



# Assessment of EU and Member States Adaptation Investment Needs

Study on the macro-economic impacts of the climate transition

January 2026

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Directorate-General for Climate Action  
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## Final Report: Assessment of EU and Member States Adaptation Investment Needs

Study on the macro-economic impact of the climate transition (CINEA/2023/OP/0013)



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# 1. Introduction

This report presents the findings of a comprehensive assessment of climate adaptation investment needs across the European Union, undertaken by Ricardo and the Euro-Mediterranean Centre on Climate Change (CMCC). The assessment forms part of Task 2 of the wider study titled Macro-economic impact of the climate transition, commissioned by the European Climate, Infrastructure and Environment Executive Agency (CINEA).

The purpose of this assessment is to provide a robust, evidence-based estimate of the investment needs – as represented by the cost of implementation of adaptation actions – required to adapt to climate risks in Europe. As climate impacts intensify, understanding the scale and distribution of adaptation investment needs becomes increasingly important for policy planning, budget allocation, and strategic prioritisation. This analysis supports the European Commission’s overall work on adaptation and resilience, on guiding Member States in developing coherent and cost-effective responses to climate risks and in its efforts to mainstream adaptation into fiscal frameworks.

The assessment was structured around several methodological phases. The methodology for each phase is discussed briefly, along with the results, in Chapter 2 and in the individual chapters that follow. These include the identification of climate risks at the level of Member States (Chapter 3), the selection and characterisation of adaptation measures (Chapter 4), the compilation of cost data (Chapter 5), the development of a scaling methodology to ensure comparability across Member States (Chapter 6), and the estimation of investment needs to 2050 (Chapter 7). The study also includes a sensitivity analysis to test the robustness of the results, and an assessment of the investment needs under an urgent investment scenario that focusses on priority areas for early action (Chapter 8). Chapter 3, 4, 5 and 6 are summaries of more detailed reports that were developed in earlier stages of the project. These reports have been published separately in full to ensure full transparency on the methodology applied.

The assessment focused on key sectors, including ecosystems, infrastructure, food, health, and economy and finance, alongside a dedicated analysis of cross-cutting measures such as research, innovation, education, and awareness. Each chapter presents the methodological steps followed, and key findings.

## 2. Methodology overview

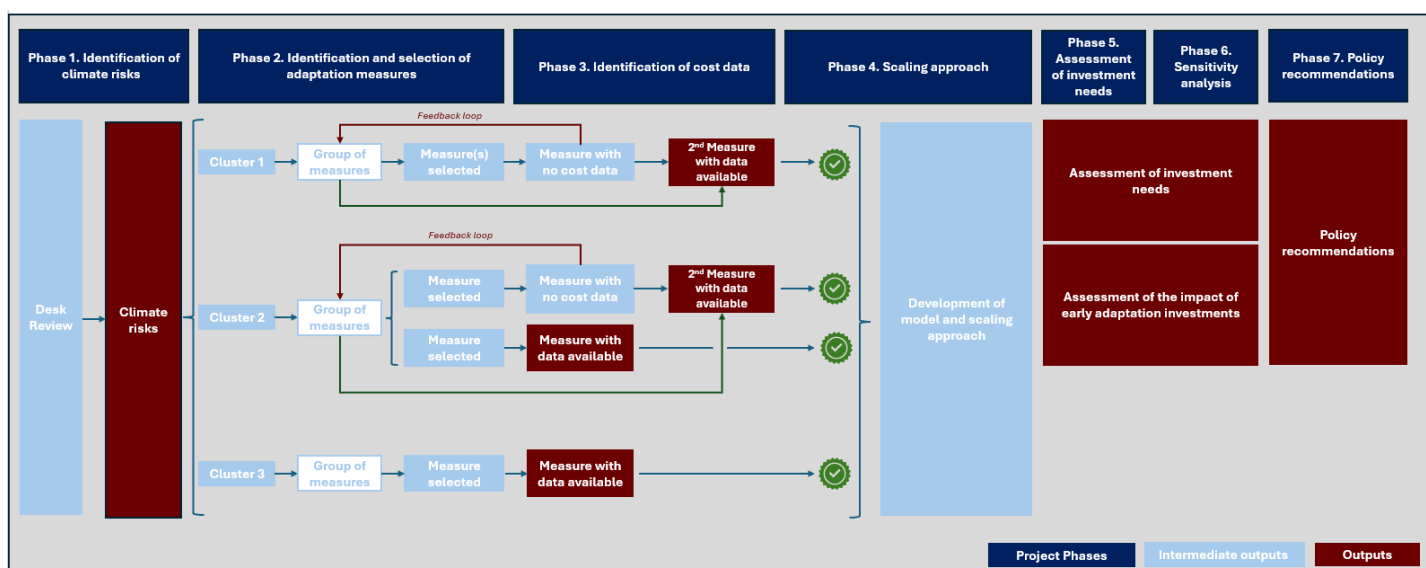
A bottom-up methodology was used to estimate the adaptation investment needs in the EU. This included an estimate of the investment needs at Member State (MS) level, and for specific sectors. The approach consisted of sequentially assessing the climate risks facing the 27 Member States, identifying the adaptation measures that may address those risks, estimating the individual cost of the measures, and then assessing the total cost of all measures applied in combination to address the risks in each of the 27 Member States (as well as by sector). Finally, the MS level cost estimates were further aggregated to assess the adaptation investment needs for the whole EU.

Compared to a top-down approach, the applied methodology allows a better representation of the specific measures required by the MS (e.g., measures outlined in a country's National Adaptation Plan (NAP)) which can inform more detailed investment plans. A further benefit of a bottom-up approach is that it allows adaptability and scalability. This means that investment costs can be tailored to the specific requirements of individual countries and sectors, thereby enhancing the relevance and applicability of the assessment. However, this flexibility comes with drawbacks, such as the significant data demands, where data is required for many individual measures.

The methodology was structured into the following sequential Phases:

- **Phase 1. Identification of climate risks.** Definition of sectoral coverage and identification of climate risks by sector and MS.
- **Phase 2. Identification and selection of adaptation measures.** Compilation of adaptation measures planned at MS level and/or proposed in relevant literature. Harmonisation and definition of a relevant and representative set of adaptation measures to be costed.
- **Phase 3. Identification of cost data.** Compilation of cost data from existing sources. Comparison and validation of these sources.
- **Phase 4. Scaling approach.** Development of a methodology for scaling available estimates consistently across all Member States to make them comparable at an EU level.
- **Phase 5. Assessment of investment needs.** Estimation of adaptation investment needs by sector and MS.
- **Phase 6. Sensitivity analysis.** Assessment of the impact of early adaptation investments. Evaluation of the robustness of the proposed analysis approach.
- **Phase 7. Policy recommendations.** Discussion of possible ways forward to promote the implementation of adaptation investment by the public and private sector.

Figure 1 Overview of the methodology.



To ensure alignment with the conceptual framework of the European Climate Risk Assessment (EUCRA), individual sectors were grouped into five clusters: **Infrastructure, Health, Ecosystems, Food, Economy and Finance**. In addition, individual climate risks identified at the national level were aligned to one of the 36 categories in the EUCRA. This approach allows coherence and continuity with any policy decisions that may be made based on the outcomes from the EUCRA.

When assessing climate risks from different sources, the underlying climate scenario strongly influences the results and therefore affects how comparable those assessments are. In Phase 1 of the study, when collecting data on climate risks severity at the MS level, and for consistency with EUCRA, mid-century (2050) and the medium trajectory scenario (RCP4.5) were taken as reference, where available.

The appropriate level of adaptation/resilience goal to address the climate risks is methodologically complex to identify. It involves balancing risk reduction – for example by identifying acceptable levels of exposure or residual risk, or maintaining status quo – societal priorities and resource efficiency, which should consider cost efficiency investments that do not waste public resources and avoid maladaptation. In addition, Member States rarely include clear, quantified resilience or adaptation targets in their NAPs or NAS. Instead, most countries articulate broad, qualitative objectives such as increasing resilience or reducing vulnerability, but do not translate these into measurable and time-bound targets.

Faced with these uncertainties, this study has identified and assessed adaptation needs based on the priorities stated by MS in their own strategic plans, with the assumption that these documents provide the best estimate of the adaptation needs for each respective MS.

The timeframe for when the climate change adaptation investments are assumed to be required is the period 2021-2050, which is considered 'mid-term'. Based on this, investment needs are defined as the total resource required from each Member State to achieve the level of adaptation consistent with country's specific exposure profile and risk drivers, over the 2021-2050 timeframe.

### Previous studies estimating EU adaptation investment needs

Several studies have estimated the scale of adaptation investment needs. They differ in breadth and focus, with some quantifying costs to reduce specific risks, others inferring needs from projected damages, and some

compiling indicative ranges for policy and finance discussions. Together they point to substantial, rising needs for investment and highlight important methodological trade-offs when modelling these investment needs.<sup>1</sup>

Recent synthesis work (CMCC<sup>2</sup>, drawing on JRC PESETA IV<sup>3</sup> and COACCH<sup>4</sup>) cites ~€35–56 bn/yr estimated adaptation needs now, rising to ~€80–120 bn/yr to address climate risks associated with the 2°C warming scenario and ~€175–200 bn/yr if temperatures increase by 3–4°C for the EU; meanwhile, the European Investment Bank (EIB) reports a much broader €35–500 bn/yr range estimated from existing studies. The range is driven by differing assumptions about climate scenarios, sectoral coverage, methodologies and financing conditions presented the different studies synthesised in the report.<sup>5</sup>

The World Bank (2024) report “Climate adaptation costing in a changing world: Valuing climate adaptation helps us orient our compass toward effective and resilient pathways” reviews national and sectoral studies of climate adaptation costs across Europe and presents consolidated ranges. The report estimates that annual investment needs for Europe lie between €15 billion (lower bound) and €64 billion (upper bound) in 2022-Euro terms. Several factors influence this range, including which national studies that are used for the extrapolation of estimates (and how), the breadth of sectors and hazards included in those studies, and different assumptions about future risks, adaptation objectives, acceptable levels of residual climate risk, and methodological approaches (bottom-up or top-down costing method). The report also collates national estimates, which vary widely: from €3.96 million per year in Estonia to €11.6 billion per year in the UK, with mid-range examples of €2.3 billion per year in France and €2.7 billion per year in Romania.<sup>6</sup> These findings underline both the diversity of approaches at national level and the large uncertainty band at EU level.

