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COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT REPORT

EU Frameowork of Climate Resilience

Accompanying the document

Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

establishing a framework to enhance climate resilience and amending Regulation (EU) 2018/1999 (European Climate Resilience Law)

{COM(2026) 730 final} - {SEC(2026) 730 final} - {SWD(2026) 730 final} - {SWD(2026) 732 final}

TRACE: Projected economic damages and mortality in EU under different climate scenarios

The maps presented here display a selection of outcomes from the TRACE (Territorial Risk Assessment of Climate in Regions of Europe) project, which focuses on assessing climate risks at the regional level across Europe (EU-27, Norway, Switzerland, and the UK), with NUTS-3 resolution (1,366 regions). The research examines 47 climate risks under various global warming scenarios projected for 2050. In particular, central and upper estimates of these impacts are provided for warming levels of 1.5°C, 2°C, and 3°C in 2050.

These maps highlight two major impact areas: the effects on human mortality due to non-optimal temperatures and poor air quality, and the direct economic impacts of climate change. Economic impacts are further classified by sectors—agriculture, residential, industry & commerce, coastal ecosystems, transport, and energy—and include the projected effects due to labour productivity losses.

The following table details the climate risks included under each of the sectors of the assessment.

Economic impacts

Agriculture
Damage to agriculture from river flooding
Damage to agriculture from coastal flooding
Agriculture losses due to drought
Damage to agriculture buildings due to drought-induced soil subsidence
Damage to agriculture from windstorms
Damage to agriculture from wildfires
Agriculture labor productivity losses

Industry and commerce
Damage to buildings/assets from river flooding
Damage to buildings/assets from coastal flooding
Productivity losses due to drought (lack of water)
Damage to buildings due to drought-induced soil subsidence
Damage to buildings and assets from windstorms
Damage to buildings and assets from wildfires
Labor productivity losses

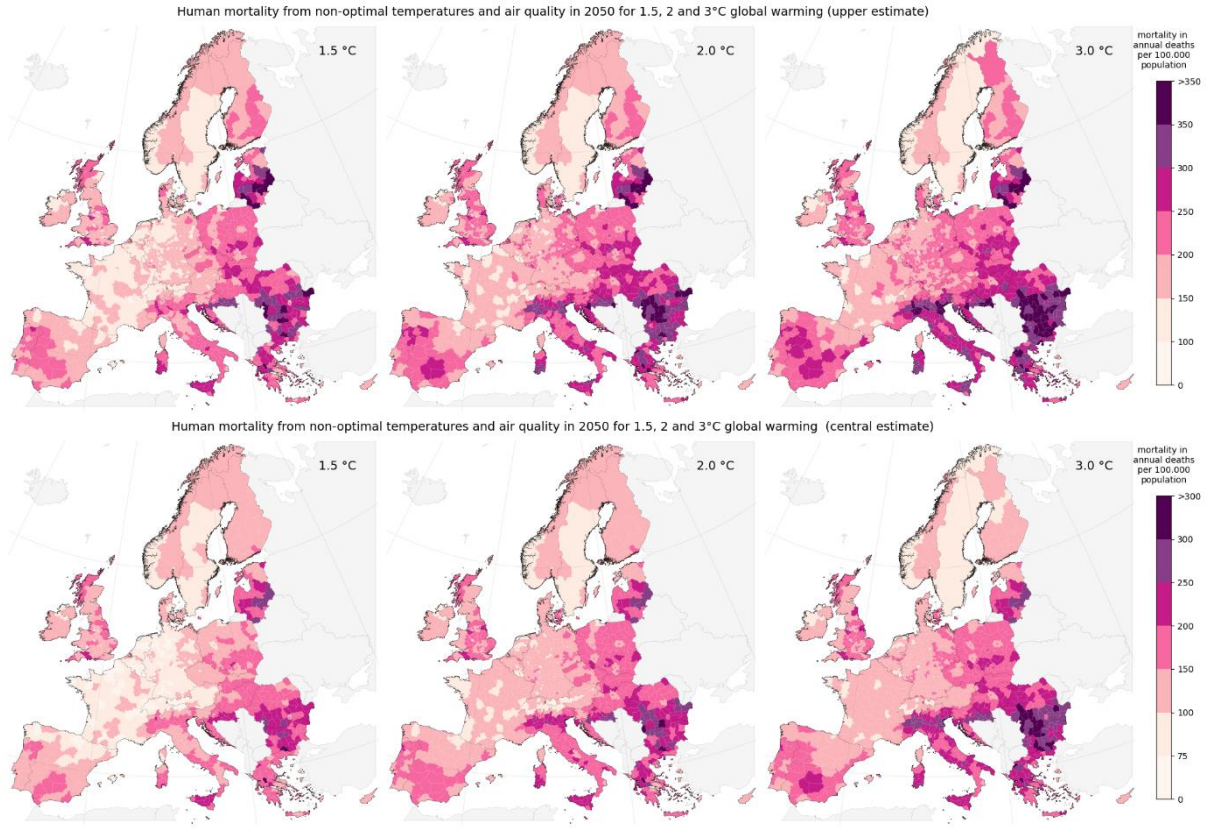
Energy
Damage to buildings/assets from river flooding
Damage to buildings/assets from coastal flooding
Losses energy production due to drought
Damage to energy buildings due to drought-induced soil subsidence
Energy labor productivity losses
Damage to buildings/assets from wildfire

Residential
Damage to houses/assets from river flooding
Damage to houses/assets from coastal flooding
Damage to houses due to drought-induced soil subsidence
Damage to houses/assets from windstorms
Damage to houses/assets from wildfires
Construction labor productivity losses

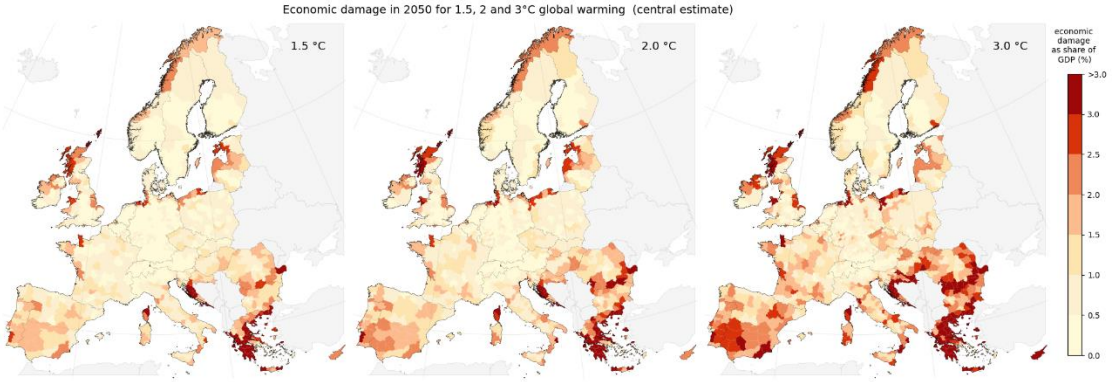
Transport
Damage to infrastructure from river flooding
Damage to infrastructure from coastal flooding
Navigation impacts from drought
Damage to infrastructure due to drought-induced soil subsidence
Damage to infrastructure from windstorms
Damage to infrastructure from wildfire
Labor productivity losses
Heat impacts on rail and road infrastructure

