructure, tourism and the economy in the affected regions.

## Climate change is a risk multiplier that can exacerbate existing risks and crises

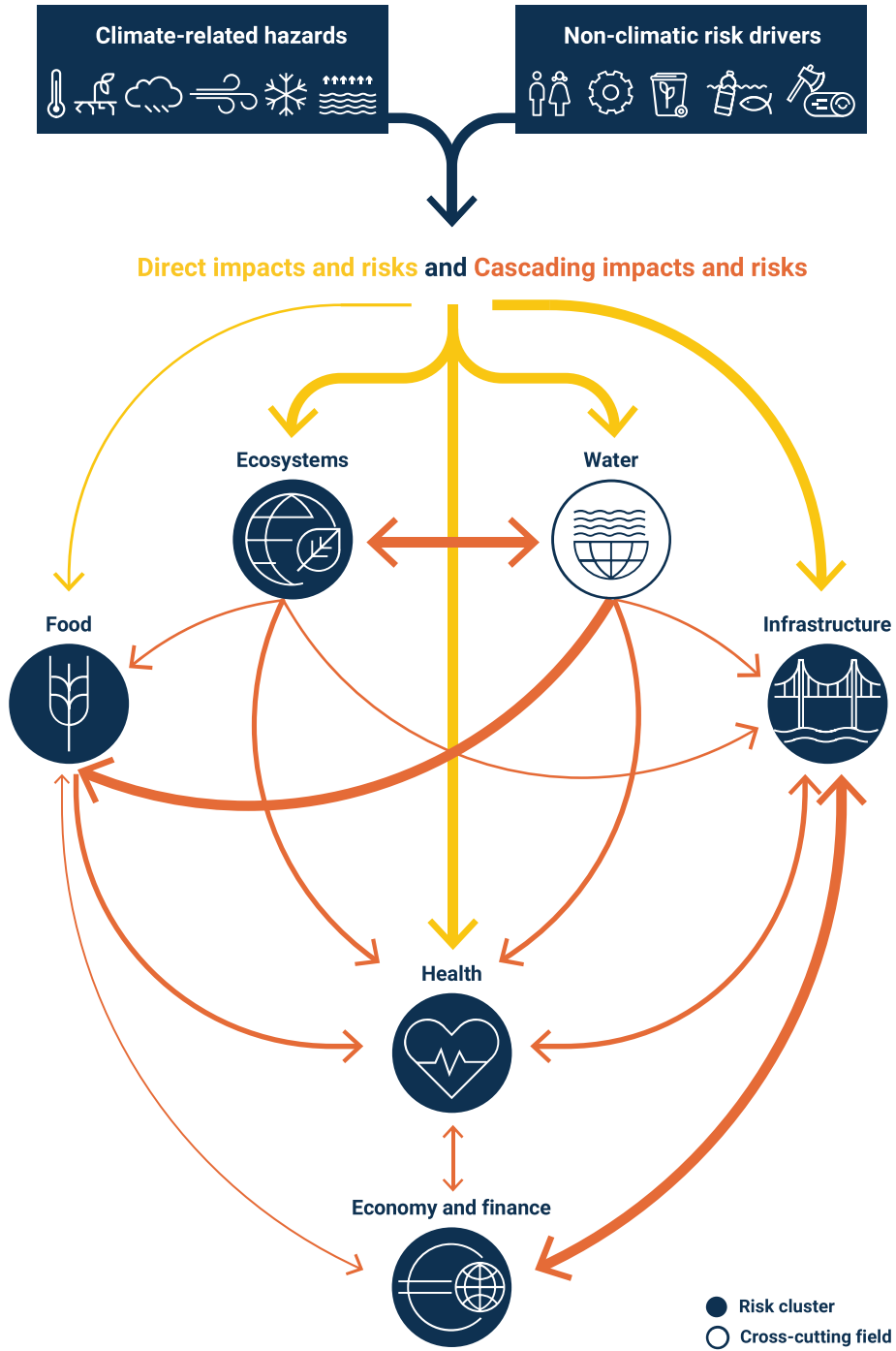
Climate-related hazards (e.g. heatwaves, prolonged droughts and floods) in interaction with non-climatic risk drivers (e.g. ecosystem fragmentation, pollution, unsustainable agricultural practices and water management, land use and settlement patterns, and social inequalities) threaten Europe's food security, public health, ecosystems, infrastructure and economy. Climate impacts can cascade from one system or region to another, including from the outside world to Europe and from Europe to the outside world. Cascading climate risks can lead to system-wide challenges affecting whole societies, with vulnerable social groups particularly implicated.

Climate risks in Europe and the climate-sensitive systems where they manifest are closely connected (see Figure ES.3). These connections can lead to risk cascades where a risk originating in one system is transmitted to others. Examples of risk cascades include:

- **Food.** Climate impacts on food production (particularly in southern Europe) can cascade to rural and coastal livelihoods, land use, the health of socially vulnerable populations, and the wider economy.
- **Health.** Climate impacts on human health and well-being, including those of workers, can affect labour productivity and resource needs of the health system, and thus the wider economy.
- **Ecosystems.** Climate impacts on terrestrial, freshwater and marine ecosystems can cascade to food production and security, human and animal health, infrastructure, land use and the wider economy.
- **Infrastructure.** Climate impacts on critical infrastructure, such as energy, water or transport infrastructure, can affect nearly all aspects of society, from human health to the wider economy and the financial system. Infrastructure assets and networks are often interconnected, so a failure at one point in the network can also cascade to other regions and countries.
- **Economy and finance.** Many climate impacts can affect the economy and the financial system, from where they can cascade further to other policy areas that may be deprived of financial resources.

Awareness of risk cascades is crucial for reducing climate risks because it offers different possible targets for risk reduction strategies. It is often more efficient to address a risk at the beginning of the cascade than where the impacts are felt most strongly. Comprehensive adaptation policies need to prevent the deterioration of the foundation of basic human needs (such as ecosystems, food and health) while promoting the resilience of human systems and activities (such as infrastructure, economy and finance). Adaptation policies also need to consider pre-existing inequalities and the disproportionate burden on vulnerable groups most affected by the lack of essential services.

Figure ES.3 Links between risk drivers and the clusters of climate risks assessed



**Note:** The figure illustrates the interconnections and risk transmission pathways from key climate-related hazards and selected non-climatic risk drivers (on top) via the main climate impacts for five clusters of interrelated risks and the cross-cutting field 'Water'.

**Source:** EEA.

## **Climate risks are determined by the interaction of climate-related hazards with non-climatic risk drivers**

The risks associated with climate hazards also depend on non-climatic risk drivers as much as on the climate hazards themselves. For example, unsustainable land use and water management, biodiversity loss, eutrophication and pollution increase ecosystems' vulnerability to climate hazards. Well-maintained infrastructure with built-in redundancy is less likely to fail during an extreme event than ageing infrastructure that was already at its limit under past climate conditions. Strong health services with robust heat-health action plans are less likely to be overwhelmed during a heatwave or climate-related infectious disease outbreak than health services that are struggling on an everyday basis. And communities with significant flood insurance are in a better position to recover and build back better after a severe flood than those without external support.

Consideration of non-climatic risk drivers is thus essential for understanding climate risks, as well as for reducing them in a just manner. Some non-climatic risk drivers can influence the severity of many climate risks whereas others are relevant for specific risks only. Non-climatic risk drivers are numerous and are highly variable across Europe, which makes them difficult to address in broad, Europe-wide scenarios. The European climate risk assessment (EUCRA) identifies those environmental, social and economic conditions that are most relevant for specific climate risks, including those that require consideration in the development of effective and just adaptation policies.

## **Major climate risks for Europe and the urgency to act**

EUCRA has followed a systematic risk assessment process to identify and analyse major climate risks for Europe, and to determine the urgency to act. The assessment process comprises an analysis of risk severity over time and an indicative policy analysis. Further information is available in the concluding section.

The systematic risk assessment process has identified and assessed 36 major climate risks for Europe, grouped into five broad clusters: ecosystems, food, health, infrastructure, and economy and finance (see Figure ES.4). Depending on their nature, each of these risks alone has the potential to cause significant environmental degradation, economic damage, social emergencies and political turbulences; their combined effects are even more impactful. The selection was based on a comprehensive review of the literature and the evidence related to climate impacts and risks in Europe; it considered the potential of various climate risks to put Europe into crisis. Almost all of the selected major risks can reach critical or even catastrophic levels during this century. In addition, the assessment identified three major climate risks specific to the EU outermost regions.

More than half (21 out of the 36) major climate risks for Europe identified in this report need more action now, with eight of them being particularly urgent. Urgent action is needed for risks from all policy clusters, indicating that policies need to increase in ambition, scope and implementation. A third of these risks need further investigation, including more research, better monitoring or a review of the policy framework.

Southern Europe, low-lying coastal regions and EU outermost regions are hotspot regions for climate risks. Southern Europe is particularly affected by heat and prolonged drought. Three out of the eight risks in the highest urgency category are evaluated with this high urgency score because of their high severity in southern



Europe. In contrast, none of the other three sub-continental regions stand out as hotspots for climate risks in Figure ES.4. Low-lying, coastal regions are also hotspots because some risks with high severity and urgency are concentrated there. Finally, EU outermost regions are hotspots based on a separate risk assessment outlined below.