The methods used in these studies vary. PESETA IV employs sectoral impact modelling, examining climate impacts across EU sectors under different scenarios and quantifying for selected risks how adaptation measures reduce damages and at what indicative cost, as in the case of coastal flooding.<sup>7</sup> The COACCH project uses a damage-to-need inference approach, linking estimates of the cost of inaction to the scale of adaptation required to avoid a large share of losses, producing scenario-dependent EU-wide annual needs. In both projects the level of adaptation ‘needed’ is therefore determined by considering both the costs and benefits of adaptation: PESETA IV does so by modelling how different measures reduce damages, while COACCH derives explicit adaptation needs by linking avoided damages to the scale of investment required. The estimates from the EEA and EIB are not based on any new modelling but instead compile ranges from multiple studies to inform policy and finance debates, emphasising uncertainty and data gaps in current spending. In parallel, several Member States have costed parts of their adaptation plans or programmes, although coverage and methods differ and results are not easily comparable.

Despite methodological differences, all studies point to a requirement for tens of billions of euros per year today, rising substantially with warming and exposure. Investment needs are concentrated in high-ticket sectors such as coastal and river flood protection, resilient infrastructure and buildings, drought and water management, and

<sup>1</sup> *Assessing the costs and benefits of climate change adaptation*, European Environment Agency (2022). Available at: <https://www.eea.europa.eu/publications/assessing-the-costs-and-benefits-of/assessing-the-costs-and-benefits>

<sup>2</sup> CMCC (2023). *The cost of adaptation: Why Europe can't afford inaction*. [Press Briefing synthesising EEA/JRC/COACCH results] <https://www.cmcc.it/about/media-and-outreach/cmcc-climate-adaptation>

<sup>3</sup> JRC PESETA IV (2020a). *Adapting to rising coastal flood risk in the EU*. Available at: <https://op.europa.eu/en/publication-detail/-/publication/cb40cf4f-9655-11ea-aac4-01aa75ed71a1/language-en>

<sup>4</sup> COACCH Project (2021–2022). *Policy briefs on economic costs of climate change in Europe*. Available at: <https://www.coacch.eu/>

<sup>5</sup> *The EIB Climate Adaptation Plan: Supporting the EU Adaptation Strategy to build resilience to climate change* (2021). Available at: <https://www.eib.org/en/publications/the-eib-climate-adaptation-plan>

<sup>6</sup> World Bank (2022). *Climate adaptation costing in a changing world: Valuing climate adaptation helps us orient our compass toward effective and resilient pathways*. Available at: <https://documents1.worldbank.org/curated/en/099050224072021662/pdf/P179070140a07209a1b5d012d978862b4ff.pdf>

<sup>7</sup> JRC PESETA IV (2020a). *Adapting to rising coastal flood risk in the EU*. Available at: <https://op.europa.eu/en/publication-detail/-/publication/cb40cf4f-9655-11ea-aac4-01aa75ed71a1/language-en>

health. Sectoral studies, for example on coastal flooding, also show that adaptation investments can be far outweighed by avoided damages, underlining the strong economic case for taking action.

All studies have limitations. No single study provides a comprehensive, high-resolution assessment across all sectors, climate hazards, and stakeholder groups. Key areas such as ecosystem services, social and institutional responses, and certain types of critical infrastructure remain underrepresented or poorly quantified. Methods answer different questions, so results are not directly comparable and ranges as substantial as €35-500 billion reflect this divergence. Estimates are also highly sensitive to assumptions about warming pathway, level of protection, and socio-economic change. Finally, data on current spending remains limited and uneven across Member States, making it difficult to precisely measure the adaptation-related investments in budgets and plans.

These limitations highlight the value of the Member State-level bottom-up approach taken in this study. By aligning measures to nationally identified risks, using transparent scaling rules and proxies, and aggregating to an EU view, this method improves comparability, avoids double-counting, and enhances transparency.

## 3. Phase 1: Climate risk identification

This chapter provides a summary of the methodology and findings of the climate risk identification phase. For more detailed reporting, please refer to the Climate Risk Identification Report (Methodology Report 1) and its Annexes.

### 3.1 Method

The objective of this phase was to obtain a consolidated list of the main climate risks relevant to each of the 27 EU Member States. Mapping of the relevant risks is important to determine what adaptation measures are required to address and manage each of them, either by reducing sensitivity and/or exposure or by increasing adaptive capacity.

#### Step 1: Review of documents and extraction of information on national climate risks

The first step in this phase involved a review of the results from the EUCRA to ensure alignment with its risk classification. The EUCRA is the most comprehensive and up-to-date assessment of climate risks at European level, expanding on the findings of the latest IPCC report (Sixth Assessment Report). It identifies 36 major climate risks for Europe presented along eight thematic factsheets and seven risk storylines, and evaluates their potential adverse consequences, likelihood, and potential for cascading effects. In the context of the EUCRA, *severity* refers to the magnitude of potential adverse consequences of a given risk, assessed through semi-quantitative impact benchmarks and classified into four levels:

- Limited: impacts are minor or manageable with existing measures.
- Substantial: impacts are significant and may require adaptation efforts.
- Critical: impacts are severe and likely to exceed current adaptive capacity.
- Catastrophic: impacts are extremely severe, with potentially irreversible or system-wide consequences.

Severity levels are combined with policy characteristics to determine the 'urgency to act'. While the EUCRA provides detailed regional and sectoral analysis for Europe and defines clusters of the most impacted sectors, it does not include country-level results. Therefore, additional national sources were required to identify and characterise risks at MS level. These included national climate risk assessments, national climate change adaptation planning and strategies (NCCAPS) reporting, and in some cases additional sectoral policies. The most recent NCCAPS reporting was submitted by Member States to the European Environment Agency in 2023 under the Regulation on the Governance of the Energy Union and Climate Action, which requires countries to report every two years on the preparation, implementation, and evaluation of national adaptation strategies and actions. The NCCAPS were used as the primary source for collecting detailed information on the climate risks of each Member State, as they provide a harmonised and up-to-date dataset in English, limiting the impact of the heterogeneity and language variety of national documents. These reports include information on observed and future hazards, their likelihood and trends, as well as vulnerability and impact assessments across sectors such as agriculture, infrastructure, human health, and forestry. The reporting structure is standardised across Member States and uses a three-point scale (low, medium, high), complemented by qualitative descriptions. If the information contained in the NCCAPS was deemed insufficient or if other national documents, such as national climate risk assessments, were considered more comprehensive, climate risks were extracted from these, and NCCAPS were used as a secondary source.

From the reviewed documents, a list of climate risks was compiled, together with their associated sector and, where available, the corresponding severity level. Where risks were reported for different climate scenarios<sup>8</sup> and time horizons (current, mid-century, end-century), these were recorded. For consistency with EUCRA and the other activities of the project, mid-century (2050) and the medium trajectory scenario (RCP4.5) were taken

<sup>8</sup> Climate scenarios combine Shared Socioeconomic Pathways (SSPs), which describe possible future socio-economic developments, with Representative Concentration Pathways (RCPs), which represent greenhouse gas concentration trajectories leading to different levels of global warming.

as reference. While risks were harmonised in this way, the cost evidence could not be aligned to a single scenario or horizon, as sources differ in scope and timing. Where severity classifications were missing, they were assigned by the project team based on qualitative descriptions.

The severity levels of the risks reported by Member States are assumed to already take into account adaptive capacity, and the latter has not been assessed explicitly. This is discussed further in Figure 2 below.

Figure 2 Understanding Adaptive Capacity and how it influences climate risk severity

According to the **IPCC AR6**, climate risk results from the interaction of **hazards**, **exposure**, and **vulnerability**. Vulnerability reflects the tendency of people, ecosystems, and assets to be affected by climate-related hazards and is determined by two key elements:

- **Sensitivity** – the degree to which systems are affected, either negatively or positively, by climate variability or change. For example, crop yields may change in response to temperature variability, or infrastructure may suffer damage from more frequent coastal flooding.
- **Adaptive capacity** – the ability to adjust to potential damage, take advantage of opportunities, or respond to consequences.

Adaptive capacity acts as a moderating factor in determining the **severity** of climate risks. High adaptive capacity — such as strong institutional preparedness, effective early-warning systems, and robust infrastructure — can reduce the level of risk from *critical* to *substantial* or lower. Conversely, limited adaptive capacity may amplify impacts, increasing overall risk severity.

In this assessment, adaptive capacity has been implicitly reflected in cases where national documents reported moderate severity levels despite high exposure or sensitivity. For instance, in several Member States, the presence of established health systems and heat-alert mechanisms has been considered sufficient to limit the severity of **heat-related health risks** to *substantial* rather than *critical*.

For the scope of this Phase of the study, the different components of risk have not been treated separately. Rather, risk severity has been considered as the main indicator when collecting the information from national documents and mapping this to the EUCRA risk categories, on the assumption that sensitivity and adaptive capacity were taken into account when assessing the severity.

## Step 2: Mapping of national risks to EUCRA categories and sectors

In the second step, we mapped and reconciled the MS-identified risks with the 36 risks defined in the EUCRA. This ensured that the investment needs assessment was based on a consistent and harmonised set of risks for all MS (i.e. those used in the EUCRA). The mapping used the titles and descriptions of each of the climate risks that were provided in the original national sources. Large Language Models (LLMs) were then used to provide an initial mapping to the EUCRA risks, which was then manually verified for accuracy. The EUCRA list was found sufficient to cover all national risks, though some assumptions were necessary. For instance, risks in the tourism sector were first grouped according to whether they referred to winter or summer tourism, and in some cases reclassified under related EUCRA risks such as heat stress, water scarcity, or transport disruption. Similarly, risks linked to international supply chain disruptions were associated with the EUCRA category on business disruptions outside Europe. The EUCRA risk on the European solidarity mechanism was not identified in any of the MS sources. In line with EUCRA, each risk was also assigned to one of five sectoral clusters (ecosystems and biodiversity, food, health, infrastructure, economy and finance), ensuring consistency in subsequent phases.