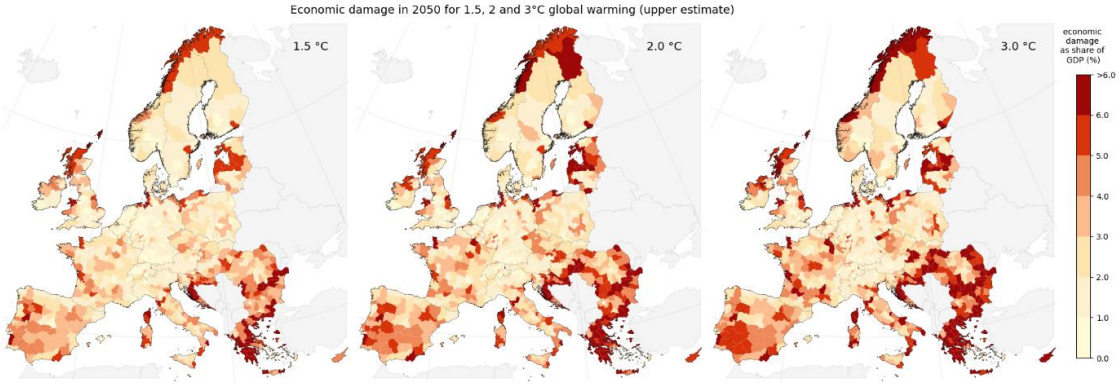
Ecosystems
Loss ecosystem services from coastal erosion

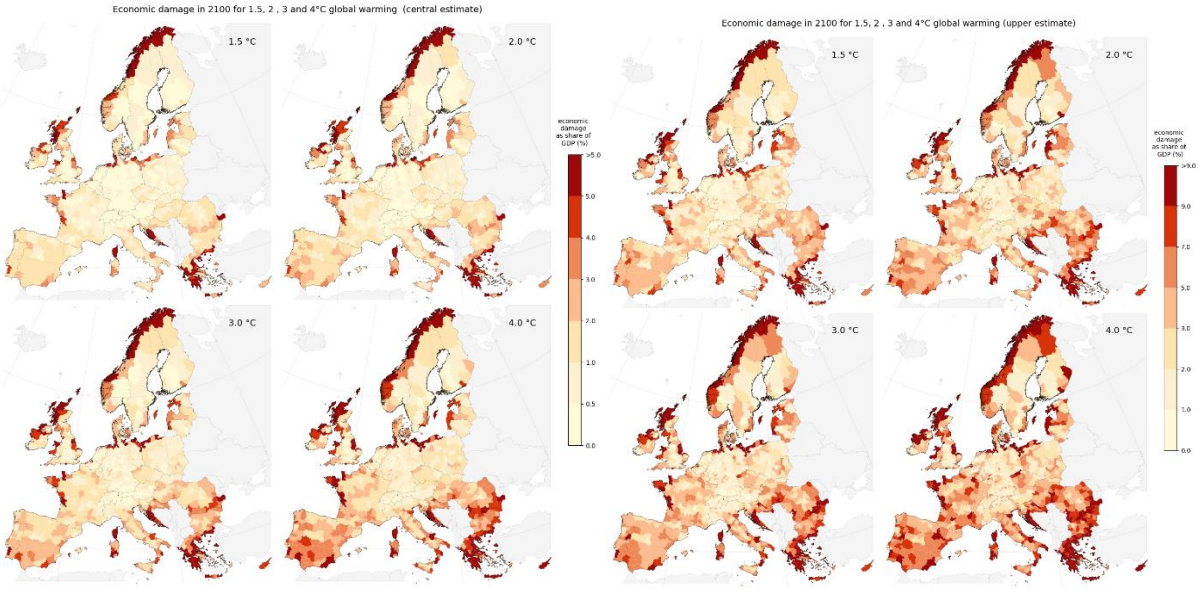
Human mortality from non-optimal temperatures and air quality in 2050 for 1.5, 2 and 3°C global warming, central and upper estimate



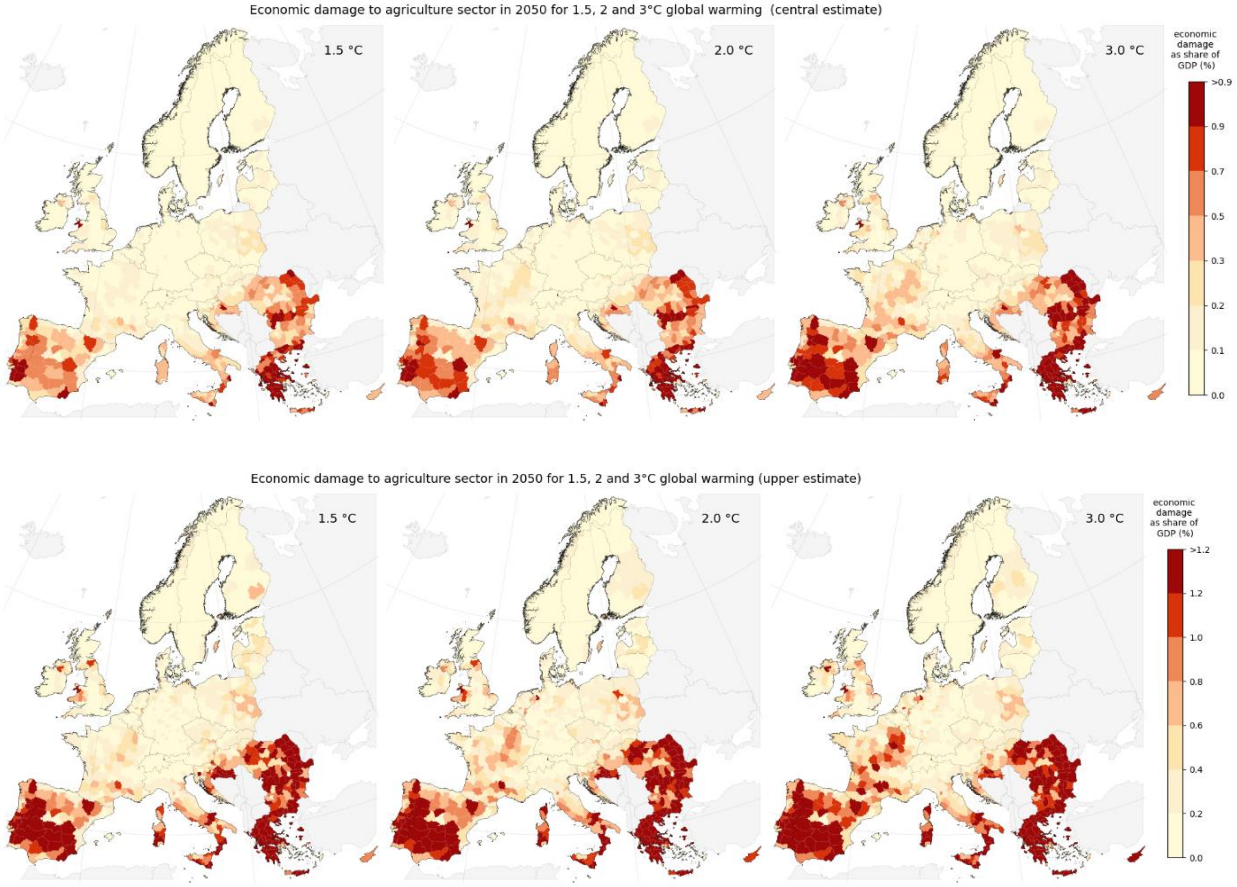
Economic damage in 2050 and 2100 for 1.5, 2 and 3°C global warming, central and upper estimate