Many climate risks are characterised by long policy horizons, meaning that risk levels projected for the second half of this century are relevant to current adaptation decisions. Long policy horizons can be caused by long lead times for planning and implementing effective adaptation actions, such as in the case of complex coastal protection infrastructure. They can also be related to long decision horizons: current decisions can create lock-ins with long-term implications, such as for infrastructure built or forests planted today. In the case of long lead times or decision horizons, even climate risks that are not currently at critical levels could require urgent action to prevent very severe impacts in the future.

### **Regional aspects and geographical hotspots**

Climate risks differ substantially within and across regions, sectors and vulnerable groups. The risks depend on their exposure to climate hazards, and the environmental and socio-economic conditions determining their vulnerability to these hazards.

Southern Europe, low-lying coastal regions and EU outermost regions are hotspots for multiple climate risks.

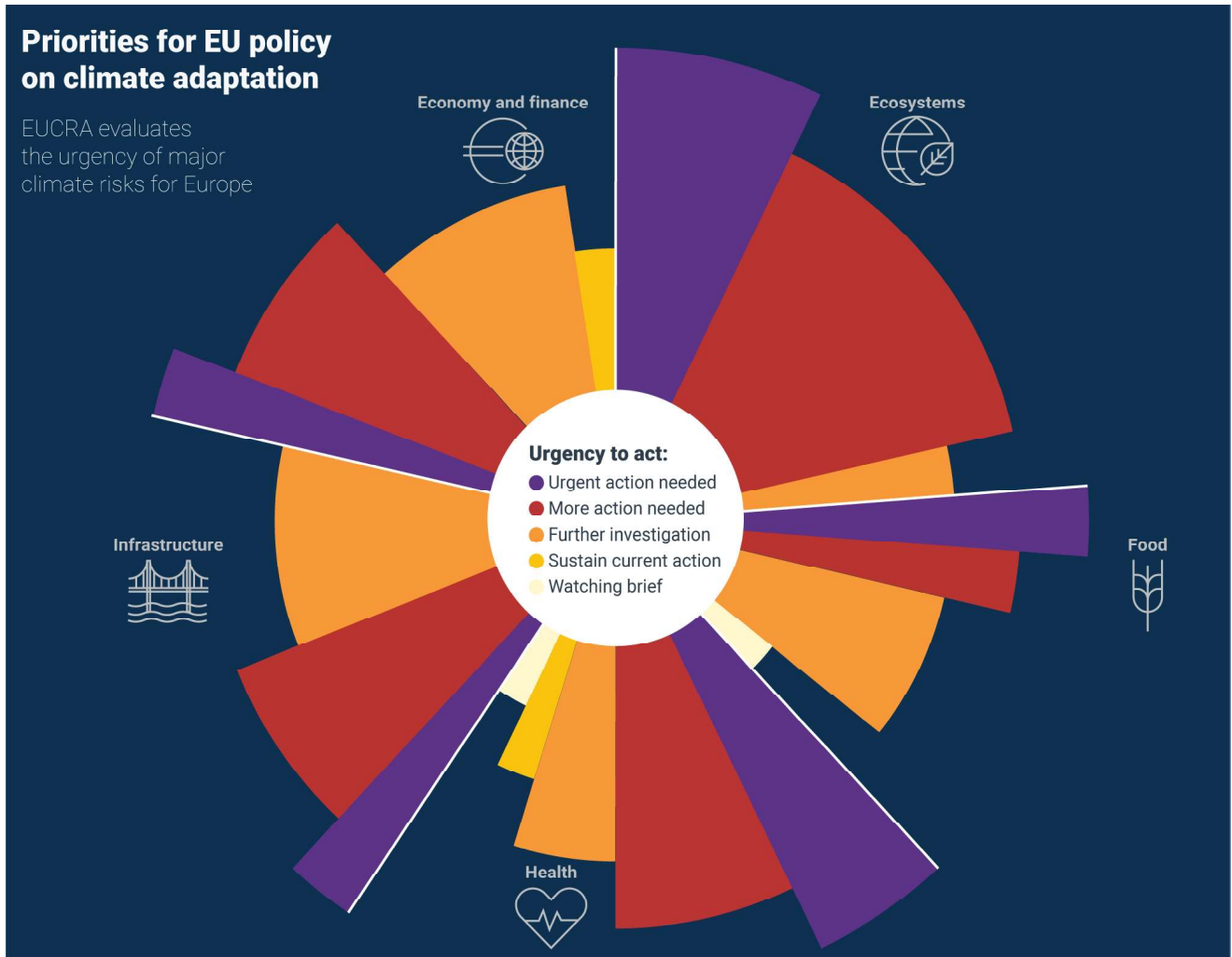
- Southern Europe is particularly at risk from the increasing impacts of heat and droughts on agricultural production, outdoor work, summer tourism and fire. Within southern Europe, rural areas and local economies dependent on ecosystem services are particularly at risk;
- Low-lying coastal regions, including many densely-populated cities, are at risk from flooding, erosion and saltwater intrusion aggravated by sea level rise;
- EU outermost regions face particular risks as a result of their remote location, weaker infrastructure, limited economic diversification and, for some of them, strong reliance on a few economic activities. Specific climate risks may have hotspots in regions beyond the ones highlighted here.

Regional and local economies that are dependent on tourism, agriculture, fisheries and forestry are especially sensitive to climatic changes. This includes the Alps and other mountain regions, coastal regions and islands in the Mediterranean, as well as large regions in northern Europe.

Regions characterised by high levels of unemployment, poverty, emigration and ageing populations have a lower capacity to adapt to the impacts of climate change. Within Europe, such regions are concentrated in central-eastern Europe and parts of southern Europe.

Densely-populated, urban areas are at particular risk from heatwaves and extreme precipitation. The urban heat island effect can amplify the effects of heatwaves, particularly at night. High amounts of soil sealing and limited green and blue spaces in the city increase the risk of flooding, especially during cloudbursts.

Figure ES.4 Major climate risks for Europe and the urgency to act on them



### Climate risks by cluster

#### Ecosystems

- Coastal ecosystems
- Marine ecosystems
- Biodiversity/carbon sinks due to wildfires\*
- Biodiversity/carbon sinks due to wildfires
- Species distribution shifts
- Ecosystems/society due to invasive species
- Soil health
- Aquatic and wetland ecosystems
- Biodiversity/carbon sinks due to droughts and pests
- Cascading impacts from forest disturbances

#### Infrastructure

- Pluvial and fluvial flooding
- Coastal flooding
- Damage to infrastructure and buildings
- Energy disruption due to heat and drought\*
- Energy disruption due to heat and drought
- Energy disruption due to flooding
- Marine transport
- Land-based transport

#### Food

- Crop production\*
- Crop production
- Fisheries and aquaculture
- Food security due to higher food prices
- Food security due to climate impacts outside Europe
- Livestock production

#### Economy and finance

- European solidarity mechanisms
- Public finances
- Property and insurance markets
- Population/economy due to water scarcity\*
- Population/economy due to water scarcity
- Pharmaceutical supply chains
- Supply chains for raw materials and components
- Financial markets
- Winter tourism

#### Health

- Heat stress – general population
- Population/built environment due to wildfires\*
- Population/built environment due to wildfires
- Well-being due to non-adapted buildings
- Heat stress – outdoor workers\*
- Pathogens in coastal waters
- Health systems and infrastructure
- Infectious diseases
- Heat stress – outdoor workers

Note: \*Hotspot region: southern Europe

**Notes:** Urgency to act for 36 major climate risks for Europe, grouped into five risk clusters. Six risks are assessed both at the pan-European level and for southern Europe, which is a hotspot region. The widths of the segments ('pies') indicates the number of risks per cluster belonging to different urgency categories. Risk names are shortened in comparison to the main report.

**Source:** EEA.

# Major climate risks and policy priorities by risk cluster



## Ecosystems cluster

### Major climate risks and policy priorities for the ecosystems cluster

'Ecosystems' is the policy cluster with the highest number of risks in the categories 'urgent action needed' or 'more action needed' (see Table ES.1). This is relevant for many other policy areas as well because climate risks to ecosystems can often cascade to other societal systems. Risks to marine and coastal ecosystems are particularly severe due to an interplay of climatic and non-climatic impact drivers.

**Table ES.1 Assessment of major risks**

Climate risks for 'Ecosystems' cluster	Urgency to act	Risk severity			Policy characteristics		
		Current	Mid-century	Late century (low/high warming scenario)	Policy horizon	Policy readiness	Risk ownership
Coastal ecosystems	Urgent action needed	+++	+++	+++	Medium	Medium	Co-owned
Marine ecosystems	Urgent action needed	+++	+++	++	Medium	Medium	EU
Biodiversity/carbon sinks due to wildfires (hotspot region: southern Europe)	Urgent action needed	+++	++	++	Medium	Medium	Co-owned
Biodiversity/carbon sinks due to wildfires	More action needed	+++	++	++	Medium	Medium	Co-owned
Biodiversity/carbon sinks due to droughts and pests	More action needed	+++	++	++	Long	Medium	Co-owned
Species distribution shifts (*)	More action needed	+++	++	++	Medium	Medium	Co-owned
Ecosystems/society due to invasive species	More action needed	+++	++	++	Medium	Medium	Co-owned
Aquatic and wetland ecosystems	More action needed	+++	++	++	Medium	Medium	Co-owned
Soil health (*)	More action needed	+++	++	++	Medium	Medium	Co-owned
Cascading impacts from forest disturbances	Further investigation	+	+	+	Long	Medium	Co-owned

**Legends and notes**

<p><b>Urgency to act</b></p> <ul style="list-style-type: none"> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: #4b0082; margin-right: 5px;"></span> Urgent action needed</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: #c00000; margin-right: 5px;"></span> More action needed</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: #e69d00; margin-right: 5px;"></span> Further investigation</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: #f0e68c; margin-right: 5px;"></span> Sustain current action</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: #fff2cc; margin-right: 5px;"></span> Watching brief</li> </ul>	<p><b>Risk severity</b></p> <ul style="list-style-type: none"> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: #4b0082; margin-right: 5px;"></span> Catastrophic</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: #c00000; margin-right: 5px;"></span> Critical</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: #e69d00; margin-right: 5px;"></span> Substantial</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: #f0e68c; margin-right: 5px;"></span> Limited</li> </ul>	<p><b>Confidence</b></p> <p>Low: + Medium: ++ High: +++</p>
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(\*) Wide range of evaluations by authors and risk reviewers.