## Step 3: Mapping risks to EUCRA severity levels

In the third step, each risk was assigned to one of the severity levels used in the EUCRA (catastrophic, critical, substantial, limited). This was done by aligning the scales used in national documents to EUCRA categories:

three-point scales (low, medium, high) were associated with limited, substantial and critical; five-point scales were reduced to limited, substantial and critical; while other scales were reviewed on a case-by-case basis. To avoid overestimation, no national risks were assigned as catastrophic, reflecting both the compressed scales used in national reporting and the fact that the EUCRA itself classifies only one risk as catastrophic by mid-century.

#### **Step 4: Standardisation of severity levels**

As national risks grouped under the same EUCRA category could vary in severity, we harmonised severity levels to assign one value per EUCRA risk per country. This was done by taking the median severity, supported by the mode, where necessary. In some cases, qualitative judgement was required. The number of national risks per category was not considered, as it reflects reporting granularity rather than severity. Finally, to ensure alignment with the EUCRA four-level classification, risks located in EUCRA-defined 'hotspot' regions, such as Southern Europe, were adjusted upward by one level. This included risks such as wildfires, crop production losses, heat stress, water scarcity, and energy disruption from heat and drought, which EUCRA identifies as having particularly high potential impacts in these regions. This provided a more robust basis for capturing regional variation in risk severity across Europe. This harmonisation process is illustrated in the example below, which shows how multiple risks identified in Germany's national documents under the agriculture sector were grouped under the corresponding EUCRA risk (*Risk to crop production in Europe from adverse weather conditions due to climate change*) and assigned a single harmonised severity level using the EUCRA scale. This meant that all risks national risks associated with a given EUCRA risk, had the same severity level.

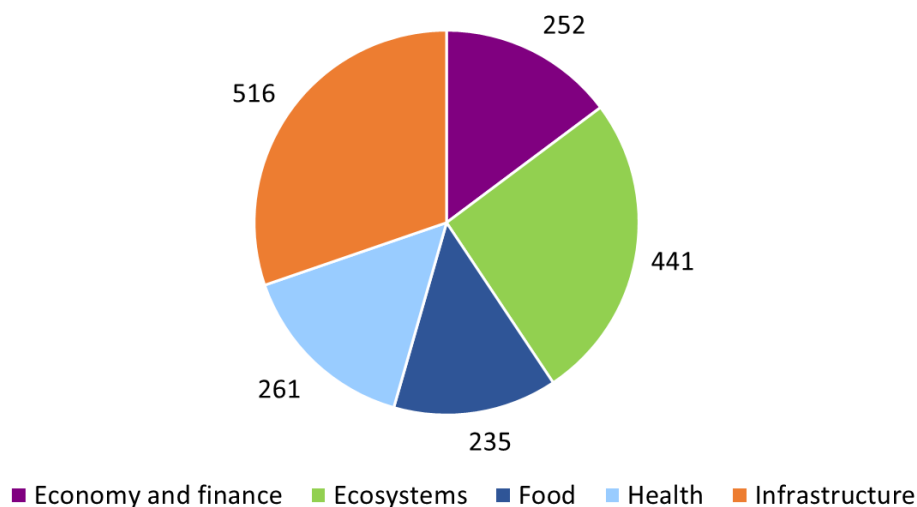
Country	Sector (original)	Risk in national document	Associated EUCRA risk	Sector (EUCRA)	STEP 3	STEP 4
					Associated severity (EUCRA scale)	Harmonized severity (EUCRA scale)
Germany	Agriculture	Abiotic stress (plants)	Risk to crop production in Europe from adverse weather conditions due to climate change	Food	Critical	Substantial
Germany	Agriculture	Shift in growing areas	Risk to crop production in Europe from adverse weather conditions due to climate change	Food	Substantial	Substantial
Germany	Agriculture	Change in agrophological phases and growing seasons	Risk to crop production in Europe from adverse weather conditions due to climate change	Food	Substantial	Substantial
Germany	Agriculture	Loss of yields	Risk to crop production in Europe from adverse weather conditions due to climate change	Food	Critical	Substantial
Germany	Agriculture	Quality of harvest products	Risk to crop production in Europe from adverse weather conditions due to climate change	Food	Substantial	Substantial

Table 1 Example of standardisation of severity levels for Risk to crop production

## 3.2 Findings

As a result of this phase, a total of 1,707 risks were identified from national documents. When mapped to the five EUCRA clusters, a majority of risks fall within the infrastructure and ecosystems sectors (56%).

Figure 3 Risk identified in national documents linked to the 5 EUCRA sectors

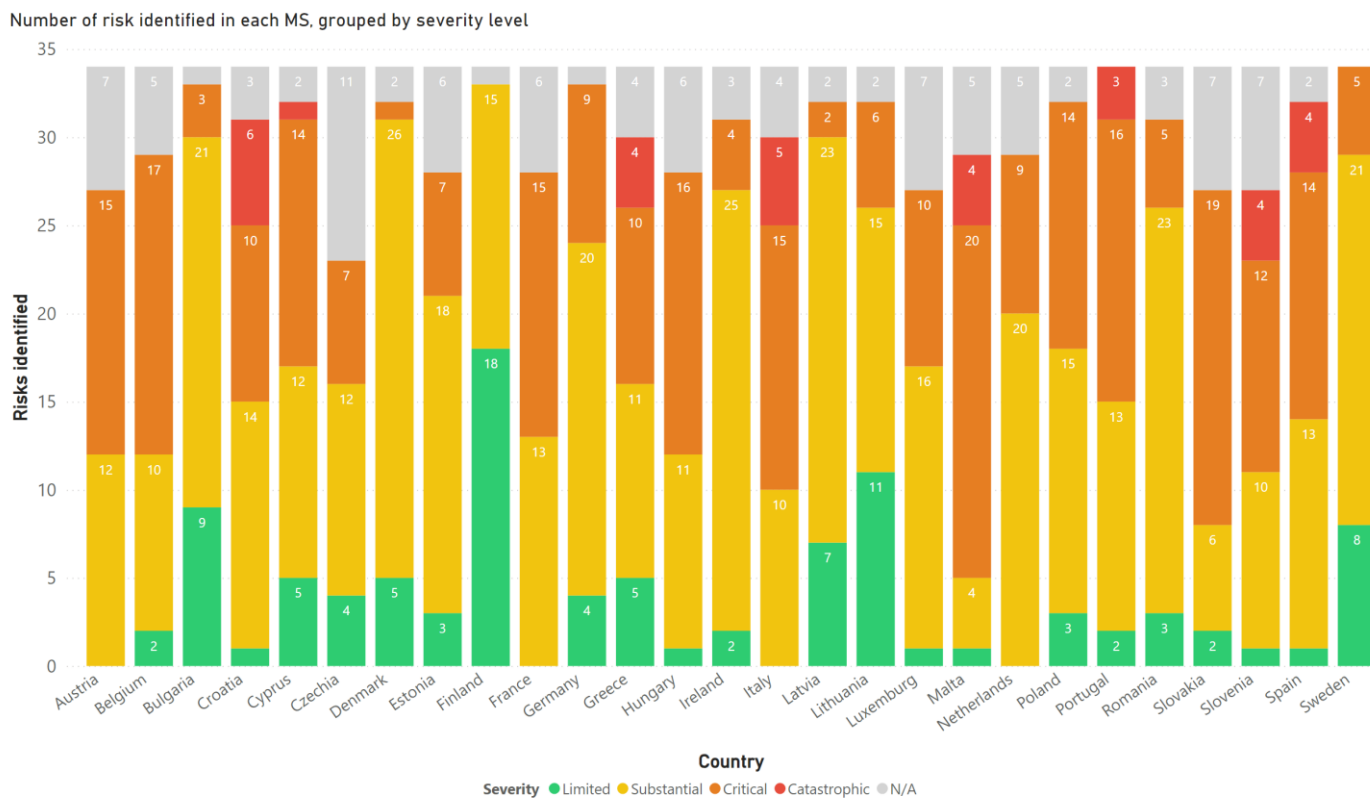


In terms of correspondence with EUCRA, almost all (94%) of the 36 risks defined in the European assessment were also identified at national level, suggesting that the EUCRA risks provide a good basis for harmonising the national risks. The two exceptions observed were the risk to pharmaceutical supply chains due to extreme weather outside Europe and the risk to the EU Solidarity Mechanism, neither of which appeared in national assessments.

When looking at severity, most risks reported by Member States were classified as *critical* or *substantial*, with fewer assigned to the *limited* category and only a small number classified as *catastrophic*, mainly in Southern European countries, reflecting the upward adjustment described previously in step 4 to account for EUCRA-identified hotspot regions. Compared with EUCRA, which applies a more uniform classification, with no risks in the limited category and only one (heat stress on human health) deemed catastrophic at mid-century, national

reporting shows greater heterogeneity. This variation reflects the absence of a common methodological framework for assessing severity across Member States, with differences in the scales, criteria, and time horizons used to evaluate impacts. As a result, the national assessments provide a more fragmented picture, highlighting the predominance of medium-to-high severity risks. Figure 3 below illustrates the number of risks identified per Member State after the alignment with EUCRA, broken down by severity level.

Figure 4 Number of the 36 EUCRA risks identified in each EU Member State, grouped by severity level<sup>9</sup>.



Several divergences between national results and the EUCRA are evident. In some cases, risks appear underestimated in national documents. For instance, the risk to human health from heat stress, classified as catastrophic in the EUCRA, is ranked as limited in some northern countries such as Finland and Sweden. Similarly, Greece and Cyprus assess risks to fisheries and aquaculture at a limited level, compared to the critical level identified by the EUCRA. In other instances, risks appear overestimated. About half of Member States classify risks to crop production as critical, whereas the EUCRA reserves the critical ranking for Southern Europe and applies a substantial level to other regions. There are also examples of conservative assumptions, such as Cyprus ranking the risk to coastal ecosystems from erosion and inundation as limited, despite the EUCRA's classification of this risk as critical.

Despite these divergences, common patterns are evident across Europe. Risks to infrastructure and the built environment are consistently reported across all severity levels, underlining the sector's vulnerability to floods, storms, heatwaves, and sea-level rise. The risk of heat stress on human health is particularly prominent in Southern and Central Europe, with countries such as Malta, Spain, Portugal, Austria, and Hungary reporting high levels of concern. In some cases, the adaptive capacity (measures already in place in MS) to deal with increasing temperature has been identified as good enough to limit the severity of the risk to substantial rather than critical. Agriculture and crop production risks are also widely reported as critical or substantial, particularly in Southern and Central Europe, where drought and temperature extremes threaten yields.