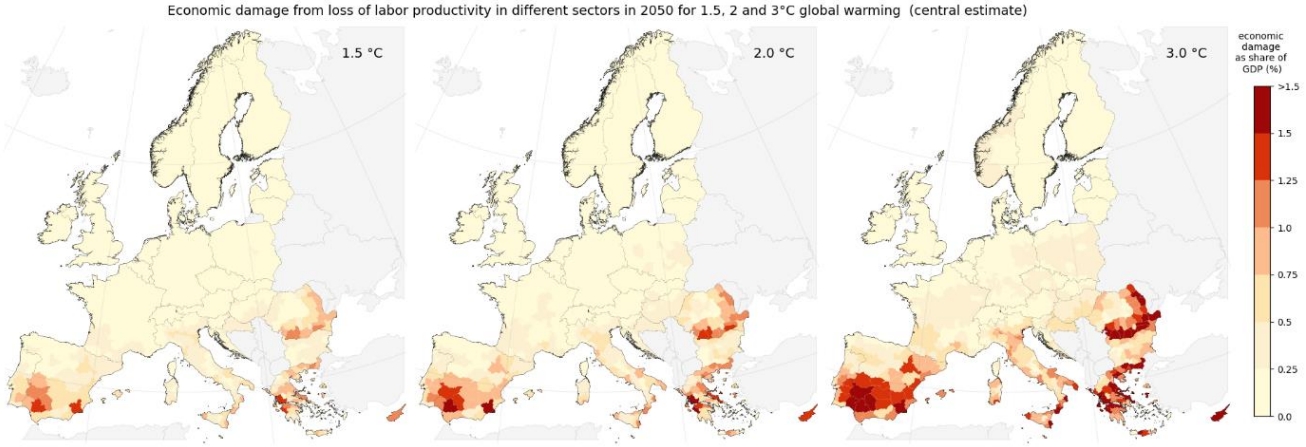


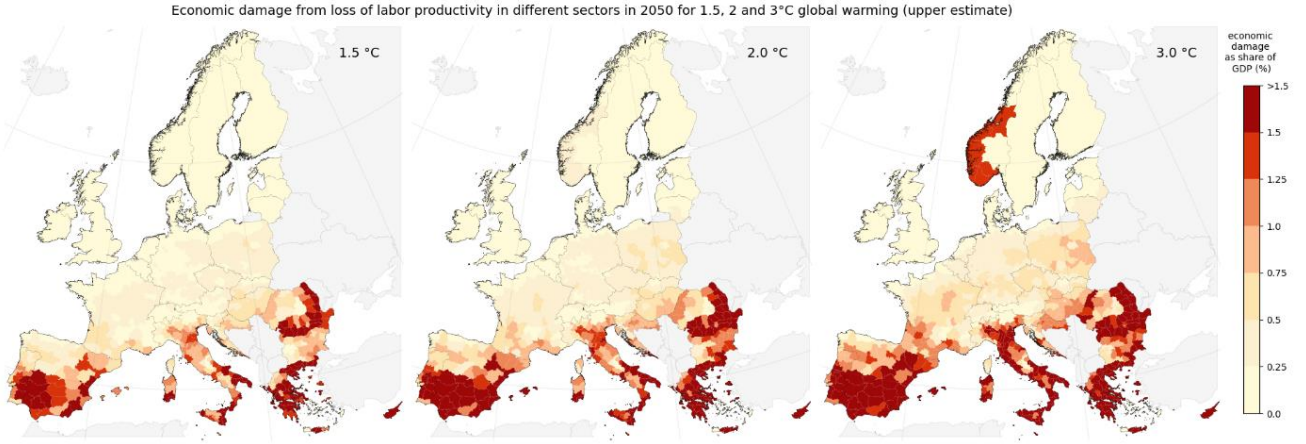


Economic damage to agriculture sector in 2050 for 1.5, 2 and 3°C global warming, central and upper estimate