Climate change is one of the main drivers of biodiversity loss and ecosystem degradation in Europe. Among climate risks related to ecosystems, risks to coastal and marine ecosystems are the most severe in the current period and entail the highest urgency to act.

- The functioning of marine ecosystems is threatened by the combined effects of climate-related drivers (e.g. marine heatwaves, acidification and oxygen depletion) and other anthropogenic drivers (e.g. pollution and eutrophication, fishing and the adverse impacts of maritime activities). This can result in substantial biodiversity loss, including mass mortality events, and declines in ecosystem services.

- Coastal ecosystems are additionally affected by erosion, flooding and permanent inundation due to the combined effects of sea level rise, storm surges and embankment due to coastal infrastructure. This creates critical risks and adaptation needs for the ecosystems themselves, as well as for communities living in coastal areas.
- Additional climate impacts, such as the deepening of the mixed ocean layer, species migration and the immigration of non-indigenous species are affecting food webs. This can lead to a substantial reduction in marine primary production.
- Eutrophication, caused by nutrient pollution and exacerbated by climatic drivers, increases harmful algal blooms and pathogens in coastal waters, creating a moderate to high risk for human health. This combination of factors is also driving the expansion of oxygen-depleted dead zones, in particular in the Baltic Sea and Black Sea.
- All of Europe's seas are strongly affected by these climate risks and anthropogenic pressures.
- There are significant gaps in our knowledge about how ecological systems respond to the interactions between different factors, and the subsequent cascading effects within and beyond ecosystems.
- Droughts and pollution impacting water-table levels in aquifers have a cascading effect on both aquatic and terrestrial dependent ecosystems.

Most risks related to terrestrial and freshwater ecosystems are currently substantial, with the potential to reach critical levels around mid-century and catastrophic levels later in the century under a high warming scenario. The urgency to act is generally assessed as 'more action needed'.

- The major climate-related hazards to terrestrial and freshwater ecosystems include longer and more severe droughts, warming, changes in rainfall patterns and increased wildfires. These hazards, in combination with unsustainable management choices and practices, may drive changes in species composition due to shifts in suitable habitats, forest mortality, altered soil health, and increased invasive alien species and insect outbreaks.
- In southern Europe, risks related to wildfires are already rated as 'critical', which leads to the urgency rating 'urgent action needed'.

Many aquatic and wetland ecosystems are already severely degraded from unsustainable land use and water management, and industrial activities; climate change is further aggravating the situation. These ecosystems require particular attention, not least because risks to them can easily cascade to other ecosystems and humans.

- Eutrophication from agricultural fertilisers and livestock is an important stressor in some hotspots for freshwater, coastal and marine ecosystems, particularly in closed seas. The effects of eutrophication can interact with warming waters and result in toxic algal blooms or oxygen-depleted 'dead zones'.
- Pollution from industrial activities, including mining, is an important stressor for many freshwater ecosystems. The effects of pollution are magnified during climate-induced low flow events. This combination of stressors can lead to ecosystem collapse, such as in the Oder River ecological disaster in 2022.

Europe's forests are strongly affected by climate change, which can exacerbate forest fires, droughts, windthrows, and pests and diseases. At the same time, healthy forests can play an important role in mitigating climate change and its consequences.

- Europe's forests provide vital ecosystem services, including carbon sequestration and storage. It is estimated that in 2021, they removed 281 million tonnes of CO<sub>2</sub> equivalent (Mt CO<sub>2</sub>e) from the atmosphere across the EU; about 7% of total emissions. However, the forest carbon sink has decreased over the last 10 years, mainly due to climate-related forest disturbances and related salvage timber harvesting.
- Climate change is exacerbating forest disturbances, including major wildfires, storms, droughts and insect outbreaks that have caused widespread tree mortality in several European countries. These impacts have reduced the carbon sinks and even turned some forest areas into sources of CO<sub>2</sub> while negatively affecting biodiversity, water regulation and other ecosystem services.
- Forest disturbances are expected to increase with further warming, thereby reducing carbon sequestration and increasing emissions from forest land. This could compromise the desired increase of net carbon removals in the land use, land use change and forestry sector (i.e. 310 Mt CO<sub>2</sub>e/year by 2030, which is a part of the EU's climate change commitments). Greenhouse gas emissions would have to be reduced even faster to compensate for the reduced land carbon sink.

There is considerable variation in climate risks to ecosystems across European regions, habitats and species.

- Ecosystems in the alpine and far northern regions are particularly vulnerable because of limited migration opportunities, whereas southern regions are particularly at risk from exacerbated water scarcity and heat stress.
- Forests, freshwater and coastal habitats, wetlands and peatlands are among the habitats most at risk from climate change.
- Amphibians, birds, bats and molluscs are among the species groups that have been reported to be negatively affected by rising temperatures and changes in precipitation, but many more will be affected in the future.

### **Risk cascades**

Ecosystems provide multiple services to humans and society. Therefore, risks to terrestrial, freshwater, marine and coastal ecosystems have high potential to cascade to other sectors and policy areas. These include food security, water security and human health.

Risks to coastal ecosystems can cascade to coastal infrastructure and settlements. This is due to their important role in flood prevention and protection against coastal erosion.

Ecosystems can also play an important role in climate change mitigation and adaptation through nature-based solutions and ecosystem-based adaptation.

## Policies and priorities for actions

Many EU policies are in place to address risks to ecosystems. However, these policies need better coherence considering the multiple services ecosystems provide. Policy implementation should be improved and the response to major climate risks strengthened.

- The EU and its Member States should implement existing policies to maintain and restore the resilience of ecosystems, particularly by strengthening protection and minimising anthropogenic pressures. This applies especially to marine and coastal ecosystems.
- Afforestation and forest conservation and restoration can help mitigate climate change. At the same time, these measures can provide a range of complementary benefits in terms of climate change adaptation, biodiversity conservation and other ecosystems services.
- Afforestation and forest restoration need to consider future climate conditions to ensure that newly planted or regenerated forests remain in a suitable habitat during their long lifetime. Furthermore, trade-offs between different forest and land uses over time need to be carefully considered.
- Europe's climate change strategies should prioritise emission reductions without over-reliance on forest carbon sinks. Forest-based mitigation should only play a complementary role in bridging the transition to a low-carbon economy and offsetting remaining emissions while providing other co-benefits.

Guidance to Member States for protecting ecosystems in a changing climate needs to be strengthened, with a focus on meeting concrete and operational targets.

- To that effect, ecosystems will benefit from Member States implementing the EU Nature Restoration Law, which requires measures to restore them.
- Guidance is also needed on spatial planning and soil health. Special attention must be paid to the implementation and restoration of protected area networks within and outside Natura2000, increasing ecosystem connectivity and reintroducing green-blue corridors in cities and agricultural landscapes.
- Member States should strengthen maritime spatial planning and implement coastal management plans with a focus on protecting essential coastal ecosystems under climate change.

Reducing pollution from agricultural and industrial activities should be a priority for protecting Europe's ecosystems under climate change.



### Major climate risks and policy priorities for the food cluster

Risks to crop production are the most urgent in the cluster 'Food', with risk severity already at a critical level in southern Europe (see Table ES.2). Further climate impacts on food production within and outside Europe can create critical risks for food security within the continent by mid-century.

**Table ES.2 Assessment of major risks**

Climate risks for 'Food' cluster	Urgency to act	Risk severity			Policy characteristics		
		Current	Mid-century	Late century (low/high warming scenario)	Policy horizon	Policy readiness	Risk ownership
Crop production (hotspot region: southern Europe)	Urgent action needed	Critical	Critical	Critical	Short	Medium	Co-owned
Crop production	More action needed	Critical	Critical	Critical	Short	Medium	Co-owned
Food security due to climate impacts outside Europe (*)	Further investigation	Substantial	Critical	Critical	Short	Medium	EU
Food security due to higher food prices	Further investigation	Substantial	Critical	Critical	Short	Medium	Co-owned
Fisheries and aquaculture	Further investigation	Substantial	Critical	Critical	Short	Medium	Co-owned
Livestock production	Sustain current action	Substantial	Critical	Critical	Short	Medium	Co-owned

**Legends and notes**

<p><b>Urgency to act</b></p> <ul style="list-style-type: none"> <li><span style="color: purple;">■</span> Urgent action needed</li> <li><span style="color: red;">■</span> More action needed</li> <li><span style="color: orange;">■</span> Further investigation</li> <li><span style="color: yellow;">■</span> Sustain current action</li> <li><span style="color: lightyellow;">■</span> Watching brief</li> </ul>	<p><b>Risk severity</b></p> <ul style="list-style-type: none"> <li><span style="color: purple;">■</span> Catastrophic</li> <li><span style="color: red;">■</span> Critical</li> <li><span style="color: orange;">■</span> Substantial</li> <li><span style="color: yellow;">■</span> Limited</li> </ul>	<p><b>Confidence</b></p> <p>Low: + Medium: ++ High: +++</p>	<p>(*) Wide range of evaluations by authors and risk reviewers.</p>
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Europe faces multiple challenges to food production and food security, including a necessity to reduce its environmental footprint. Crop production is already facing substantial climate risks in Europe as a whole, and critical risk levels in southern Europe.