<sup>9</sup> The N/A category reflects the number of risks in EUCRA which do not find a corresponding risk in the national assessments. In this case, Sweden is the only country for which at least one risk that falls within each of the EUCRA risk categories has been identified. The figure shows only 34 EUCRA (out of 36 total) categories because during the analysis of national documents EUCRA risks to pharmaceutical supply chains due to disruptions outside Europe, and risk to functioning of the EU solidarity mechanism did not show correspondence in any MS assessments.

Other cross-cutting themes include the increasing recognition of water scarcity, not only in Southern Europe but also in traditionally water-abundant northern countries such as Finland and Latvia, pointing to changing hydrological cycles. Flooding, whether coastal, pluvial, or fluvial, is also a widespread concern, with national assessments generally focusing on direct damages while paying less attention to cascading effects across interconnected infrastructure networks, a key element highlighted in the EUCRA. Energy disruption due to the combined impacts of heat and drought is particularly critical in Southern Europe, where reduced hydropower generation coincides with rising electricity demand for cooling. Finally, risks to biodiversity and carbon sinks from wildfires are increasingly recognised in Northern Europe, including Sweden, Latvia, and Germany, reflecting the growing threat to forests that also serve as key carbon sinks.

When looking at results across the EUCRA's climatic regions, regional patterns emerge. In Southern Europe, heat stress on human health and damage to infrastructure are dominant, together with water scarcity and wildfire risks. In Central-Eastern Europe, crop production and water-related risks are consistently critical, reflecting the agricultural importance of the region. In Western Europe, health risks from heat stress, infrastructure vulnerability, and aquatic ecosystem degradation due to reduced flows are most prominent. In Northern Europe, fisheries and aquaculture risks stand out, along with flooding and biodiversity losses, although severity levels are generally lower than in other regions.

### 3.3 Discussion

The results of this phase provide a harmonised overview of climate risks across EU Member States, but they also reveal important limitations and opportunities for improvement.

A first challenge lies on the reliance on national documents that are highly heterogeneous in scope, quality, and timeliness. Some Member States provide detailed quantitative assessments with severity rankings, while others report only qualitative descriptions. Scales also vary (two-, three-, four- or five-point), requiring methodological adjustments to ensure comparability. In addition, the lack of a harmonised framework means that not all sectors or risk categories are consistently covered, while cross-border and systemic risks are often overlooked.

Our approach also had limitations. To achieve consistency, we mapped national risks to the EUCRA framework and converted severity scales into EUCRA's categories. In this process, we refrained from assigning 'catastrophic' severity to national risks, except when adjusting severity upwards for hotspot regions identified in the EUCRA. While this improved comparability, it may also have smoothed over nuances in national assessments. Similarly, harmonising severity levels by using the median or mode within each EUCRA risk may have concealed extremes in the underlying data. The limited treatment of cascading effects and interdependencies across risks further reduces the granularity of the results. While the EUCRA identifies systemic and transboundary risks, our investment needs assessment primarily considered adaptation measures that could be mapped to national contexts. Cascading effects, such as disruptions spreading across interconnected infrastructure or supply chains, were therefore only indirectly represented and not fully costed.

These challenges suggest several areas for improvement. For policymakers, the lack of standardisation across national risk assessments underscores the need for stronger guidance on reporting formats, severity scales, and scenario use. Establishing a common EU framework would improve comparability and reduce the need for assumptions when aggregating national results. Methodologically, future work could integrate more quantitative indicators (e.g., exposure data, economic costs) and expand the treatment of systemic and transboundary risks. Stakeholder engagement and expert validation will also be essential to refine severity estimates and to capture national specificities not evident in documents alone.

## 4. Phase 2: Climate adaptation measures

Following the identification of climate risks for the 27 MS, the next phase of the study involved the development of a comprehensive and standardised list of the main climate adaptation measures that can mitigate those risks. This list was used as a key input to the next phase of the study, which involved the identification of cost data for each of the measure.

This chapter provides a summary of the methodology and findings of the climate adaptation measure identification and selection phase. For further details, please refer to the Climate Adaptation Measures Report (Methodology Report 2) and its Annexes.

### 4.1 Method

The climate adaptation measures phase concerned the identification, collation and standardisation of an extensive dataset of climate change adaptation measures that are applicable to the EU Member States. This activity also included an assessment of some key characteristics of the identified measures. The objective was to obtain a comprehensive list of the main climate adaptation measures that would be required to mitigate the climate risks identified for each of the 27 EU MS in the previous phase of the work.

The method involved several steps:

#### 1. Collection of adaptation measures from various sources.

To generate a preliminary list of adaptation measures for each Member State, we reviewed a number of sources, including the National Adaptation Plans (NAPs) and the National Adaptation Strategies (NASs) of the respective Member States, sectoral adaptation plans, EU-wide and multi-Member State studies (grey literature), academic literature accessed through Scopus, and information on adaptation-related research projects from CORDIS.

A database of adaptation measures was compiled. The following information was recorded for each measure: source, country, title of the measure, sector and risk the measure aims to mitigate.

#### 2. Matching of adaptation measures to the 36 EUCRA risks.

To help organise the list of measures, each individual measure was associated to one of the 36 risks in EUCRA. Since each EUCRA risk is also associated to a specific sector (Ecosystems, Economy & Finance, Food, Health, Infrastructure), each adaptation measure was therefore also associated with one of these sectors.

The matching was performed manually by using information previously collected on the adaptation measures. The table below provides an example of the result of this step for an adaptation measure from the Finnish NAP.

*Table 2 Output of the association of adaptation measures from original sources to EUCRA risk. Example from the Risk to population, infrastructure and economic activities from pluvial and fluvial flooding.*

Source	Country	Sector (original source)	Risk	Adaptation measure title	Adaptation measure description	Associated risk per EUCRA	Sector
NAP	Finland	Water management	Flood	Dams and Artificial Lakes	Building and managing dams and artificial lakes to control water flow and reduce flood risks.	Risk to population, infrastructure and economic activities from pluvial and fluvial flooding	Infrastructure

#### 3. Analysis of comprehensiveness and coverage of the initial list of measures

After the full list of adaptation measures was compiled, and each measure was matched to one of the 36 EUCRA risks, an analysis was then made of then coverage and consistency of the initial list of measures identified from national documents, against the risks identified at the Member State level.

This identified any potential inconsistencies at the Member State level between the identified risks in previous phase and the adaptation measures collected from national sources in this phase.

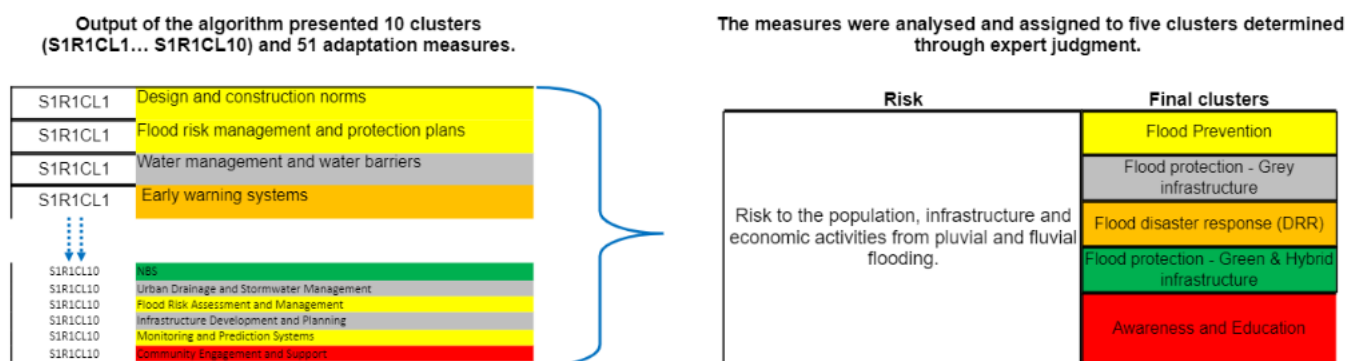
#### 4. Clustering and standardisation process

In the next step, an algorithm was developed to cluster and standardise the list of measures. The initial list of measures was highly variable in how measures are described, formulated and categorised across the different sources. If not addressed, this variability would make it difficult to consolidate measures into a coherent framework. Therefore, the individual measures were clustered together, and their descriptions were standardised.

Each cluster represents a broader grouping of a given measure type and each of the measures within the cluster correspond to the same climate risk and sector. The results of the algorithm were reviewed, re-classified and quality checked by the team using expert judgement.

An example of this process applied to the risk to the population, infrastructure and economic activities from pluvial and fluvial flooding as shown in Figure 5.

*Figure 5 Quality check and review of clustering exercise using expert knowledge, applied to the risk to the population, infrastructure and economic activities from pluvial and fluvial flooding.*



#### 5. Characterisation and selection of the measures.

The final step in the methodology was to prioritise and select the adaptation measures that would be costed in the next phase of the project. This was necessary to keep the list of adaptation options to a manageable number and allow efforts to be focussed on the most important and expensive measures, given the scope of this study. However, lower-cost and “low-regret” measures can still play a crucial role in reducing vulnerability and building resilience. Although these measures were not included in the costing exercise, they are highlighted in Figure 6 to acknowledge their importance in supporting effective and impactful adaptation strategies.

The shortlisting exercise was informed by the key characteristics of the measure, the main risk it addresses, and its attributes. Attributes included: intervention type, effectiveness to reduce key climate risk, efficacy to address multiple risks, potential maladaptation risk, linkages with mitigation, efficacy timeframe, lifespan and contribution to disaster management. When assessing the attributes, priority was given to measures that are highly effective to mitigate a risk, address multiple risks, are applicable to different MS contexts, and for which robust and relevant cost data could be identified.

Finally, informed by the availability of cost data and on the basis of the attributes, a shortlist of measures to address a specific risk was selected. This selection process was supported by the team's expertise and ensures that the proposed measures are representative and in line with the general objectives of this research. This resulted in a list of 62 clusters and 155 unique adaptation measures.