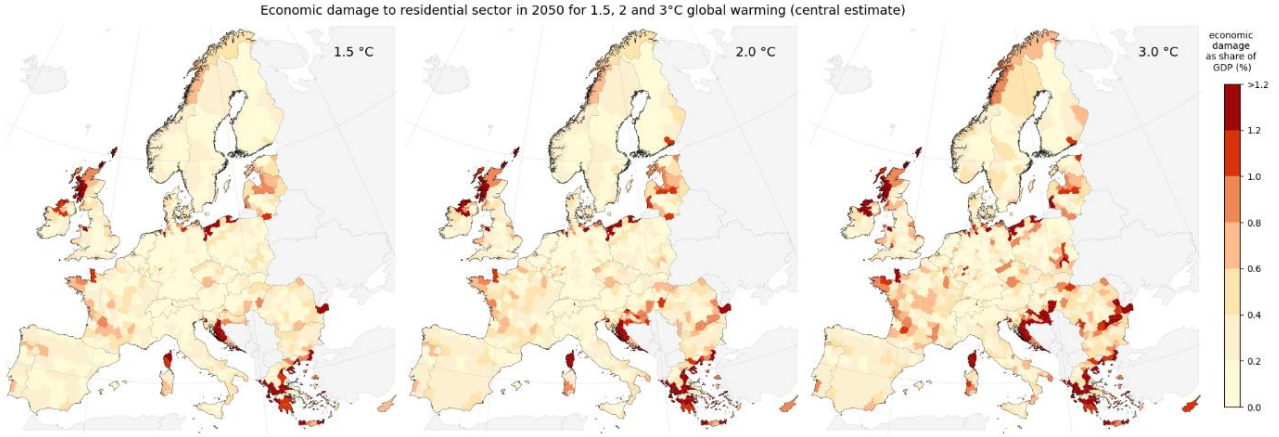
Economic damage from loss of labour productivity in different sectors in 2050 for 1.5, 2 and 3°C global warming , central and upper estimate

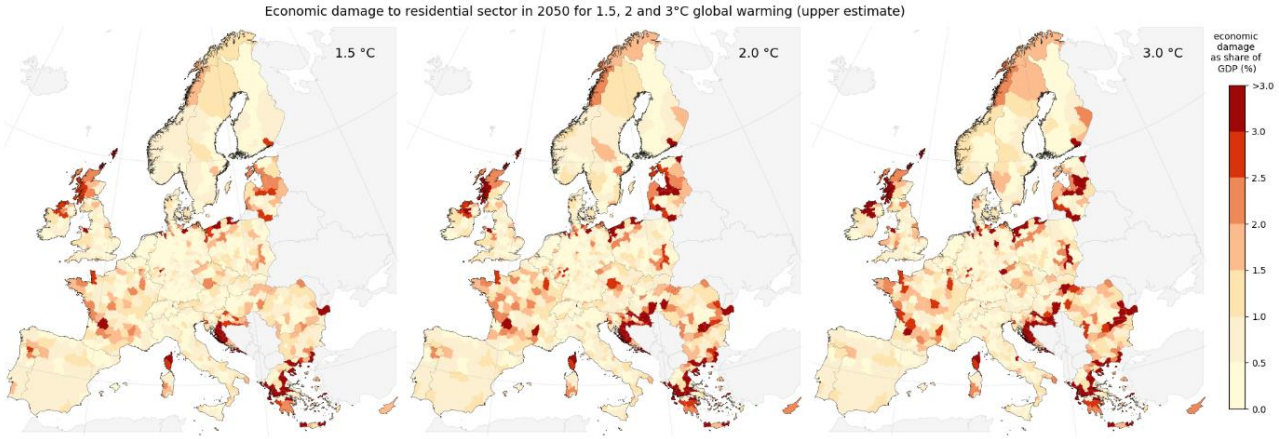




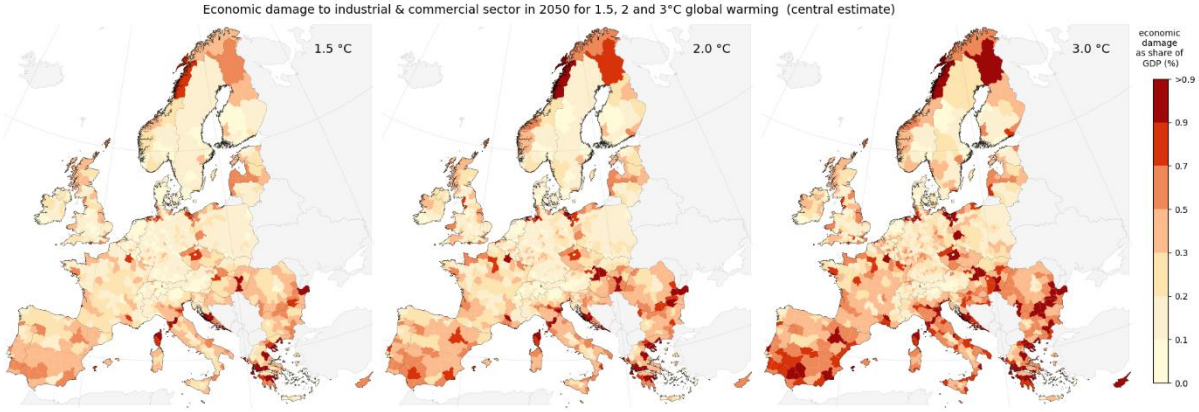
Note: the maps above represent the damages due to labour productivity losses. They are the result of the aggregation of the realted losses across the six economic sectors presented at the table at the beginning of this section.

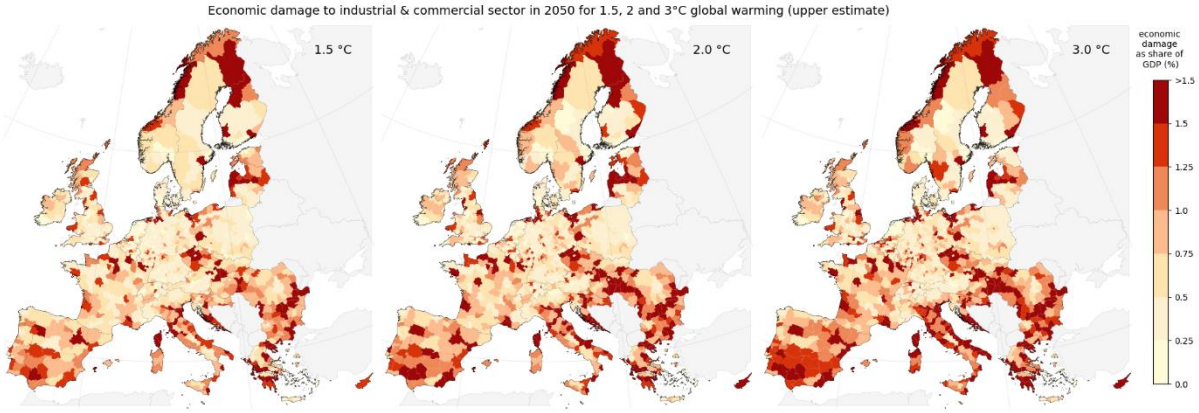
Economic damage to residential sector in 2050 for 1.5, 2 and 3°C global warming, central and upper estimate