- Crop failures and reduced yields already pose a critical risk in southern Europe during years of prolonged drought and excessive heat. The specific regional situation is determined by the frequency of droughts, hydrological conditions and the status of irrigation infrastructure where available.
- Megadroughts pose a significant threat, potentially affecting large areas for prolonged periods. They negatively impact crop production, food security, drinking water supplies and energy production.
- Food production can also be impaired by specific meteorological events, such as late frosts and heavy rain, as well as current and new pests and diseases potentially facilitated by climate change. It is difficult to assess the overall risk levels due to the wide variety of regional conditions.
- Food security in Europe is determined not only by food production in Europe, but also by production abroad and the overall socio-economic situation. Production and supply chain risks from outside Europe are expected to grow rapidly because of even higher climate impacts in many non-European production regions and increasing demand from a growing global population.

## Risk cascades

Risks to ecosystems and international supply chains can cascade into risks to food security.

- Healthy soils, rivers, lakes and seas are critical natural resources for food production. Climate-related hazards, such as warming and changing water flows, combined with non-climatic risk drivers, such as increased competition over scarcer water resources, can compromise food production and security.
- Climate-related disruptions to food supply chains can lead to shortages and price volatility of food and feed products in Europe. This ultimately threatens nutritious food affordability for parts of the European population, in particular low-income households.

The risks to food production have strong potential to impact the interconnected systems upon which food production itself depends as well as basic human needs.

- If crop yields are reduced under climate change, efforts to maintain overall production levels can further increase pressures on biodiversity, water resources, soil and ecosystems. This can create new risks to water security and quality, ecosystems and marine environments.
- Risks to food security, including access to nutritious food, can cascade further to human health and social equity.

## Policies and priorities for action

Addressing climate risks to food production and security requires many policy levers. These include adapting and transforming food production systems, influencing demand and improving access to nutritious foods for all population groups.

- Increased efforts are urgently needed to manage the risk of prolonged drought, including in the common agricultural policy (CAP) strategic plans of the Member States. This could look like supporting drought-resilient crops or varieties and favouring less water-intensive crops. An analysis of the current CAP strategic plans indicates considerable room for further improvement.
- There is a need to raise awareness of risks to food production that is water-intensive or depends heavily on imported fodder. More resources must be allocated to risk management and decision support tools, and measures to minimise risks to drought-sensitive crops should be promoted.

The development and application of sustainable and transformative agricultural practices that also enhance ecosystem resilience should be supported at all policy levels.

- Such measures promote food security while strengthening ecosystem resilience, such as by improving soil quality and health, enhancing water retention and limiting soil erosion.
- Diversifying agricultural approaches and promoting sustainable agricultural models, such as regenerative agriculture, are crucial for increasing adaptive capacity and coping with climate extremes.

The consistency and coherence of key EU policies affecting food production and security needs to be improved.

- The key EU policies related to food production, the CAP and the common fisheries policy (CFP), do not address climate risks and adaptation needs adequately.
- Mainstreaming and clarifying the options available to Member States under the CAP, as well as further integrating risks to aquaculture and fisheries into the CFP, are essential for comprehensive policy development.
- The transition to more climate-resilient and sustainable food systems in Europe requires actions at many levels, from farms to national and EU policies. EU policy and governance has a critical role to play to support and accelerate this transition, such as by better coordinating actions at territorial level.

Production changes, dietary shifts and targeted social policies are further levers to ensure food security in a changing climate.

- A partial shift from animal-based to plant-based food, as foreseen under the Farm to Fork Strategy and in line with international dietary guidelines, can reduce freshwater consumption for food production, as well as dependency from feed sourced outside Europe.
- Such a shift towards more sustainable and healthier dietary patterns can be supported using policies targeting both supply and demand.
- Social policies should ensure access to nutritious diets and affordability, also for disadvantaged groups.

### Major climate risks and policy priorities for the health cluster

'Health' is impacted in many ways by climate change, both at the individual level and through systemic risks to the health system. Heat is the largest and most urgent climate hazard for human health, affecting different population groups in different ways. More and urgent action is needed to reduce health risks from heat indoors and outdoors as well as from wildfires (see Table ES.3). At the same time, we should better prepare to counter outbreaks of vector- and water-borne diseases associated with extreme weather conditions.

**Table ES.3 Assessment of major risks**

Climate risks for 'Health' cluster	Urgency to act	Risk severity			Policy characteristics		
		Current	Mid-century	Late century (low/high warming scenario)	Policy horizon	Policy readiness	Risk ownership
Heat stress – general population	Urgent action needed	+++	+++	+++	Long	Medium	National
Population/built environment due to wildfires (hotspot region: southern Europe)	Urgent action needed	+++	+++	+++	Medium	Medium	Co-owned
Population/built environment due to wildfires	More action needed	+++	++	++	Medium	Medium	Co-owned
Well-being due to non-adapted buildings (*)	More action needed	++	++	++	Long	Medium	Co-owned
Heat stress – outdoor workers (hotspot region: southern Europe)	More action needed	+++	+++	+++	Short	Medium	Co-owned
Heat stress – outdoor workers	Further investigation	+++	+++	+++	Short	Medium	Co-owned
Pathogens in coastal waters	Further investigation	+	+	+	Medium	Medium	Co-owned
Health systems and infrastructure	Further investigation	+++	++	++	Medium	Medium	National
Infectious diseases	Sustain current action	+++	++	++	Short	Advanced	Co-owned

**Legends and notes**

<p><b>Urgency to act</b></p> <ul style="list-style-type: none"> <li><span style="color: purple;">■</span> Urgent action needed</li> <li><span style="color: red;">■</span> More action needed</li> <li><span style="color: orange;">■</span> Further investigation</li> <li><span style="color: yellow;">■</span> Sustain current action</li> <li><span style="color: lightyellow;">■</span> Watching brief</li> </ul>	<p><b>Risk severity</b></p> <ul style="list-style-type: none"> <li><span style="color: purple;">■</span> Catastrophic</li> <li><span style="color: red;">■</span> Critical</li> <li><span style="color: orange;">■</span> Substantial</li> <li><span style="color: yellow;">■</span> Limited</li> </ul>	<p><b>Confidence</b></p> <p>Low: + Medium: ++ High: +++</p>
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(\*) Urgency based on high warming scenario (late century).

Climate change poses major risks to human health systems; risks related to heat are already at critical levels in southern Europe.

- Europe is experiencing more frequent and more intense heatwaves. This warming, as well as its more potent effects on ageing groups, exposes a larger part of the population to heat stress, especially in southern and western-central Europe.
- In the summer of 2022, between 60,000 and 70,000 premature deaths in Europe were attributed to heat. Heat risks to the general population are already at critical levels in southern Europe.
- Different population groups are exposed to and affected differently by hot temperatures indoors and outdoors. These differences need to be considered in adaptation policies.

Wildfires are associated with multiple risks to human health, which are already at critical levels in southern Europe.

- Wildfires can destroy people's homes as well as infrastructure that is crucial for their health and wellbeing.
- The smoke associated with wildfires is a major health threat, which can affect populations far away from the actual fire.
- Accidental burn injuries could happen, leading to a long recovery and adding an additional burden for local hospitals. Firefighters and other rescue service workers may be subject to additional risks at work when combatting wildfires.
- Urgent action is needed to reduce wildfire risks to human populations, particularly in southern Europe.

Climate change can increase risks from infectious and water-borne diseases.

- Hotter summers, milder winters, and more frequent floods and prolonged droughts are creating favourable conditions for the spread of several infectious diseases. These include vector-borne diseases, such as West Nile virus and tick-borne infections, and water- and food-borne infections such as those from campylobacter and salmonella.
- Warmer temperatures have facilitated the northward movement of disease vectors and their spread to higher elevations. Southern Europe is now warm enough for mosquitoes to transmit formerly tropical diseases, including dengue and chikungunya, and several outbreaks have occurred in recent years.
- Tick-borne diseases, more prevalent in northern and central Europe, are also moving northwards as climate change favours tick survival and development in the northern distribution range.

Climate risks to health are most severe for vulnerable populations, and health systems' capacity to protect them may be impaired under climate change.

- Climate-sensitive health risks are disproportionately felt by the most vulnerable and disadvantaged population groups, such as children, older people, persons with disabilities, and those who are immuno-compromised or have other pre-existing medical conditions.
- Some climate-sensitive health risks are gender-sensitive. In the general population, women are more affected by heatwaves than men due to biological, demographic and socio-economic factors. At the same time, men are disproportionately exposed to climate-related hazards at work because more men than women work in construction and agriculture, or as firefighters.
- Language barriers, precarious socio-economic conditions and social isolation can increase the vulnerability of population groups during extreme weather events.
- Health infrastructure can be directly affected by climate change, e.g. by large-scale flooding or high temperatures.

## Risk cascades

Social and economic factors as well as infrastructure conditions crucially influence how climate change and extreme weather affect human health.