*Figure 6 Low cost and no regret adaptation measures*

For the scope of this study, low-cost measures or measures whose costs are negligible were given less importance, even though their contribution to climate resilience is significant. Many of these low-cost measures fall within the economy and finance sector. Some examples include promoting green investments; insurance programmes and risk management strategies tailored to different sectors; developing insurance systems for properties in high-risk areas; implementing green and climate bonds; supporting circular economy initiatives; implementing subsidy reforms and environmental taxation; fostering Public Private Partnerships in adaptation; implementing risk transfer and financing protection mechanism; water pricing and tariffs.

Within the ecosystem sector, some measures that were considered negligible in costs are: regulation and standards to prevent pollution; establishment of marine protected areas; legislation to control deforestation; optimization of dam management. In the health sector, examples include epidemiological and clinical research on infectious diseases, and outdoor work restrictions for outdoor workers during heatwave.

When discussing low-cost measures, it is important to also mention low-regret (or "no-regret") adaptation measures. These are actions that are relatively low costs and deliver benefits under a wide range of future climate scenarios. They are designed to be useful regardless of how climate risks evolve, ensuring that investments are not wasted even if climate impacts turn out to be less severe than expected.

Low-regret measures are central to climate adaptation planning because they reduce vulnerability and enhance resilience while providing immediate social, economic, or environmental benefits. They are especially valuable in contexts of high uncertainty about future climate impacts, as they minimize the risk of maladaptation costs. Implementing such measures can also help build institutional capacity, raise awareness, and create the foundations for more transformative adaptation in future stages. Some examples of low-regret measures that were identified during the study include enhancing building design standards, strengthening early warning systems, water resources optimization, leakage detection system, and restoring wetlands. In this study, many low-regret measures are included and costed within the cross-cutting sector. These include stakeholder engagement, communication and awareness actions, reporting efforts, vertical alignments and other initiatives aimed at mainstream adaptation in society. Under the finance and economy sector, measures such as taxonomy creation of climate-adapted products and services; enhancing climate risk disclosure and transparency are examples of no regret measures.

## 4.2 Findings

This section provides a summary of the clusters, and their associated shortlisted adaptation measures, that result from the completion of the activities described in the Methodology, up to adaptation measure definition. Table 3 is structured by EUCRA sectors. For each sector, the clusters, and the adaptation measures that are associated with them are listed below. A mapping of the adaptation measures to the 'most related' EUCRA risks is also shown.

More detail on the characteristics of the individual measures is provided in the Climate Adaptation Report (Methodology report 2) and its Annexes. This includes information on typology, efficiency, efficacy, maladaptation risk, linkages with mitigation, efficacy timeframe and timespan of intervention.

*Table 3 Summary list of adaptation measures and clusters per climate risk and sector*

Sector	Risk	Cluster	Adaptation measures	
Infrastructure	Risk of energy disruption due to damage to energy transportation or storage infrastructure following coastal or inland flooding	Relocation of energy assets	Relocation of substations and network stations to safer locations	
		Improved energy assets	Rerouting of critical energy transportation infrastructure	
			Physical reinforcement of energy assets	
			Reviewed design standards	
		Enhanced monitoring and control systems	Diversification of energy systems	Development of decentralised energy systems (microgrids, energy communities, distributed energy generation)
				Energy storage systems for supply stability
		Energy demand management	Implementation of Demand-Side management programs	
			Improved cooling efficiency for energy systems (cooling towers or air coolers in power plants to maintain efficiency during heatwaves)	
		Risk to the population, infrastructure and economic activities from pluvial and fluvial flooding.	Flood protection - Grey infrastructure	Barriers
				Sustainable Drainage Systems (urban and non-urban)
	Improved sewage systems			
	Flood protection - Green & Hybrid infrastructure		Stabilisation using Riverbank stabilization using Bioengineering	
			Restoration of natural floodplains	
	Flood Prevention		Relocation of exposed population/assets	
			Monitoring and prediction systems	
			Climate work permit (red alert events)	
	Flood disaster response		Flood early warning systems	
			Emergency plans (including shelters)	
	Risk of damage to infrastructures and buildings due to slow-onset climate change and extreme climate events	Retrofitting of existing building and infrastructure	Buildings and infrastructure retrofitting	
			Adoption of climate-resilient construction materials	
		Protection of cultural heritage and historic buildings	Maintenance and enhancement of heritage buildings	
			Assessment of assets at risk	
		Legislative and Regulatory Measures	Enhanced design standards	
			Land use planning (including construction laws and permits)	
	Widespread disruption of marine transport	Resilient Maritime and Transport Systems	Winter and Maritime Navigation Management	
			Monitoring and Data for Maritime Routes	
Transport Infrastructure Optimisation				
Risk to population, infrastructure and economic activities from coastal flooding	Coastal protection - Grey infrastructure	Seawalls		
		Dikes, Sandbanks		
	Coastal protection - Green & Hybrid infrastructure	Cliff protection and stabilization		
	Coastal zones management	Relocation of exposed assets/population		
		Flood proofing and elevations		

	Widespread disruption of land-based transport	Coastal disaster response	Early warning systems (coastal flooding, storm surge) Emergency plans
		Physical Reinforcement of Transport Infrastructure	Strengthen road and rail network
		Reduced criticality	Emergency Plans
			Alternative and bypass routes for critical connections
Economy and finance	Risks to winter tourism and countries or regions strongly depending on it	Adapting the winter tourism sector to climate change	Development of year-round tourism offerings Water resource optimisation for snowmaking
	Risks to European financial markets from climate impacts in Europe and beyond	Adapting European financial markets to climate change	Risk Transfer and Financial Protection Mechanisms
			Climate Risk Disclosure and Transparency
			Promoting Green Investments and Resilience
	Climate risks to European property and insurance markets	Adapting European property and insurance markets to climate change	Insurance programs and risk management strategies (tailored for different sectors agri, industry ...)
			State aid and insurance systems for properties in high-risk areas
	Climate risk to public finances leading to a financial crisis	Climate-Responsive Financial Mechanisms and Economic Policy	Blended finance Strategies
			Subsidy Reforms and Environmental Taxation
			Green and Climate Bonds
			Public-Private Partnerships (PPPs)
			International Financial Support Mechanisms
	Risk of business disruptions in key industrial sectors in Europe due to supply chain disruptions for critical raw materials or components from outside Europe	Supply Chain and Operational Resilience	Routes and import diversification
			Build reserves of critical raw materials
			Ensuring continuous flows of goods in the industry through trade agreements
			Operational continuity of industrial units
		Climate-Adapted Products and Services	Promote localization and green manufacturing clusters
			Taxonomy creation of Climate-adapted products and services
Support circular economy initiatives			

	Risk to population and economic sectors due to water scarcity	Water demand management	Water pricing/tariffs
			Water saving technologies
			Water conservation targets
		Water supply management	Water and wastewater reuse (it includes water and reclaimed water sources)
			Desalination
		Water distribution network	Leakage detection system and reparation of distribution network
Ecosystems	Risk to forest ecosystems and the carbon sink from more severe and frequent hot-dry events and related insect pest outbreaks.	Adaptive forest management	Selection of climate-resilient tree species
			Post-Disturbance Recovery (Reforest areas affected or degraded by pests or drought with appropriate species to restore carbon sequestration potential)
		Forest pest and disease management	Early Monitoring System for Pest and Disease Outbreaks in Forests
			Invasive species (non-native plants and insects) management
	Climate risks to soil health related to direct impacts on soil parameters and to soil erosion	Soil Restoration and Management	Regenerative agriculture
			Brownfield remediation
			Agroforestry
		Soil Pollution prevention and control	Regulations and standards
			Inventory of potentially polluted sites
	Monitoring		
	Risk to coastal ecosystems from coastal erosion and inundation from climate change in combination with other anthropogenic drivers	Restoration of coastal ecosystems	Dune restoration
			Saltmarsh restoration
		Coastal management - green & hybrid	Beach nourishment
			Sediment management
	Risk to food web dynamics and related ecosystem services due to phenological changes and species distribution shifts	Restoration of terrestrial ecosystems	Grassland maintenance and restoration
			Heath, steppe & scrub restoration
			Peatlands & marshlands restoration
			Freshwater system restoration
		Biodiversity and Species conservation	Enhanced habitat connectivity, including creation of buffer zones, ecological corridors and refuges
			Pollinators
	Risk to marine ecosystems from climate change in combination with other anthropogenic drivers	Restoration of marine ecosystems	Seagrass meadows restoration
Establishment and expansion of marine protected areas			
Coral structures restoration			
Risk to biodiversity and carbon sinks from increased frequency and intensity of wildfires	Wildfire prevention	Wildfire Containment Corridors	
		Planned burns on prescribed areas	

	Risk to aquatic and wetland ecosystems and their services due to reduction of low flow in rivers	Forest Management and Restoration	Legislation to control deforestation	
		Water ecosystem management	Artificial recharge zones	
			Habitat refuges (ex. Fish passage)	
	Risk to ecosystems and society from climate-induced species invasions	Prevention of invasive alien species	Early detection systems for species invasion	
			Legislative measures for biosecurity	
		Management of invasive alien species	Increase border control on imported goods	
			Control and eradication programs	
	Health	Risk to human health from heat stress increased by climate change	Urban Cooling and Infrastructure Resilience - Green & Hybrid	Nature on buildings
				Blue infrastructure
				Green corridors and parks
Expansion of shaded public spaces and tree canopy cover				
Promotion of sustainable urban planning to enhance natural ventilation				
Allotments and community gardens				
Urban Cooling and Infrastructure Resilience - Grey		Urban heat island mitigation through reflective surfaces and cool pavements		
		Improving cooling in public transport systems		
Risk from geographic expansion and increased transmission of infectious diseases		Prevention of infectious diseases	Develop and integrate monitoring systems for vectors (e.g., ticks, mosquitoes) and pathogens in new habitats	
		Management of infectious diseases	epidemiological and clinical research to understand the spread and activity of infectious disease carriers under changing climate conditions	
Risk to population and built environment from wildfires facilitated by drought and heat	Wildfire disaster response	Wildfire early warning systems		
		Emergency plans		
		Strengthening fire and emergency response infrastructure		
Health risks to outdoor workers from increased heat stress	Organisational measures for OHS	Outdoor work restrictions (bans, recommendations)		
		Occupational health and safety regulations (inspections, monitoring, enforcement)		
		Implementing work-rest schedules and shaded rest areas		
		Providing heat-protective clothing and personal cooling devices		
		Monitoring workplace heat indices and enforcing safety regulations		
Risk to human health from the emergence of harmful algal bloom and pathogens	Water quality management (seawater, freshwater)	Real-time water quality monitoring systems (freshwater and marine ecosystems)		
	Public Health and Safety	Waterborne disease database improvement		
	Water quality management (seawater, freshwater)	Nutrient reduction initiatives (agricultural best practices)		
		Upgrade wastewater treatment facilities		
	Public Health and Safety	Improve/update Drinking water safety regulations		
		Early warning systems (detection and alerts) -pathogens		
		technological equipment improvements		