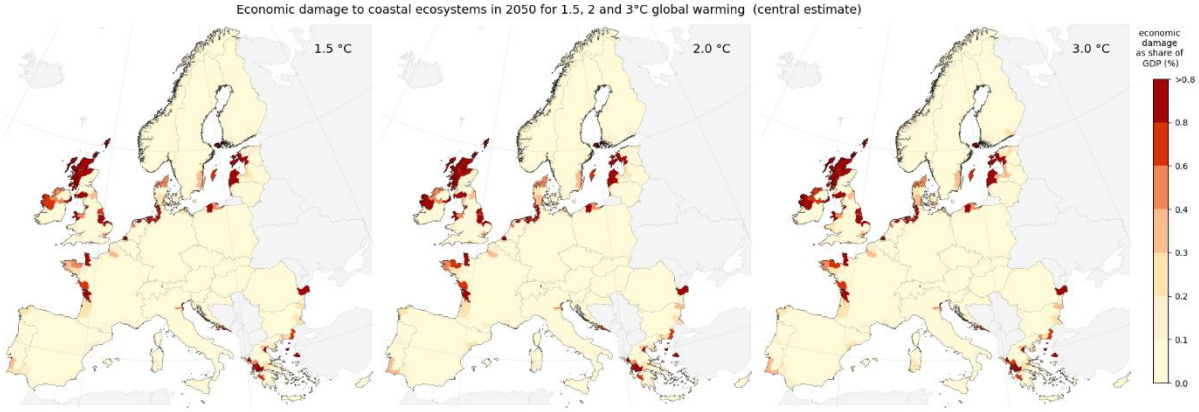


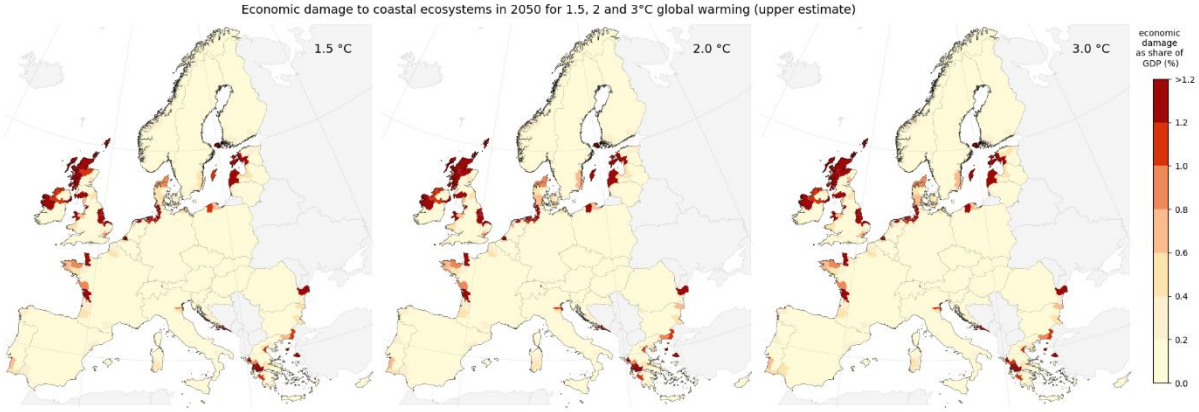
Economic damage to industrial & commercial sector in 2050 for 1.5, 2 and 3°C global warming, central and upper estimate



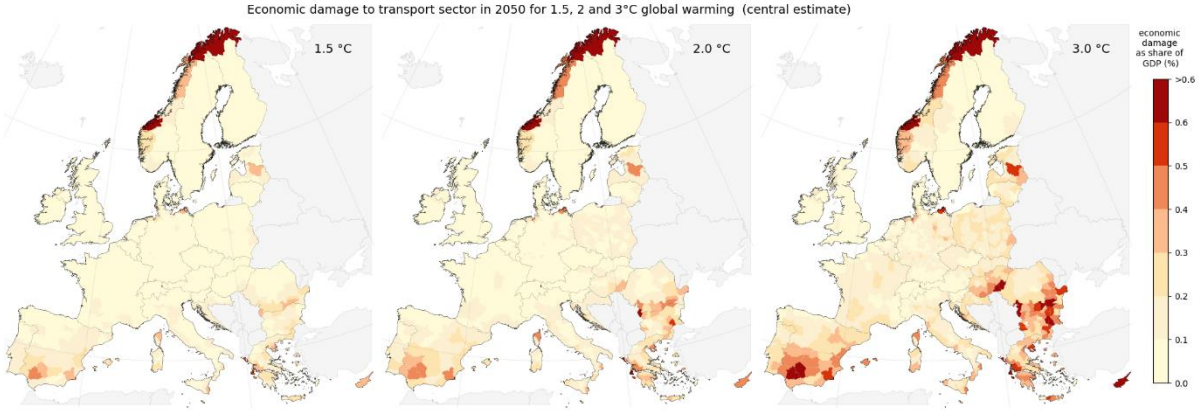


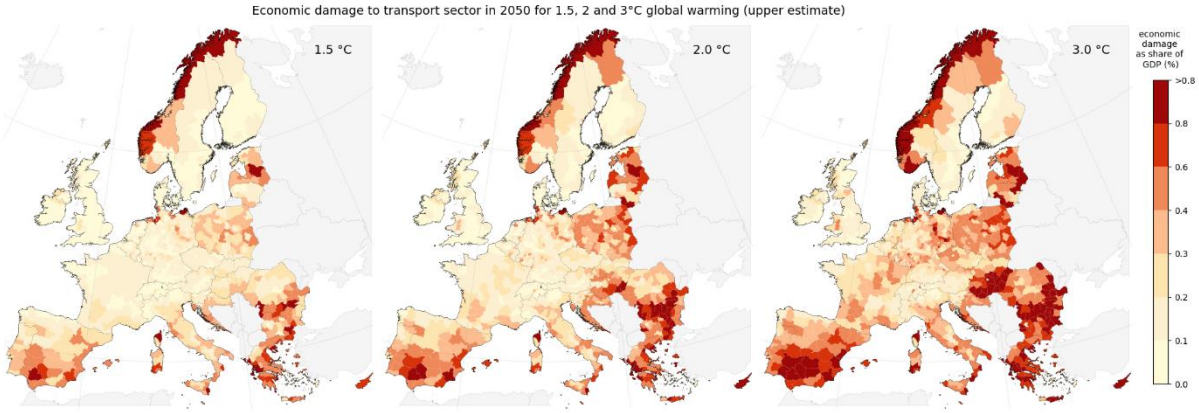
Economic damage to coastal ecosystems in 2050 for 1.5, 2 and 3°C global warming, central and upper estimate