- Population groups living in dwellings with poor insulation, in densely-inhabited urban quarters or with a strong urban heat island effect, and with inadequate access to cooling or secure drinking water are disproportionately at risk from heatwaves.
- Climate-related disruptions of critical infrastructure, including energy, water supply and sanitation, can cascade into health risks.

Climate risks to health can affect the overall health system and cascade into many economic sectors.

- A combination of infectious disease outbreaks and a surge in heat stress-related illnesses could considerably strain health systems that are already under pressure. This strain could more broadly affect patients in the health system overall.
- Impaired health and wellbeing during heatwaves can reduce labour productivity, especially in southern Europe and for outdoor workers. This reduction can lead to wider economic and financial impacts in the most affected regions.

## Policies and priorities for action

Key priorities for policy action include improved coordination of health policies at different levels and between Member States. This is to ensure timely and effective responses to the various health impacts of climate change.

- Health policies are primarily a responsibility of Member States. The EU could support assessments of health systems' preparedness for climate risks in Member States. It could also support efforts for mutual learning and building relevant capacities in the health sector.
- Further assistance could be provided by strengthening the Union Civil Protection Mechanism. This would support cross-border mobilisation of medical personnel and supplies during climate-related health emergencies, as well as the deployment of, for example, emergency medical teams. Continuous education for healthcare workers is important so they can identify illnesses that have not previously been prevalent in a given country or region.

Many levers to reduce climate-related health risks lie outside classical health policies.

- Human health considerations, with a focus on the most vulnerable population groups, should be incorporated into all relevant policies and climate adaptation measures.
- Spatial planning and building standards are key policy levers to reduce heat-related health risks. These policies have a long decision horizon and need to consider future climate change to prevent lock-ins of unsustainable infrastructure.
- The EU can use its legislative authority, including the European Framework Directive for Safety and Health at Work, to establish mandatory requirements and robust enforcement mechanisms to protect outdoor workers from extreme heat (e.g. in agriculture and construction).



- Provisions can be introduced within the framework of the EU's Critical Entities Resilience Directive to enhance health infrastructure resilience to climate impacts.

EU measures to address significant cross-border health threats may have to be strengthened.

- The EU is already taking measures to tackle the effects of climate change on infectious diseases. This is being done through policy initiatives, such as EU4Health. In addition, different Commission services and EU agencies ensure adequate preparedness for and responses to possible future outbreaks.
- Disease surveillance systems for climate-sensitive systems may have to be strengthened and harmonised across Europe.
- The EU may support relevant actions of Member States, such as vector and infectious disease control programmes (including vaccination programmes where vaccines exist), the development and implementation of health action plans and resilience measures tailored to regional needs.



## Infrastructure cluster

### Major climate risks and policy priorities for the infrastructure cluster

'Infrastructure' is highly susceptible to climate risks, with risks from pluvial, fluvial and coastal flooding the most urgent to evaluate and address (see Table ES.4). In addition to these, further major climate risks are affecting buildings, the energy system and the transport system.

**Table ES.4 Assessment of major risks**

Climate risks for 'Infrastructure' cluster	Urgency to act	Risk severity			Policy characteristics		
		Current	Mid-century	Late century (low/high warming scenario)	Policy horizon	Policy readiness	Risk ownership
Pluvial and fluvial flooding	Urgent action needed	High	Critical	Substantial	Long	Medium	Co-owned
Coastal flooding	Urgent action needed	High	Critical	Catastrophic	Long	Advanced	Co-owned
Damage to infrastructure and buildings (*)	Further investigation	Medium	Substantial	Substantial	Long	Medium	Co-owned
Energy disruption due to heat and drought (hotspot region: southern Europe)	Further investigation	Medium	Substantial	Substantial	Medium	Medium	Co-owned
Energy disruption due to heat and drought	Further investigation	Medium	Substantial	Limited	Medium	Medium	Co-owned
Energy disruption due to flooding	Further investigation	Medium	Substantial	Substantial	Long	Advanced	Co-owned
Marine transport	Further investigation	Medium	Substantial	Substantial	Medium	Medium	Co-owned
Land-based transport	Further investigation	Medium	Substantial	Substantial	Medium	Medium	Co-owned

**Legends and notes**

<p><b>Urgency to act</b></p> <ul style="list-style-type: none"> <li><span style="color: purple;">■</span> Urgent action needed</li> <li><span style="color: red;">■</span> More action needed</li> <li><span style="color: orange;">■</span> Further investigation</li> <li><span style="color: yellow;">■</span> Sustain current action</li> <li><span style="color: lightyellow;">■</span> Watching brief</li> </ul>	<p><b>Risk severity</b></p> <ul style="list-style-type: none"> <li><span style="color: purple;">■</span> Catastrophic</li> <li><span style="color: red;">■</span> Critical</li> <li><span style="color: orange;">■</span> Substantial</li> <li><span style="color: yellow;">■</span> Limited</li> </ul>	<p><b>Confidence</b></p> <p>Low: + Medium: ++ High: +++</p>	<p>(*) Urgency based on high warming scenario (late century).</p>
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Extreme weather events are posing increasing risks to the built environment and infrastructure in Europe, as well as the services they provide. Such events can disrupt essential services, including energy supply, water supply and transport networks.

- The impacts of extreme weather events and slow onset climate change pose a serious risk to Europe's built environment and infrastructure, with grave implications for human wellbeing. This risk is further exacerbated by the ageing condition of much of Europe's buildings and infrastructure, as well as growing demand for the services they provide.
- Pluvial and fluvial flooding are already creating substantial risks for the built environment and population across Europe, as evidenced by various highly destructive floods in recent years. Further increases in flood risk are projected for the future, and urgent action is needed to ensure that long-lived infrastructure is climate-resilient.
- Coastal flood risks have been successfully managed in Europe overall, with no major destruction or loss of life during the last 50 years. However, the accelerating pace of sea level rise and the exponential increase in the resulting flooding risks require more action now. The focus should be to prepare settlements, critical infrastructure and the European population for this major and rapidly rising threat in the future.

- Projected increase in sea level and changes in storm patterns will increase the frequency and severity of coastal flooding in Europe, with potentially devastating impacts on Europe's population, infrastructure and economic activities. In addition, the risk of compound flooding arising from the concurrence of high sea levels and heavy precipitation will also increase.

Climate change can pose major risks to all modes of water and land-based transportation.

- This report includes broad assessments of the risks to marine (or maritime) and land-based transport, but transport on inland waterways is also affected.
- In the absence of comprehensive sectoral risk assessments, considerable uncertainty remains about the direct and cascading impacts of climate change on transport infrastructure and services.

The European energy system is exposed to multiple climate risks, with southern Europe affected most strongly.

- The energy system in southern Europe already faces substantial risks from the impacts of heat and prolonged droughts on energy production, transmission and peak demand.
- Inland and coastal flooding create substantial risks to energy production, distribution and storage infrastructure in Europe.

### **Risk cascades**

Infrastructure assets are often part of a network of systems, where a disruption to one asset can quickly cascade and affect other sectors and assets.

- Power outages caused by extreme climate conditions can disrupt telecommunication and transportation systems as well as many other economic activities.
- Conversely, climate-related disruptions to digital infrastructure can lead to power outages as power generation, transmission and distribution are controlled by digital systems.
- The impacts of extreme weather on critical infrastructure and buildings can exacerbate the health consequences of climate change, as health systems are dependent on power and water supply as well as transportation services.
- Poorly adapted dwellings and other buildings can increase the risk of heat stress during heatwaves.

### **Policies and priorities for action**

Key priorities for policy action include conducting assessments and implementing measures to enhance the resilience of critical infrastructure on a systems level, and incorporating climate projections into the Eurocodes <sup>(1)</sup>.

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(1) Eurocodes: European standards to guide the structural design of buildings and civil engineering works. These are further explained below.

- The Critical Entities Resilience Directive adopted in 2022 provides important opportunities for assessing and improving the resilience of critical entities in Europe, independent of whether they are publicly or privately owned. These opportunities should be utilised to the fullest, including for resilience to climate change and extremes.
- Some of the critical infrastructure is agreed and co-financed at the EU level, such as the trans-European networks for transport (TEN-T) and energy (TEN-E). The EU should carry out or facilitate systems-level assessments of current and future climate risks to critical infrastructure and its services in Europe. The bloc should also develop guidance that promotes systems- and network-centred methods to support systemic adaptation of critical infrastructure in Member States.
- The EU and its Member States urgently need greater clarity about the location and characteristics of critical infrastructure, and its exposure and vulnerability to climatic hazards. This entails both stress tests to identify weaknesses and regulatory oversight to monitor where progress is lacking. More clarity on private and public infrastructure is key to assess risk ownership and financial implications from measures. This is needed to increase resilience to hazards or reconstruction.
- A series of European standards (Eurocodes) is currently being updated to guide the structural design of buildings and civil engineering works. However, these standards are largely based on historical climate data. To account for future climate risks during the lifetime of current infrastructure, these standards need to incorporate climate projections based on scenario analyses, including worst-case scenarios for particularly critical assets.

Increasing resilience to climate change needs to be an essential part of EU climate and energy policies, including integrated national energy and climate plans (NECPs). Ensuring security of supply in southern Europe during prolonged droughts and heatwaves is key.