	Stress to health systems, including health infrastructure, from climate change	Heat-Resilient Healthcare Systems	Expansion of healthcare infrastructure for emergencies related to epidemics outbreaks
		Health alert and response	Training of health professionals in disaster management Early warning systems for health risks
Food	Risk to crop production in Europe from adverse weather conditions due to climate change	Climate smart agriculture	Drought-resistant and climate-adapted crop varieties
			Precision farming
			Agroecology
			Improved irrigation systems and water efficiency techniques
			Soil conservation and erosion control practices
			Enhanced water storage and harvesting systems
		Financial support	Subsidised crop insurance scheme
			Direct payments for ecosystem services
	Risk to fisheries and aquaculture in Europe and international waters from changed environmental conditions due to climate change related ocean acidification	Adaptive fisheries management	Access higher-value markets
			Targeted management of vulnerable species
			Reduction of fishing effort and bycatch
			Flexible fishing regulations
		Fisheries innovation	Mobility of fleets, markets and distribution networks
			Flexible allocation and access schemes
			Improve vessel design and onboard technology for safety, efficiency, and adaptability to changing marine conditions
		Financial support (to European fisheries sector)	Direct payments
			Insurance and risk management schemes
			Grants and subsidies for adopting sustainable fishing technologies
	Sustainable aquaculture	Sustainable aquaculture	
	Risk to food and nutrition security from increasing food prices due to climate impacts on food production in Europe.	Sustainable consumption	Incentives and subsidies for sustainable food consumption
Ecolabelling and energy labelling			
Sustainable production		Encourage crop and livestock diversification	
		Incentives and subsidies for sustainable food production	
Risk to livestock production in Europe from direct climate change impacts and increased spread of pests and diseases	Livestock and Animal Management	Development of heat-tolerant livestock breeds	
		Climate-proofing barns (shades, cooling, water supply ) - livestock infrastructure	
		Encouraging the diversification of livestock breeds and farming practice	
	Pest and Disease Management	Early monitoring systems for zoonosis, and climate-sensitive pathogens	
		Livestock vaccination programs targeting emerging diseases	
	Financial support (to European livestock sector)	Subsidies or incentives for climate-adaptive livestock practices.	
		Expand climate risk insurance mechanisms for vulnerable sectors (e.g., agriculture, livestock, farming)	

## **Cross-cutting measures**

Two additional clusters of measures have been identified to enhance the overall adaptive capacity of natural and social systems across Europe. These clusters are not specific to any sectors, and therefore cross-cutting. They focus on "Research and Innovation and Development" and "Education and Awareness," which are critical to addressing a wide range of climate risks as defined by the EUCRA. These measures aim to strengthen resilience by fostering knowledge, innovation, and societal engagement.

Research and Innovation and Development cluster includes national efforts to:

- Understand climate patterns and risks more effectively.
- Develop innovative adaptation strategies for vulnerable systems.
- Establish monitoring, evaluation, and learning frameworks to track progress.

Education and Awareness cluster encompasses measures aimed at:

- Engaging stakeholders through communication and reporting efforts.
- Promoting vertical alignment and cooperation across governance levels.
- Mainstreaming climate adaptation into societal practices.

## 5. Phase 3: Identifying data on costs

The objectives of this phase were to identify and extract cost information for the shortlisted climate adaptation measures at the sectoral level, and to select the cost data to be applied for the modelling in subsequent phases of the project. The output is a database, informed by an extensive literature review, that provides information on the type and availability of relevant cost data for each of the adaptation measures.

This Chapter provides a summary of the methodology and findings of the data cost identification phase. For more detailed reporting, please refer to the Identification of Cost Data for Adaptation Measures Report (Methodology Report 3) and its Annexes.

### 5.1 Method

Starting from the list of clusters and measures developed in the previous phase, a tailored online search strategy was developed to identify cost data for each of the climate adaptation measures.

The search for cost data was initiated at both the cluster and measure level. Priority was given to cluster-level costs, as this approach reduces the reliance on broad extrapolations and assumptions, which is necessary when using a cost for a specific project in a specific country to represent a broader cluster of measures. The search process followed Figure 7 Search cost data process.

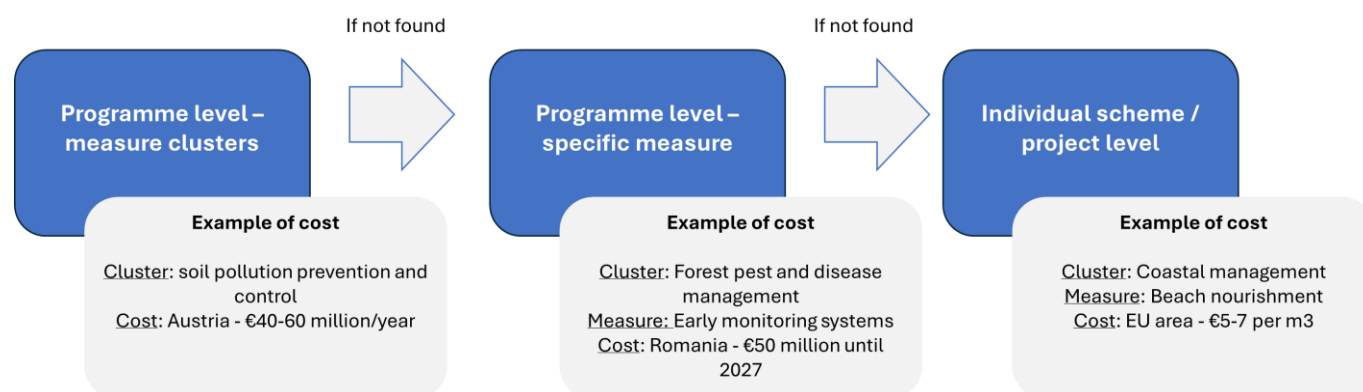


Figure 7 Search cost data process

When cost data at the cluster level was not available, a search at measure level was undertaken. Programme level measure costs (e.g., national budget costs, where cost estimates for a particular measure applied across multiple location, such as within a region or nation-wide) were still prioritised over project costs as these are more easily applicable and require fewer assumptions to integrate into the investment needs modelling. If programme level cost estimates were unavailable, the search focused on project-specific costs. When project-specific costs were the only estimates available, more complex scaling assumptions needed to be developed for extrapolating investment needs at the Member State level. An example of a cost identified at the program level nationally for Romania, and a cost at project level from the UK, is provided in Table 4.

Table 4 Example of costs identified at the program level, and a cost at project level

Cost (description)	Cost (value)	Year	Level	Geography	Source	Related Cluster	Representativeness
Budget planned until 2026 for measures to conserve and protect pollinators	34.8 Million EUR/year	2023	National (programme level)	Romania	Ministry of Environment, Waters and Forests (n.d.) Draft Decision approving the National Strategy on Climate Change Adaptation for the period 2023-2030, with a 2050 perspective (SNASC), and the National Action Plan for the	Biodiversity and species conservation	Specific

					Implementation of the National Strategy on Climate Change Adaptation for the period 2023-2030 (PNASC)		
Cost per hectare associated with peatlands and marshlands restoration	172–8,037 EUR/ha	2019	Project-level	United Kingdom	Committee on Climate Change (2019) Outcomes and Impacts of Climate Change on Meeting Government Outcomes: Summary	Restoration of terrestrial ecosystems	General

A database of cost data was developed from 65 different sources, including national adaptation plans and strategies, grey literature, academic studies and project reports from European-funded projects (available through CORDIS), and the Climate-ADAPT database.

Cost data for adaptation measures differ in usefulness depending on how directly they address specific climate risks, and the type of costs reported. Some, like projected expenditures from national plans, are directly applicable, while others (e.g. single-project costs) need adjustments. To ensure consistency, the cost estimates were assessed using expert judgement for both their relevance (i.e. how well they represented the measure type concerned) and their scope (i.e. the ease in which they can be scaled at national level). Each estimate was then classified as specific or general.

This classification guided the use of the cost data and the selection of the most appropriate proxy in future phases. Priority was given to those estimates that directly address specific climate risks and can be effectively applied within the investment modelling framework.

### Cross-cutting measures methodology

Given the nature of these cross-cutting measures, and the lack of available estimates on their costs, a specialised costing method was applied to assess investment needs using targets for adaptation-related expenditure, and MS willingness to invest in research and education as a proxy. The cost estimation for cross-cutting measures was based on each country's allocation of adaptation-related expenditures under European budgets and adjusted by a country-specific expenditure factor. This factor reflects each country's relative willingness to invest in these cross-cutting measures compared to the overall economy.

For the R&D cluster, the factor was derived from the sum of sectoral R&D investments as a share of GDP, while for education, the only consistent macro-level data available was total educational expenditure as a share of GDP.

To estimate each country's allocation of adaptation-related expenditures the European Commission's current framework for climate mainstreaming under the EU budget 2021–2027 was considered. The latest data<sup>10</sup> indicates that the EU budget 2021-2027 is projected to contribute €662 billion to climate-related objectives, representing 34% of the budget envelope, surpassing the initial target of 30%. The relative share of this budget that is dedicated to adaptation is estimated to be 21%<sup>11</sup>, and a further 14% concerns expenditures that support both mitigation and adaptation (the remaining 65% is for mitigation or not attributable). Accordingly, expenditure for cross-cutting measures was estimated in proportion to each country's allocation of EU funds identified as climate-relevant, ensuring alignment with this 21% figure. These percentages have been applied to the 2023 EU budget clusters detailed in Table 4. These clusters provide a framework for categorizing expenditures related to adaptation measures.