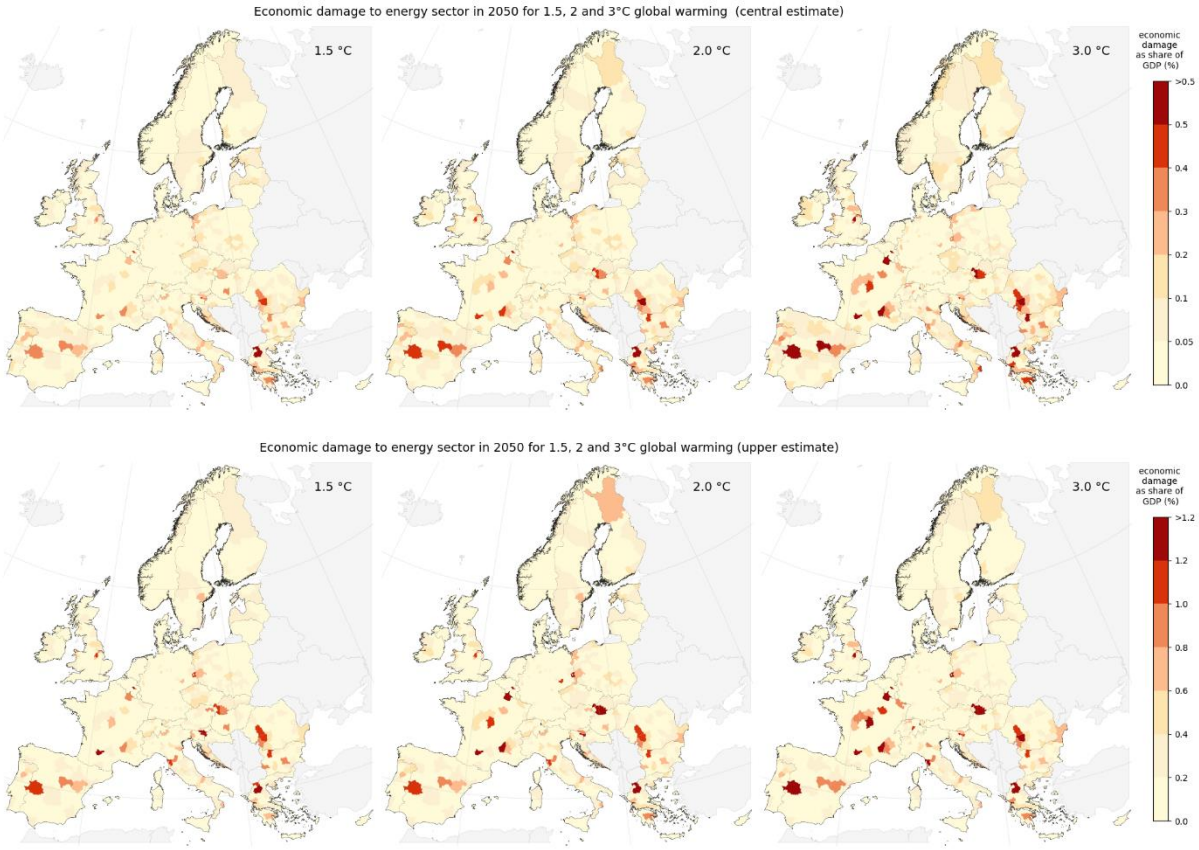


Economic damage to transport sector in 2050 for 1.5, 2 and 3°C global warming, central and upper estimate





Economic damage to energy sector in 2050 for 1.5, 2 and 3°C global warming, central and upper estimate



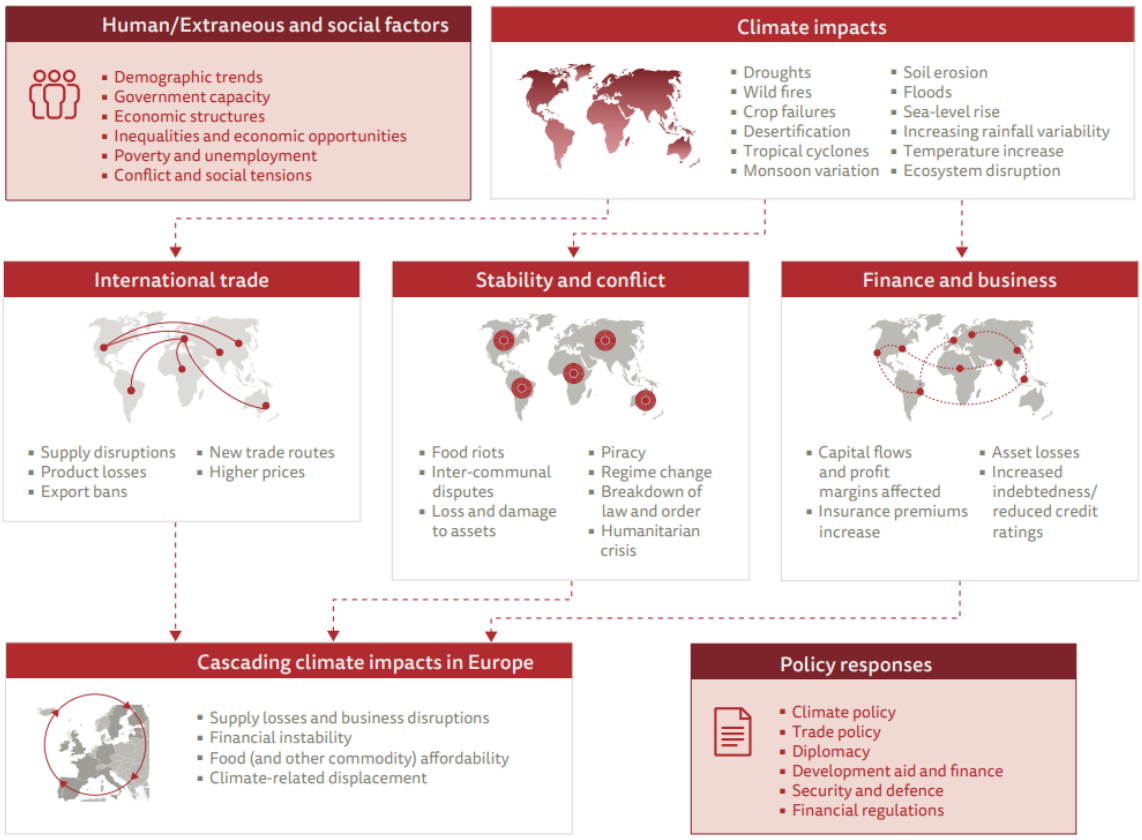
International dimension and systemic risks

Impacts of climate change, both extreme weather events and gradual climatic changes, can have cascading effects that cross borders and continents. The effects can further cascade and escalate through political and security relations, international trade, supply chains, financial markets, international aid as well as migration.[1] As a strongly interconnected actors, the EU is hence not only exposed to the regional effects of a changing climate, but to the transboundary impacts of climate risks materialising elsewhere.[2] For example, European companies with assets and operations in affected areas may see shocks influence capital flows, profit margins and insurance premiums, with potential knock-on effects for the banking sector and national economies.