- EU climate and energy policies should better integrate climate adaptation into the planning and implementation of measures in the energy sector. This will help actors meet objectives on energy system decarbonisation and security of supply.
- EU policies have been successful in safeguarding energy supply so far but more actions are needed for demand-side management, especially during extreme climate events.
- Cooling needs for buildings are increasing due to climate change, but cooling can create trade-offs with mitigation objectives because of the associated energy needs. Therefore, developing low-carbon approaches for cooling buildings, both passively and actively, and facilitating their wide implementation, is a high priority.
- The operation of existing energy infrastructure and the planning of a new one should incorporate hydrological forecasting and monitoring systems to manage risk from prolonged droughts and water scarcity. New energy infrastructure in water-scarce regions should be as water-efficient as possible and be planned considering climate projections and potentially competing demands from other sectors.



## Economy and finance cluster

### Major climate risks and policy priorities for the economy and finance cluster

'Economy and finance' are facing multiple, climate-related risks. Risks to European solidarity mechanisms are already at critical levels and require urgent action (see Table ES.5). Three other financial risks are evaluated as 'more action needed', and all of them could reach catastrophic risk levels in the late century without proper action.

**Table ES.5 Assessment of major risks**

Climate risks for 'Economy and finance' cluster	Urgency to act	Risk severity			Policy characteristics		
		Current	Mid-century	Late century (low/high warming scenario)	Policy horizon	Policy readiness	Risk ownership
European solidarity mechanisms	Urgent action needed	+++	++	++	Short	Medium	Co-owned
Public finances	More action needed	++	++	++	Medium	Medium	Co-owned
Property and insurance markets	More action needed	++	++	++	Medium	Medium	Co-owned
Population/economy due to water scarcity (hotspot region: southern Europe)	More action needed	++	++	++	Medium	Medium	Co-owned
Population/economy due to water scarcity	Further investigation	++	++	++	Medium	Medium	Co-owned
Pharmaceutical supply chains (*)	Further investigation	++	+	+	Short	Medium	EU
Supply chains for raw materials and components (*)	Further investigation	++	++	++	Short	Medium	EU
Financial markets	Further investigation	+	+	+	Short	Medium	Co-owned
Winter tourism	Watching brief	+++	+++	++	Medium	Advanced	National

**Legends and notes**

<p><b>Urgency to act</b></p> <ul style="list-style-type: none"> <li><span style="color: purple;">■</span> Urgent action needed</li> <li><span style="color: red;">■</span> More action needed</li> <li><span style="color: orange;">■</span> Further investigation</li> <li><span style="color: yellow;">■</span> Sustain current action</li> <li><span style="color: lightyellow;">■</span> Watching brief</li> </ul>	<p><b>Risk severity</b></p> <ul style="list-style-type: none"> <li><span style="color: purple;">■</span> Catastrophic</li> <li><span style="color: red;">■</span> Critical</li> <li><span style="color: orange;">■</span> Substantial</li> <li><span style="color: yellow;">■</span> Limited</li> </ul>	<p><b>Confidence</b></p> <p>Low: + Medium: ++ High: +++</p>	<p>(*) Wide range of evaluations by authors and risk reviewers.</p>
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Current assessments project that the European macro-fiscal and financial system are at substantial risk from the impacts of climate change, both within Europe and abroad. Serious sector- and regional-specific risks to Europe could catalyse a systemic financial shock.

- Existing assessments and stress tests provide a first assessment of the risks to important financial actors. However, they are likely to underestimate the cascading and compounding risks from climate change both in the EU and internationally, and the tail risks associated with rare extreme events.
- Public finances of EU Member States face substantial risks from climate change, even in the near-term. Costly climate extremes can result in reduced tax revenues, increased government expenditure, lower credit ratings and increased cost of borrowing, among others. Recent examples include the fiscal implications of large floods in Germany in 2021 and in Slovenia in 2023.
- The viability of EU solidarity funds is already critically threatened as these have been oversubscribed by various costly events, such as floods and wildfires in recent years.

- The European property and insurance markets are also facing substantial risks from climate change. Intensifying climate impacts can further increase insurance premia, widen the existing protection gap, amplify economic losses, and exacerbate vulnerability among low-income households and other disadvantaged groups.
- Financial institutions are exposed to climate risks from increased probability of default and loss of asset value.

European societies, including businesses and services in essential sectors, are exposed to risks from climate-related disruptions to supply chains.

- Climate-related disruptions can interact with supply chain shocks caused by other factors, including geopolitical tension.
- Supply chain disruption can have downstream implications for food security, access to medicine and business operations.
- Risk severity is uncertain due to the lack of stress tests and insufficient monitoring of supply chain vulnerabilities against current and future climatic hazards.

### **Risk cascades**

Climate change presents a systemic risk to the European macro-fiscal and financial system and the real economy, with effects transcending both borders and sectors. The likely transfer of risk from the private sector to the public sector will amplify the impacts of climate change on public finance.

- With more awareness and disclosure of climate-related financial risk, financial markets and companies will increasingly price physical and transition climate risks, and take them into account in their investment, lending and insurance activities. This could result in shifts, divestments or exit from high-risk sectors and regions, which could transfer more risks to households and the public sector.
- There is a considerable risk that the potential effects of climate change are brought forward by financial market anticipation or exacerbated by overreaction. The high potential for risks to be transferred within the system (contagion and second-round effects) and also to governments exacerbates climate risk to public finance. Several risks could reach catastrophic levels throughout this century under high warming scenarios.

### **Policies and priorities for action**

Better integration of physical climate risks and adaptation needs is required for existing disclosure and due-diligence frameworks.

- Recently-introduced EU taxonomy disclosures, tools and future corporate sustainability due diligence requirements, as part of the sectoral regulatory and broader EU sustainable finance framework, are likely to improve predictability and oversight of the risks and opportunities in improving sustainability. However, these measures alone will not ensure the climate resilience of the system. This is because exposure to physical climate impacts and related adaptation needs are not systematically assessed.



- Corporate disclosure and due diligence frameworks should better account for physical climate risks and adaptation needs within companies' own business operations and along the wider value chain. This should occur alongside existing requirements on transition and a consideration of human rights risks. This would help private sector actors identify mutual benefits and trade-offs.

EU policies should introduce dedicated financial- and market-pull mechanisms to incentivise business-led adaptation.

- Business-led adaptation, including through investment into nature-based solutions, is currently limited among larger corporates due to low climate risk awareness and lack of risk data. The same is largely absent among small- and medium-sized enterprises (SMEs), as well.
- In the absence of market incentives, EU policies are needed to incentivise adaptation and level the playing field for early-movers in the private sector. This can take place through public procurement mechanisms and dedicated adaptation support for SMEs.

Public finance resilience in Member States needs to be strengthened through financial and insurance instruments.

- EU-level policy response must ensure a robust increase in the resources of the EU Solidarity Fund, the Union Civil Protection Mechanism and other solidarity mechanisms. These should also be used to incentivise higher adaptation action at the national level. These policies should also introduce or reinforce insurance and climate-resilient debt instruments to mitigate the impacts of extreme weather on public finances and the wider EU financial system.

Stress tests need to better account for cascading, compounding and tail risks from climate change.

- Increased funding and efforts are needed to strengthen the stress tests of financial institutions alongside wider risk assessments. They should include broader sets of hazards and scenarios, and better account for cascading, compounding and tail risks to the overall EU economy, strategic industry and productive sectors, and financial markets.

More action is needed to facilitate affordable access to and increase the purchase of weather-related insurance for homeowners and businesses.

- Policies need to promote insurance with resilience-enhancing provisions that simultaneously incentivise vulnerability reductions, provide affordable access to insurance and limit the stress on public finances following extreme events. They also need to consider large differences in insurance penetration and arrangements across Member States.



## EU outermost regions

### Major climate risks and policy priorities for the EU outermost regions

EU outermost regions (EU OMRs) are comprised of islands and coastal regions in subtropical and tropical zones (French Guiana, Martinique, Guadeloupe, Saint Martin, La Réunion, Mayotte, Canary Islands, Madeira and the Azores). Due to their remote locations, weaker infrastructure and economic vulnerability, urgent action is needed to help them cope with tropical cyclones, sea level rise, marine heatwaves, and droughts and wildfires. These risks are in addition to those affecting mainland regions of the EU (see Table ES.6).

**Table ES.6 Assessment of major risks**

Climate risks for EU outermost regions	Urgency to act	Risk severity			Policy characteristics		
		Current	Mid-century	Late century (low/high warming scenario)	Policy horizon	Policy readiness	Risk ownership
Marine ecosystems due to marine heatwaves (all outermost regions)	Urgent action needed	Critical	Critical	Catastrophic	Medium	Medium	Co-owned
Ecosystems/built environment due to sea-level rise and tropical cyclones (small islands in tropical regions)	Urgent action needed	Critical	Critical	Catastrophic	Long	Medium	Co-owned
Ecosystems/built environment due to sea-level rise and tropical cyclones (Macaronesia)	Further investigation	Substantial	Substantial	Critical	Long	Medium	Co-owned
Ecosystems/built environment due to sea-level rise and tropical cyclones (French Guiana)	Sustain current action	Substantial	Substantial	Substantial	Long	Medium	Co-owned
Ecosystems due to wildfires (Macaronesia)	Further investigation	Critical	Critical	Catastrophic	Long	Medium	National
Ecosystems due to wildfires (small islands in tropical regions and French Guiana) (*)	Sustain current action	Substantial	Substantial	Substantial	Long	Medium	National

**Legends and notes**

<p><b>Urgency to act</b></p> <ul style="list-style-type: none"> <li><span style="color: purple;">■</span> Urgent action needed</li> <li><span style="color: red;">■</span> More action needed</li> <li><span style="color: orange;">■</span> Further investigation</li> <li><span style="color: yellow;">■</span> Sustain current action</li> <li><span style="color: lightyellow;">■</span> Watching brief</li> </ul>	<p><b>Risk severity</b></p> <ul style="list-style-type: none"> <li><span style="color: purple;">■</span> Catastrophic</li> <li><span style="color: red;">■</span> Critical</li> <li><span style="color: orange;">■</span> Substantial</li> <li><span style="color: yellow;">■</span> Limited</li> </ul>	<p><b>Confidence</b></p> <p>Low: + Medium: ++ High: +++</p>	<p>(*) Urgency based on high warming scenario (late century).</p>
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This report has assessed major climate risks specifically for the EU outermost regions, further divided into three subregions.