Where data limitations existed, expert judgment was used to adjust cost estimates for each cluster, based on country-specific economic and sectoral contexts. Experts reviewed the assumptions underlying this

<sup>10</sup> [https://commission.europa.eu/document/download/873907ad-d658-4a14-975f-1afc2449abb8\\_en?filename=Climate%20Overview%202025.pdf](https://commission.europa.eu/document/download/873907ad-d658-4a14-975f-1afc2449abb8_en?filename=Climate%20Overview%202025.pdf)

<sup>11</sup> [https://commission.europa.eu/strategy-and-policy/eu-budget/performance-and-reporting/horizontal-priorities/green-budgeting/climate-mainstreaming\\_en](https://commission.europa.eu/strategy-and-policy/eu-budget/performance-and-reporting/horizontal-priorities/green-budgeting/climate-mainstreaming_en)

methodology and provided guidance to refine preliminary estimates, ensuring consistency with observed investment patterns and policy priorities.

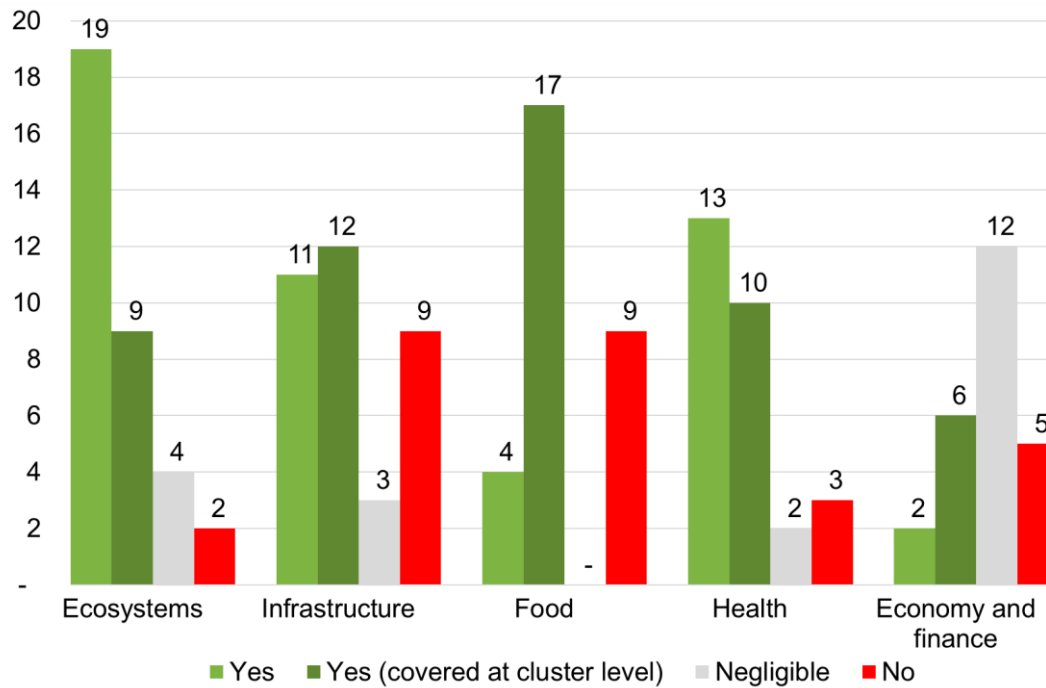
*Table 5 Summary of types of expenditure that should contain adaptation measure projects*

CODE	BUDGET CLUSTER
1.0.11	Horizon Europe
1.0.10TH	Other actions
1.0.1PPPA	Pilot projects and preparatory actions
1.0.221	Connecting Europe Facility (CEF) - Transport
1.0.222	Connecting Europe Facility (CEF) - Energy
1.0.223	Connecting Europe Facility (CEF) - Digital
1.0.23	Digital Europe Programme
1.0.41	European Space Programme
2.1.11	European Regional Development Fund (ERDF)
2.1.122	Cohesion Fund (CF), contribution to the Connecting Europe Facility (CEF) - Transport
2.2.21	European Recovery and Resilience Facility (incl. Technical Support Instrument)
2.2.32	Erasmus+
2.2.33	European Solidarity Corps (ESC)
3.2.12	European Agricultural Fund for Rural Development (EAFRD)
3.2.13	European Maritime and Fisheries Fund (EMFF)
3.2.21	Programme for Environment and Climate Action (LIFE)
3.2.22	Just Transition Fund

## 5.2 Findings

The output of this phase was a database with identified cost data for the relevant adaptation measures and/or clusters, which can be found in the Methodology Report 3 and its Annexes. Figure 8 below provides an overview of the cost data identified per sector. It highlights whether a cost was retrieved specifically for a single measure or a cluster of measures, whether it was considered negligible, or whether it could not be found.

Figure 8 Coverage of Adaptation Measures cost data retrieved by Sector



A more detailed summary of available cost data identified by sector is provided in the following tables.

### Ecosystems

Risk name	Cluster name	Adaptation measures	Available cost data
Risk to food web dynamics and related ecosystem services due to phenological changes and species distribution shifts	Restoration of terrestrial ecosystems	Grassland maintenance and restoration	Yes
		Heath, steppe & scrub restoration	Yes
		Peatlands & marshlands restoration	Yes
		Freshwater system restoration	Yes
	Biodiversity and Species conservation	Enhanced habitat connectivity, including creation of buffer zones, ecological corridors, and refuges	Yes
		Pollinators	Yes
Risk to ecosystems and society from climate-induced species invasions	Prevention of invasive alien species	Early detection systems for species invasion	Yes
		Legislative measures for biosecurity	Negligible
		Increase border control on imported goods	No
	Management of invasive alien species	Control and eradication programs	Yes (covered at cluster level)
		Pest and disease management	Yes (covered at cluster level)
Climate risks to soil health related to direct impacts on soil parameters and to soil erosion	Soil Restoration and Management	Regenerative agriculture	Yes (covered at cluster level)
		Brownfield remediation	Yes (covered at cluster level)
		Agroforestry	Yes (covered at cluster level)
	Soil Pollution prevention and control	Regulations and standards	Negligible
		Inventory of potentially polluted sites	Yes (covered at cluster level)
		Monitoring	Yes (covered at cluster level)
Risk to aquatic and wetland ecosystems and their services due to reduction of low flow in rivers	Water ecosystem management	Artificial recharge zones	Yes
		Habitat refuges (ex. Fish passage)	Yes
		Optimised dams' management	No
Risk to coastal ecosystems from coastal erosion and inundation from climate change in combination with other anthropogenic drivers	Restoration of coastal ecosystems	Dune restoration	Yes
		Saltmarsh restoration	Yes
		Beach nourishment	Yes

	Coastal management - green & hybrid	Sediment management	Yes
Risk to marine ecosystems from climate change in combination with other anthropogenic drivers	Restoration of marine ecosystems	Seagrass meadows restoration	yes
		Establishment and expansion of marine protected areas	Negligible
		Coral structures restoration	yes
Risk to forest ecosystems and the carbon sink from more severe and frequent hot-dry events and related insect pest outbreaks.	Adaptive forest management	Selection of climate-resilient tree species	Yes (covered at cluster level)
		Post-Disturbance Recovery (Reforest areas affected or degraded by pests or drought with appropriate species to restore carbon sequestration potential)	Yes (covered at cluster level)
	Forest pest and disease management	Early Monitoring System for Pest and Disease Outbreaks in Forests	Yes
		Invasive species (non-native-plants and insects) management	Yes
Risk to biodiversity and carbon sinks from increased frequency and intensity of wildfires	Wildfire prevention	Wildfire Containment Corridors	Yes (covered at cluster level)
		Planned burns on prescribed areas	Yes (covered at cluster level)
	Forest Management and Restoration	Legislation to control deforestation	Negligible

## Infrastructure

Risk name	Cluster name	Adaptation measures	Available cost data
Risk of energy disruption due to damage to energy transportation or storage infrastructure following coastal or inland flooding	Relocation of energy assets	Relocation of substations and network stations to safer locations	No
		Rerouting of critical energy transportation infrastructure	No
	Improved energy assets	Physical reinforcement of energy assets	Yes (covered at cluster level)
		Reviewed design standards	Yes (covered at cluster level)
		Enhanced monitoring and control systems	Yes (covered at cluster level)
Risk of electricity disruption due to the impacts of heat and droughts impacts on energy production and peak demand	Diversification of energy systems	Development of decentralised energy systems (microgrids, energy communities, distributed energy generation)	Yes (covered at cluster level)
		Energy storage systems for supply stability	Yes (covered at cluster level)
	Energy demand management	Implementation of Demand-Side management programs	Negligible
		Improved cooling efficiency for energy systems (cooling towers or air coolers in power plants to maintain efficiency during heatwaves)	Yes
Risk to the population, infrastructure and economic activities from pluvial and fluvial flooding.	Flood protection - Grey infrastructure	Barriers	Yes (covered at cluster level)
		Sustainable Drainage Systems (urban and non urban)	Yes (covered at cluster level)
		Improved sewage systems	Yes (covered at cluster level)
	Flood protection - Green & Hybrid infrastructure	Stabilisation using Riverbank stabilization using Bioengineering	Yes
		Restoration of natural floodplains	Yes
	Flood Prevention	Relocation of exposed population/assets	Yes
		Monitoring and prediction systems	Yes
		Climate work permit (red alert events)	Negligible
	Flood disaster response	Flood early warning systems	Yes
		Emergency plans (including shelters)	No
	Risk of damage to infrastructures and buildings due to slow-onset climate change and extreme climate events	Retrofitting of existing building and infrastructure	Buildings and infrastructure retrofitting
Adoption of climate-resilient construction materials			No
Protection of cultural heritage and historic buildings		Maintenance and enhancement of heritage buildings	Yes (covered at cluster level)
		Assessment of assets at risk	Yes (covered at cluster level)
Legislative and Regulatory Measures		Enhanced design standards	Negligible
		Land use planning (including construction laws and permits)	Yes
		Winter and Maritime Navigation Management	Yes (covered at cluster level)

Widespread disruption of marine transport	Resilient Maritime and Transport Systems	Monitoring and Data for Maritime Routes	No
		Transport Infrastructure Optimization	Yes (covered at cluster level)
Risk to population, infrastructure and economic activities from coastal flooding	Coastal protection - Grey infrastructure	Seawalls	Yes (covered at cluster level)
		Dikes, Sandbanks	Yes (covered at cluster level)
	Coastal protection - Green & Hybrid infrastructure	Cliff protection and stabilization	No
	Coastal zones management	Relocation of exposed assets/population	No
		Flood proofing and elevations	Yes (covered at cluster level)
	Coastal disaster response	Early warning systems (coastal flooding, storm surge)	No
Emergency plans		No	
Widespread disruption of land-based transport	Physical Reinforcement of Transport Infrastructure	Strengthen road and rail network	Yes (covered at cluster level)
	Reduced criticality	Emergency Plans	Yes (covered at cluster level)
		Alternative and bypass routes for critical connections	Yes (covered at cluster level)