With their potential to lead to far reaching and unforeseen effects – potentially affecting political and social stability worldwide, these transboundary risks have been increasingly recognised as a systemic risk for the EU endangering its security and prosperity in the short and long run.[3]

[1] (Auer et al., 2025; Hildén et al., 2020)
[2] (Hildén et al., 2020; West et al., 2021)
[3] (Auer et al., 2025; Clark et al., 2025; Council of the European Union. European External Action Service, 2021; Harris et al., 2026; Knaepen et al., 2022; West et al., 2021)

Figure: Examples of European exposure to cascading climate impacts.



Source: Hilden, et al. 2020

In the past, cross-border and cascading climatic impacts have taken governments and business by surprise increasing the risk for adverse impacts and limiting local, national and EU-level resilience.

While some policies and strategies such as the Climate Change and Defence Roadmap or the European Green Deal already feature transboundary climate change impacts, improved policy coherence and a comprehensive nexus approach in addressing interconnected vulnerabilities in policies across all sectors is needed.[4]

This starts with recognising these cross-border impacts of climate change, monitoring current international dependencies, such as critical resource dependencies (e.g. critical minerals, technologies or fertiliser) and developing an understanding of climate change risk and resilience in critical sourcing countries and strategic partners.

[4] (Auer et al., 2025; Hildén et al., 2020; Knaepen et al., 2022)

The EU has already acted on this need with the CASCADES project, which aimed to understand the conditions under which conditions climate risks propagate and may adversely affects European stability.[5]

Furthermore, the Corporate Climate Change Adaptation Supplier-of-Suppliers Sustainability Project aims to reveal the hidden climate risks in supply chains for improving European resilience to cascading supply chain risks.[6]

[5] (European Commission, 2019)
[6] https://sdglabs.ai/projects/3ca3s

Potential benefits of climate resilience – sectoral examples

Ecosystem Resilience and its compounding mitigation effects

Ecosystem investment carries some of the highest aggregate returns, reflecting the cross-sectoral co-benefits that healthy ecosystems deliver — flood attenuation, drought buffering, carbon sequestration, water quality, and support for agricultural productivity. The Commission's own Impact Assessment for the Nature Restoration Law estimated EU-wide restoration costs at approximately €7.4 billion per year, with a benefit-cost ratio of bet 4 – 38:1.

More targeted evidence reinforces this:

- **Greece (floodplain and natural water retention restoration):** Restoring natural floodplains and river retention areas delivers a BCR of 2.5, alongside ecological benefits including improved water quality, groundwater recharge, and reduced drought risk. [7]
- **Wetland restoration (EU-wide):** Studies show wetland restoration reduces annual maximum peak flows by 12–24%, lowers occurrence of high flow events by up to 45%, increases low flows in summer by up to 21% (reducing drought risk), and reduces nitrogen exports by 38–50% and phosphorus exports by 52–67% — delivering measurable value to downstream agriculture and water systems. [8]

Realising returns at the upper end of the 4–38:1 Nature Restoration Law range depends on ecosystem investment being coordinated with the sectoral planning decisions that determine where ecosystem services are most needed. The duty to consider climate risk across policy and investment decisions is the mechanism that drives this coordination; **risk ownership frameworks clarify which authority is responsible for maintaining the ecosystem functions that underpin returns in agriculture, water and flood management**, preventing the free-riding that currently leaves ecosystem investment chronically underfunded relative to its cross-sectoral value.

Food Sector Returns

Agriculture accounts for more than half of total drought losses in Europe (approximately €4.8 billion annually) and faces accelerating exposure as drought frequency and severity increase under all warming scenarios.[9] The investment case for food sector adaptation is in part a case for arresting ongoing productive capacity depletion: over 60% of European soils are currently assessed as unhealthy, with degradation costs estimated at €40.9–72.7 billion per year from erosion, nutrient loss, compaction and contamination alone.[10] While robust benefit-cost ratios for food sector adaptation remain difficult to quantify given the challenge of monetising ecosystem co-benefits and the absence of standardised assessment frameworks, available

[7] (European Commission. Joint Research Centre., 2020b)
[8] (Aubert et al., 2022)
[9] (European Environment Agency, 2026)
[10] (European Environment Agency, 2026)

European evidence trends consistently positive. EEA analysis of 51 farm transitions across Europe found that climate-resilient practices such as reduced tillage can deliver production cost reductions of around 40%, diesel savings of around 50%, and labour reductions of 25–30%, connected to lower dependence on external inputs and restored soil-water functions.

The food sector's returns depend on farmers having access to reliable climate risk information and the agronomic guidance to act on it. The duty to consider climate risk in agricultural planning and rural investment decisions is the mechanism through which public investment is directed toward the practices with demonstrated returns. **Climate resilience by design in food system infrastructure, from irrigation networks to storage and supply chain logistics, ensures that capital investment in the sector is not rendered obsolete by the climate conditions it will face over its operational life**. Risk ownership can also improve conditions where drought losses fall on uninsured farmers and cascade to rural economies and food supply chains, the absence of clear risk allocation discourages the anticipatory investment that the BCR evidence justifies.

Health Sector Benefits

The health sector offers some of the most striking benefit-cost ratios in the adaptation literature, driven primarily by the low cost but high mortality-reduction impact of heat-health early warning systems (HHWS). EEA analysis drawing on studies across European capital cities — including Madrid, London and Prague — estimated BCRs for heatwave warning systems ranging from 11:1 to 3,700:1, depending on the valuation method, time horizon, and climate scenario applied. Even at the lower end of this range, heat-health warning systems represent among the highest-return public health investments available.

Peer-reviewed assessment of HHWS across Europe consistently classifies them as 'no-regret' or 'low-regret' adaptation, with BCR greater than 1 under both current and projected future climate conditions. Benefits are realised through reduced heat-related mortality and morbidity, reduced healthcare utilisation, and reduced public health system costs — particularly for elderly and vulnerable populations.