- The risk assessment has followed the same approach as for mainland Europe, but the results are not directly comparable. This is because the threshold values for classifying risk severity have been adjusted downwards to account for the small area, population size and economic output of EU OMRs.
- All EU OMRs are facing critical risks to their marine ecosystems from ocean warming and marine heatwaves that require urgent action.
- Tropical cyclones and sea level rise can lead to catastrophic risks for assets, infrastructure and ecosystems in small islands in tropical regions (Martinique, Guadeloupe, Saint-Martin, Saint-Barthélemy, La Réunion and Mayotte). These risks call for urgent action, as well.

- The Macaronesian islands (Canary Islands, Madeira and the Azores) are already facing critical risks from wildfires. More action is also needed in relation to risks from sea level rise and tropical cyclones.

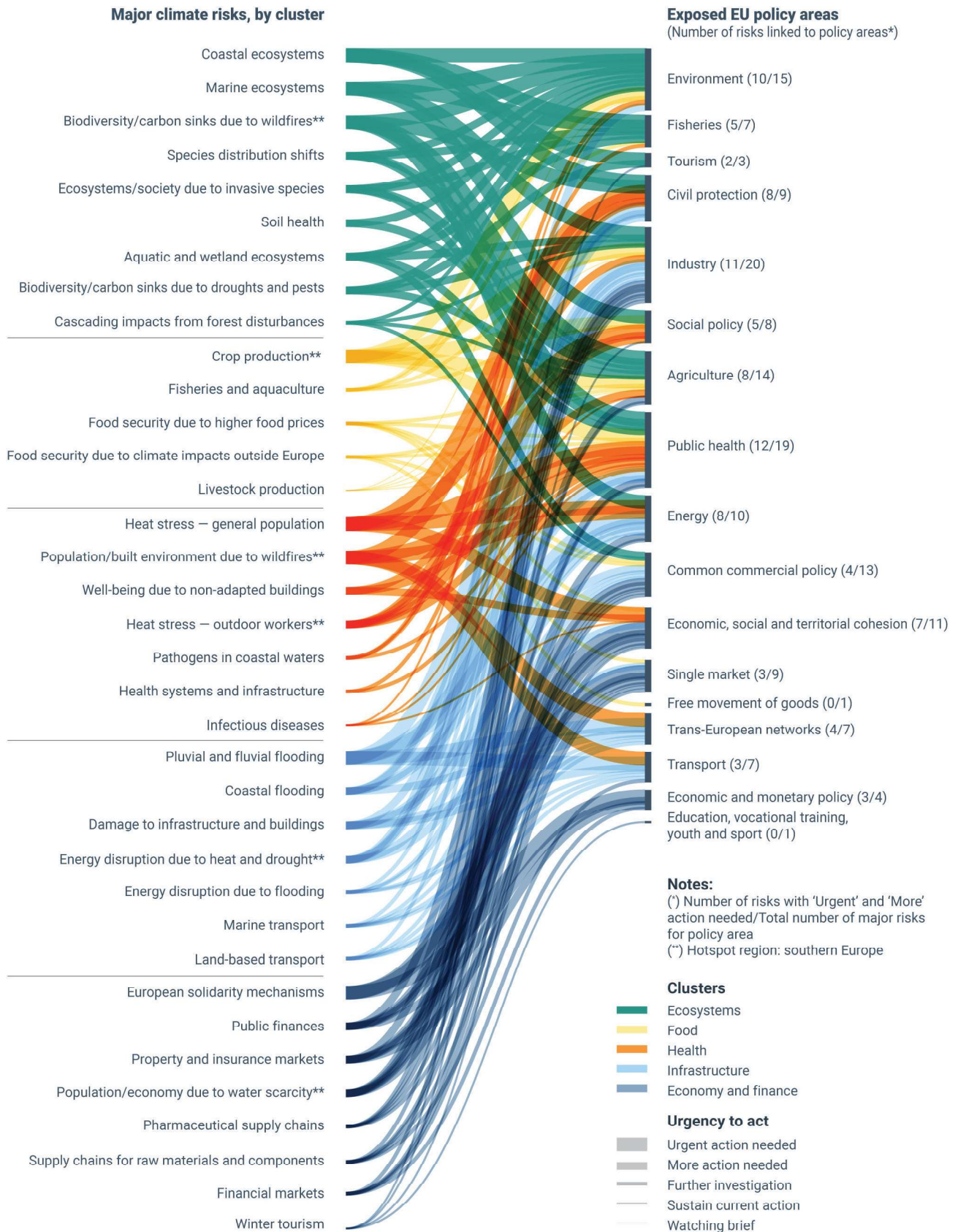
### **Policies and priorities for action**

The main responsibility for addressing climate risks in the EU OMRs lies with these regions and the relevant Member States, but EU policies can support these efforts.

- Most relevant EU policies for the EU OMRs do not have a clear climate adaptation focus. For successful implementation, a better understanding of the specific risk and governance contexts of each individual region will be required.

## What can Europe do to reduce climate risks and increase societal preparedness?

Figure ES.5 Links between major climate risks for Europe and exposed policy areas



Source: EEA.

## Climate risks are outpacing the development and implementation of EU policies

**The impacts of climate change compromise the ability and efficiency of EU policies to meet their objectives.** The projected impacts of climate change that lie ahead could profoundly affect every aspect of society and every economic sector in Europe. Against this backdrop, addressing climate risks is an increasingly important responsibility of European governments, and more resources are required for adaptation-related action and investments.

**Most EU policy areas are exposed to climate risks, either directly or indirectly.** Public health, environment, agriculture and energy are among those policy areas most directly affected by major climate risks in Europe that require urgent action. The policy analysis displayed in Figure ES.5 reveals that various other EU policy areas are highly exposed, as well; in particular, industry, trade and economic, social and territorial cohesion.

**The existing array of EU-level policies is insufficiently progressing to manage most climate risks.** EUCRA carried out a preliminary assessment of policy readiness at the EU-level, drawing on an evaluation of relevant EU policies by sector experts and a review by an independent risk review panel. For most major climate risks, EU policies are not specific enough to ensure resilience against rapidly increasing risk levels. Stronger policy action or implementation is particularly urgent to reduce climate risks to marine, coastal and terrestrial ecosystems, food production, health risks from heatwaves, risks from coastal and inland flooding, and risks from wildfires. Urgent action is also needed to ensure that European solidarity mechanisms can cope with increasing climate-related disasters.

## Uncertainties and tail risks call for a precautionary policy approach

Due to limitations, current climate risk assessments tend to underestimate overall risk levels. This calls for a precautionary approach to climate risk assessment. It is essential that adaptation policies are underpinned by sound scientific evidence. However, existing approaches for climate impact modelling and quantitative climate risk assessments tend to underestimate risk levels associated with climate variability (e.g. extreme weather events), compound effects (e.g. interplay between climatic and non-climatic drivers), complex cascading risks, indirect economic impacts (e.g. run on the markets), and unlikely yet plausible scenarios of risk drivers (also known as 'tail risks'). Hence, most current climate risk assessments are inherently conservative and tend to underestimate the potential impact of climate change. EUCRA attempts to address this bias by complementing quantitative evidence of climate risks with an expert-based assessment of current and future risk levels.

**European adaptation policies on both EU and Member State level should follow a precautionary approach to risk management, particularly for risks with potentially catastrophic consequences.** While it is standard practice in insurance and the wider financial industry to focus on low-probability, high impact scenarios (so-called tail risks), current European adaptation policies largely centre on middle-of-the-road scenarios at the cost of neglecting tail risks. Since the weather extremes of recent years increasingly suggest that the effects of climate change are likely to exceed many scenarios from climate models, it is thus imperative that adaptation (and mitigation) policies designed by the EU and Member States hedge against this uncertainty by developing policies that also consider the impacts of tail risks. Failing to account for them can leave the EU dangerously exposed to the extreme and unexpected impacts of climate change, such as catastrophic coastal flooding under high-end sea level rise scenarios.



## A systems-approach for increasing Europe's resilience to climate change

**A systems-approach to adaptation and resilience-building must be prioritised on both EU and Member State level. This will help transcend sector silos and isolated risk drivers to better account for cascading and compounding risks.** It is evident across EUCRA that the effects of climate change can be exacerbated by the compound effects of multiple climate drivers, and the interplay between climate and non-climate drivers. Therefore, a holistic and integrated approach to ensure policy coherence and adaptation on a whole systems level is needed. This is particularly important as the policies that may be most effective in managing the risk can reside outside the exposed policy area. Indeed, EUCRA indicates that policies related to ecosystems, agriculture and health have an especially high adaptation potential across different sectors.