Urban infrastructure investments that deliver health co-benefits alongside temperature reduction show more moderate but consistently positive returns:

- **Berlin (urban green infrastructure — tree drains, facade greening, green roofs):** BCR of 1.09–1.91, accounting for reduced heat-related hospitalisations and mortality. [11]
- **Austrian cities — Mödling, Klagenfurt and Salzburg (green infrastructure with high-albedo surfaces):** BCR of 1.27–2.68, generating billions in localised social and health benefits. [12]

[11] (Johnson, Exl et al., 2021)
[12] (Johnson, See et al., 2021)

- **Nitra, Slovakia (urban transformation to community gardens):** Social return of €2.15–€4.27 per €1 invested, beyond direct temperature reduction benefits. [13]
- **Ireland (social housing retrofit — fabric-first approach):** BCR of 1.43–1.92 when indirect societal benefits including improved health outcomes and reduced public maintenance costs are included. [14]

The exceptional returns on heat-health warning systems which are achievable at very low cost relative to avoided mortality are unrealised where no authority has a clear duty to act. **The duty to consider climate risk in public health and urban planning decisions converts these no-regret investments from optional additions into standard practice.** Climate resilience by design in urban infrastructure procurement, building codes and public space planning similarly ensures that the moderate but consistent BCRs on green infrastructure are captured systematically rather than project by project.

For climate-sensitive infectious diseases, the evidence similarly supports early prevention and preparedness as highly cost-effective adaptation measures. Research concludes that integrated surveillance systems combining epidemiological, entomological and climatic data enable earlier outbreak detection, allowing vector control and public health interventions to be deployed before widespread transmission occurs. These approaches can in turn reduce outbreak size, healthcare costs and productivity losses, particularly for mosquito-borne diseases such as dengue, chikungunya and West Nile virus, which also carry a rising global economic burden.[15]

Economic and Financial Returns

The economic and finance sector represents the smallest investment requirement in Table 2 but performs a structurally distinct function in enabling more effective mobilisation of investment flows in all other sectors. CGE modelling[16] from across Spain, Austria and the Netherlands provides indicators of fiscal returns to adaptation.[17] In Spain, adaptation reduces GDP losses from 0.69% to 0.22% under expected annual climate impacts by mid-century, with government revenue rising 1.01% relative to a no-adaptation baseline. This is driven primarily by avoided productivity losses and stronger consumption tax revenues. Austria shows comparable results where GDP losses fall from 0.51% to 0.09% and government revenue rises 0.71%. The cumulative adaptation debt stock implied by these investments remains modest at 0.10% of GDP in Spain and 0.99% in Austria by 2050 confirming that the fiscal commitment involved is manageable relative to the returns generated. The case of the Netherlands highlights a

[13] (Vačková et al., 2025)
[14] (Colclough, 2021)
[15] (Roiz et al., 2024) https://linkinghub.elsevier.com/retrieve/pii/S0048969724032017; (World Health Organisation, 2017) https://cdn.who.int/media/docs/default-source/searo/india/health-topic-pdf/9789241512978-eng.pdf?sfvrsn=7294b7b5_2
[16] Computable General Equilibrium (CGE) modelling is a frequently used quantitative methodology for evaluating the effects of various economic scenarios on different parts of the economy. Estimations are for risk impacts are most likely underestimations due to underlying assumptions of the models, hence benefits of adaptation can be even higher then estimated here.
[17] (Preinfalk et al., 2026)

particular problem in adaptation returns accounting. Modelling shows that high flood protection costs reduce fiscal space under expected annual damages, but this result reverses sharply under tail-risk conditions. Under severe and rare but increasingly likely flood conditions, adaptation limits GDP losses to 0.18% compared with 16.02% without it and raises government revenue 33.7% relative to the no-adaptation scenario. The implication is that governments **evaluating adaptation against expected annual costs alone are systematically underinvesting relative to the fiscal risk-adjusted optimum** and that the 75% insurance protection gap, which leaves uninsured climate losses to fall on public balance sheets, compounds this problem.

Quantified BCRs for this category are sparse in the EU literature, returns are realised primarily through indirect channels: improved risk pricing in insurance and financial markets, reduced credit default risk, avoided fiscal costs from uninsured losses, and faster economic recovery after climate events. The major benefit of this sector is enabling value: risk assessment infrastructure, climate disclosure frameworks, and financial risk management tools are preconditions for the efficient allocation of the much larger investment flows in the other sectors.

Defence and Security

What distinguishes climate preparedness in defence and security from the other sectors examined above is that there has historically been a low level of data collection on both investment requirements and returns in this space. Unlike infrastructure, health or food, where investment needs and indicative benefit-cost ratios can be drawn from a growing body of European evidence, the JRC and European Defence Agency noted as recently as 2023 a paucity of quantitative studies on the impacts of climate change on military installations and an absence of systematic guidance for assessing climate risk and resilience in defence. No equivalent of the sectoral investment needs estimates underpinning Table 2 exists for defence. Many EU military installations may currently be operating under unknown climate risk, with climate hazards, energy system dependencies and cascading infrastructure failures not yet systematically assessed across Member States' defence estates.

There are significant recent developments in this space. A growing body of analysis and political consensus encourages climate risk assessment systematically. Defence investment must be climate-proofed by design, and civilian and military resilience planning must be coordinated. At the 2025 Hague Summit, NATO allies committed to investing 5% of GDP annually in defence and security-related spending by 2035, with up to 1.5% of GDP explicitly designated for civil preparedness, resilience, critical infrastructure protection and supply chain resilience. The Integrated Framework's duty to consider climate risk across public investment decisions, common risk assessment standards, and risk ownership frameworks provide exactly the infrastructure which would ensure ownership of risk and resilience by design which can be used to effectively mobilise increased funding toward climate-proofed assets and dual-use capability, grounded in evidence rather than assumption, and closing the data gap that has

historically prevented this sector from making the investment case that the others in this analysis can now make.

Cross Cutting Measures

Cross-cutting investments including integrated early warning and monitoring systems, climate risk data infrastructure, and capacity building are embedded within the sectoral returns described above but should also be acknowledged separately. EEA analysis identifies early warning systems as a class among the highest-return adaptation investments in the literature, with the heatwave warning system BCR evidence (11:1 to 3,700:1) representing the upper bound of documented adaptation returns across all sectors. Multi-hazard early warning systems that serve multiple sectors simultaneously have similarly high aggregate returns relative to their modest operating costs.

The high returns on early warning and monitoring systems are contingent on those systems being shared, interoperable and built on common risk data. None of this emerges from fragmented national approaches. Climate resilience by design, applied to data infrastructure and monitoring investment, and a common risk assessment standard underpinning the duty to consider, are what convert isolated high-performing pilot systems into the EU-wide early warning capability that realises returns at scale.

The degree to which the success of these investments vary is dependent on the reach and efficacy of the actions themselves.