Some progress has been made, in particular since the adoption of the EU Adaptation Strategy in 2021, which sets out important objectives around mainstreaming adaptation across different policy areas. The EU has introduced or expanded important horizontal policies and instruments to support adaptation across sectors, including the Critical Entities Resilience Directive, the Union Civil Protection Mechanism, the European Regional Development Fund, the Cohesion Fund and the European Social Fund Plus. The EU should bolster climate adaptation actions further through regulatory and policy levers. This includes, among others, the CAP, the CFP, the Water Framework Directive and the Nature Restoration Law. The development of a systems-approach to adaptation remains a major area for future research.

## Investing in social justice and cohesion

**Addressing underlying social drivers of climate risks is essential to achieving just resilience.** Demographic and socio-economic factors (e.g. age and health status; access to resources, healthcare, social protection, transportation, insurance and communication; and occupational exposure to climate-related hazards) are shaping the distribution of climate risks and exacerbating the effects on specific population groups in Europe. Furthermore, ill-designed adaptation policies can leave vulnerable and marginalised social groups behind in benefitting from collective adaptation action. Some adaptation responses can even exacerbate existing inequalities and worsen security and overall well-being, thereby increasing climate vulnerability. Therefore, considerations of justice, fairness and inclusiveness must be central to EU adaptation policies. At the national level, a few European countries have started to integrate 'just resilience' and social justice concerns into adaptation policies, but consideration of these factors is still sporadic and uneven.

Inclusive decision-making processes that involve marginalised and vulnerable groups are essential to adaptation planning at national, regional and local levels. The consideration of diverse perspectives contributes to more effective and equitable transformative adaptation strategies. Local knowledge and community engagement are essential to identifying context-specific vulnerabilities and effective adaptation strategies. Inclusive approaches to climate risk management can also discourage recurrence to climate litigation, which has become an important legal tool to address climate risks and inequalities.

## Risk ownership and governance barriers

**The EU and Member States need to work together to reduce climate risks in Europe effectively.** Most major climate risks for Europe identified in this report are 'co-owned' by the EU and its Member States, which may involve further sub-national

levels. This means that policies key to mitigating climate risks fall under the EU's shared competences or multiple competence areas under the auspices of both the EU and Member States. In many cases, this involves the EU providing policy framing whereas the Member States maintain the responsibility for designing the implementation approaches.

The complicated and at times ambiguous configuration of risk ownership between the EU and its Member States can be a barrier to effective risk reduction. The EU's policy and legal frameworks also place constraints on the EU's ability to introduce binding legislation or targets on adaptation. For instance, one of the main climate risks identified that requires urgent policy action is the risk to human health from heat stress exacerbated by climate change. With the exception of occupational health, relevant health policies are mainly the responsibility of individual Member States, which places real limits on EU-level adaptation to this risk. In addition, adaptation objectives are inherently difficult to quantify.

The rapid rise of climate risks across Europe may require new ways of cooperating across governance levels to achieve tangible and measurable progress in reducing the most urgent climate risks. Such approaches can be informed by experiences with the EU Mission on Climate Adaptation and other relevant EU instruments and policies.

### **Stronger policy objectives and improved risk analysis for the most urgent climate risks**

Some of the commitments outlined in the 2021 EU Adaptation Strategy are underpinned by legally-binding EU directives in relevant policy areas, but many of its objectives and actions are vaguely defined and lack concrete proposals.

Some actions rely on voluntary commitments by Member States, most of which in turn rely on legally non-binding commitments and soft policies for guiding adaptation actions.

**Stronger EU policy action is urgently needed to manage several climate risks where the EU either has the legislative responsibility or is in the position to act.** A few major climate risks identified in this report either largely reside under the legislative responsibility of the EU, or the EU appears in the best position to act based on the cross-border nature of the affected system. For example, the risk relating to climate change impacts on marine ecosystems requires urgent policy action in policy areas from maritime spatial planning to marine environmental protection, to fisheries policy and land-based pollution control. While some of these policies fall under the shared responsibility of the EU and Member States, the international coordination required to protect marine ecosystems under climate change suggests that the EU is in the best position to lead these efforts.

**The EU can play an important role in improving the analysis of major climate risks identified in this report through legislation, monitoring, funding and technical support.** About a third of the major climate risks for Europe identified in this report were categorised as 'Further investigation'. These include risks to energy systems, transport networks and other critical infrastructure, and risks of climate-related, supply chain disruptions from outside Europe. Most of these risks can reach critical or even catastrophic levels, but current knowledge may be insufficient for adopting concrete policies to reduce these risks. The EU can play an important role in filling such knowledge gaps and improving the understanding of the risks themselves, as well as of the ability of European and national-level policies to address these risks. Such information would also be instrumental input for a follow-up EUCRA.



## About the report

The first European Climate Risk Assessment (EUCRA) aims to support the identification of climate adaptation-related policy priorities in Europe and policy development in climate-sensitive sectors. It was conducted by the European Environment Agency at the request of the European Commission, with involvement of a wide range of experts and stakeholders.

EUCRA focuses on climate risks that have potentially large consequences in Europe or need coordination at the European or transnational level. EUCRA also indicates particularly affected regions, sectors or population groups where possible.

This report builds on, extends and complements the existing knowledge base on climate impacts and risks for Europe. This knowledge base includes recent reports by the Intergovernmental Panel on Climate Change (IPCC), the Copernicus Climate Change Service (C3S) and the Joint Research Centre of the European Commission (JRC); outcomes of EU-funded research and development projects; and national climate risk assessments. The current knowledge is synthesised with the goal to make it more directly relevant to strategic policymaking. Innovations in EUCRA include a more granular identification of major climate risks for Europe, linking these risks with the European policy context, a structured risk evaluation process and systematic involvement of key stakeholders throughout the production of the report.

The first EUCRA is a fast-track assessment that does not cover all aspects about how climate change can impact Europe. This report has been produced over one and a half years, which is much shorter than typical national climate risk assessments. Considering the limited time available, the political priorities and the expertise of the partners involved, some climate-related risks for Europe have received limited or no attention. These include risks related to the EU's Common Foreign and Security Policy, including geopolitical risks, and climate risks that are predominantly being managed by private actors. Furthermore, this report does not review adaptation policies and actions at the national level, and it does not assess specific adaptation solutions or their costs and benefits.

This report presents information in thematic factsheets and risk storylines. Thematic factsheets give a concise overview of how climate change affects specific sectors or systems, using a common structure. Risk storylines address 'complex' climate risks resulting from the interaction of various climatic and non-climatic risk drivers, which can cascade across sectors or national borders and could lead to systemic impacts. The risk storylines use a common structure as well, but their content shows more variation than for factsheets. Impact chains played an important role in the development of this report; they were used in all factsheets and several storylines.

## A systematic process for assessing the severity and urgency of climate risks

EUCRA has followed a systematic risk assessment process to identify, analyse and evaluate major climate risks for Europe. The risk analysis assesses risk severity according to four categories (catastrophic, critical, substantial and limited <sup>(2)</sup>) for three time periods (current, mid-century and late century). This analysis also addresses the distribution of risks across regions where relevant and the confidence in the knowledge base. The policy analysis includes indicative assessments of the policy horizon (lead time and decision horizon), risk ownership across governance levels (describing where the lead responsibility to manage a major climate risk lies), and an indicative assessment of policy readiness <sup>(3)</sup> with a focus at the EU level. Climate risks are as a general principle evaluated at the pan-European level. When a climate risk affects different parts of Europe very differently, regional assessments were conducted for four sub-continental regions: northern, western, central-eastern and southern Europe.

EUCRA evaluates the urgency to act for all major climate risks according to five categories: urgent action needed, more action needed, further investigation, maintain current action and watching brief. The urgency to act for each climate risk is determined based on the risk severity and confidence level over time, policy horizon and policy readiness.

EUCRA was supported by an independent risk review panel. This panel consisted of senior European experts on climate impact modelling, climate risk assessment and adaptation planning. The panel members reviewed and, where necessary, adjusted authors' initial assessments of risk and policy characteristics to ensure homogeneity and comparability across the different chapters of the EUCRA report.

EUCRA draws on a wide range of knowledge and expertise, but subjective elements cannot be completely avoided. The risk assessment process was designed to produce policy-relevant results in a transparent manner. Nevertheless, each step includes some subjective elements from the experts involved, such as how narrowly or widely to define a climate risk, how to combine knowledge from different sources or assumptions related to the future development of non-climatic risk drivers. Furthermore, the methodology includes guidance on how to evaluate the severity of risks to the economy, health and ecosystems in a comparative manner. Such a comparison unavoidably requires assumptions on the importance of risks affecting very different systems and aspects of societies. Finally, the policy assessment is only indicative: this first EUCRA did not consider national policies and policy implementation in a systematic manner.

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<sup>(2)</sup> Risk severity categories: Catastrophic – Very large and frequent damage, very large extent or very high pervasiveness, irreversible loss of system functionality, systemic risk. Critical – Large and frequent damage, large extent and high pervasiveness, long-term disturbance of system functionality, cascading effects beyond system boundaries. Substantial – Substantial losses, moderate extent or pervasiveness, temporary or moderate disturbance of system functionality. Limited – Limited or rare losses, no significant disturbance of system functionality. Further information, including quantitative benchmarks related to climate risks to people, the economy and ecosystems, is available in the main report.

<sup>(3)</sup> Policy readiness categories: Medium – policies, plans, strategies or legislation are in place, but their targets and objectives are vague, or only short-term actions are considered. Advanced – policies, plans or strategies that manage the risk effectively are partly in place.

## European Environment Agency

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