## Food

Risk name	Cluster name	Adaptation measures	Available cost data
Risk to crop production in Europe from adverse weather conditions due to climate change Financial support	Climate smart agriculture	Drought-resistant and climate-adapted crop varieties	Yes (covered at cluster level)
		Precision farming	Yes (covered at cluster level)
		Agroecology	Yes (covered at cluster level)
		Improved irrigation systems and water efficiency techniques	Yes (covered at cluster level)
		Soil conservation and erosion control practices	Yes (covered at cluster level)
		Enhanced water storage and harvesting systems	Yes (covered at cluster level)
	Financial support	Subsidised crop insurance scheme	Yes (covered at cluster level)
		Direct payments for ecosystem services	Yes (covered at cluster level)
Risk to fisheries and aquaculture in Europe and international waters from changed environmental conditions due to climate change related ocean acidification Fisheries innovation Financial support (to European fisheries sector) Sustainable aquaculture	Adaptive fisheries management	Access higher-value markets	Yes (covered at cluster level)
		Targeted management of vulnerable species	Yes (covered at cluster level)
		Reduction of fishing effort and bycatch	Yes (covered at cluster level)
		Flexible fishing regulations	Yes (covered at cluster level)
	Fisheries innovation	Mobility of fleets, markets and distribution networks	Yes (covered at cluster level)
		Flexible allocation and access schemes	Yes (covered at cluster level)
		Improve vessel design and onboard technology for safety, efficiency, and adaptability to changing marine conditions	Yes (covered at cluster level)
	Financial support (to European fisheries sector)	Direct payments	No
		Insurance and risk management schemes	No
		Grants and subsidies for adopting sustainable fishing technologies	No
Sustainable aquaculture	Sustainable aquaculture	No	
Risk to food and nutrition security from increasing food prices due to climate impacts on food production in Europe.	Sustainable consumption	Incentives and subsidies for sustainable food consumption	Yes
		Ecolabelling and energy labelling	Yes
		Encourage crop and livestock diversification	No
		Incentives and subsidies for sustainable food production	Yes
Risk to livestock production in Europe from direct climate	Livestock and Animal Management	Development of heat-tolerant livestock breeds	Yes (covered at cluster level)
		Climate-proofing barns (shades, cooling, water supply) - livestock infrastructure	Yes

change impacts and increased spread of pests and diseases Pest and Disease Management Risk to livestock production in Europe from direct climate change impacts and increased spread of pests and diseases		Encouraging the diversification of livestock breeds and farming practice	Yes (covered at cluster level)
	Pest and Disease Management	Early monitoring systems for zoonosis, and climate-sensitive pathogens	No
		Livestock vaccination programs targeting emerging diseases	No
	Financial support (to European livestock sector)	Subsidies or incentives for climate-adaptive livestock practices.	No
		Expand climate risk insurance mechanisms for vulnerable sectors (e.g., agriculture, livestock, farming)	No

## Health

Risk name	Cluster name	Adaptation measures	Available cost data
Risk to human health from heat stress exacerbated by rising temperatures and heatwaves	Urban Cooling and Infrastructure Resilience - Green & Hybrid	Nature on buildings	Yes (covered at cluster level)
		Blue infrastructure	Yes (covered at cluster level)
		Green corridors and parks	Yes (covered at cluster level)
		Expansion of shaded public spaces and tree canopy cover	Yes (covered at cluster level)
		Promotion of sustainable urban planning to enhance natural ventilation	Yes (covered at cluster level)
		Allotments and community gardens	Yes (covered at cluster level)
	Urban Cooling and Infrastructure Resilience - Grey	Urban heat island mitigation through reflective surfaces and cool pavements	Yes
		Improving cooling in public transport systems	Yes
Risk from geographic expansion and increased transmission of infectious diseases as climate conditions become more favourable for disease vectors like mosquitoes and ticks	Prevention of infectious diseases	Develop and integrate monitoring systems for vectors (e.g., ticks, mosquitoes) and pathogens in new habitats	Yes
	Management of infectious diseases	Epidemiological and clinical research to understand the spread and activity of infectious disease carriers under changing climate conditions	Negligible
Risk to population and built environment from wildfires, intensified by drought and heat	Wildfire disaster response	Wildfire early warning systems	Yes
		Emergency plans	Yes
		Strengthening fire and emergency response infrastructure	Yes
Health risks to outdoor workers from increased heat stress	Organisational measures for OHS	Outdoor work restrictions (bans, recommendations)	Negligible
		Occupational health and safety regulations (inspections, monitoring, enforcement)	Yes (covered at cluster level)
		Implementing work-rest schedules and shaded rest areas	Yes (covered at cluster level)
		Providing heat-protective clothing and personal cooling devices	Yes (covered at cluster level)
		Monitoring workplace heat indices and enforcing safety regulations	Yes (covered at cluster level)
Risk to human health from harmful algal blooms and the spread of pathogens due to changing water temperatures and conditions	Water quality management (seawater, freshwater)	Real-time water quality monitoring systems (freshwater and marine ecosystems)	Yes
		Waterborne disease database improvement	No
		Nutrient reduction initiatives (agricultural best practices)	Yes
		Upgrade wastewater treatment facilities	Yes
	Public Health and Safety	Improve/update drinking water safety regulations	Yes
		Early warning systems (detection and alerts) -pathogens	Yes
Stress to health systems, including health infrastructure, from increased demand for services and disruptions due to climate change impacts	Heat-Resilient Healthcare Systems	Technological equipment improvements	No
		Expansion of healthcare infrastructure for emergencies related to epidemics outbreaks	No
	Health alert and response	Training of health professionals in disaster management	Yes
		Early warning systems for health risks	Yes

## Economy and Finance

Risk name	Cluster name	Adaptation measures	Available cost data
Risks to winter tourism and countries or regions strongly depending on it	Adapting the winter tourism sector to climate change	Development of year-round tourism offerings	Yes (covered at cluster level)
		Water resource optimization for snowmaking	Yes (covered at cluster level)
Risks to European financial markets from climate impacts in Europe and beyond	Adapting European financial markets to climate change	Risk Transfer and Financial Protection Mechanisms	Negligible
		Climate Risk Disclosure and Transparency	Negligible
		Promoting Green Investments and Resilience	Negligible
Climate risks to European property and insurance markets	Adapting European property and insurance markets to climate change	Insurance programs and risk management strategies (tailored for different sectors agri, industry ...)	Yes (covered by cluster)
		State aid and insurance systems for properties in high-risk areas	Yes (covered by cluster)
Climate risk to public finances leading to a financial crisis	Climate-Responsive Financial Mechanisms and Economic Policy	Blended finance Strategies	Negligible
		Subsidy Reforms and Environmental Taxation	Negligible
		Green and Climate Bonds	Negligible
		Public-Private Partnerships (PPPs)	Negligible
		International Financial Support Mechanisms	Negligible
Risk of business disruptions in key industrial sectors in Europe due to supply chain disruptions for critical raw materials or components from outside Europe	Supply Chain and Operational Resilience	Routes and import diversification	No
		Build reserves of critical raw materials	No
		Ensuring continuous flows of goods in the industry through trade agreements	No
		Operational continuity of industrial units	No
	Climate-Adapted Products and Services	Promote localization and green manufacturing clusters	Negligible
		Taxonomy creation of Climate-adapted products and services	Negligible
		Support circular economy initiatives	Negligible
Risk to population and economic sectors due to water scarcity	Water demand management	Water pricing/tariffs	Negligible
		Water saving technologies	No
		Water conservation targets	Yes
	Water supply management	Water and wastewater reuse (it includes water and reclaimed water sources)	Yes (covered by cluster)
		Desalination	Yes (covered by cluster)
	Water distribution network	Leakage detection system and reparation of distribution network	Yes

## Cross-cutting measures

Overall, the estimated cost for cross-cutting measures across the EU amounts to €257 million, 75% of which allocated to "Education and Awareness" and 25% to "Research and Innovation and Development" at the EU level, and a notable variation at MS level.

The values for each country highlight variations in their willingness to invest in cross-cutting measures. These differences reflect national priorities and economic characteristics. Countries with higher investments in education, research, or both are likely to exhibit stronger adaptive capacities, as these sectors strengthen the structural and institutional foundations necessary for effective climate adaptation. Education enhances human capital and institutional capabilities, enabling societies to anticipate, understand, and respond more effectively to climate-related risks. R&D investment provides the scientific and technological basis for adaptation, supporting the development of resilient infrastructure, early warning systems, and innovative solutions, while also facilitating the continuous evaluation and improvement of adaptation measures.

By focusing resources on these strategic areas, adaptation funding can build on existing capacities, promote evidence-based decision-making, and increase the overall effectiveness of adaptation interventions. This underlines the importance of targeted funding to maximise the impact of adaptation efforts across Europe.

It is important noting that the findings in Table 6 are a conservative estimate of the investment needed to implement the identified cross-cutting adaptation measures. The methodology relies on information on current ambition and spending on adaptation, including climate-related expenditure of the 2021-2027 Multiannual Financial Framework and the estimated share of this expenditure related to climate adaptation. Beyond these figures, there is no EU-wide commitment to dedicate a certain share of budget to adaptation-related expenditure in the future. Nevertheless, adaptation spending is expected to grow substantially towards 2050, implying that investment needs in the crosscutting sector will also rise.

*Table 6 Summary of cross-cutting measures costs per country*

Country	Education (EUR million)	R&D (EUR million)	Total Cross-Cutting Measures (EUR million)
European Union	194,5	62,6	257,1
Belgium	13,5	5,9	19,4
Bulgaria	3,9	0,6	4,6
Czechia	8,3	2,9	11,2
Denmark	2,7	0,9	3,6
Germany	22,4	12,0	34,4
Estonia	2,0	0,5	2,6
Ireland	1,8	0,6	2,4
Greece	5,4	1,7	7,2
Spain	15,4	3,9	19,3
France	24,3	7,9	32,1
Croatia	1,6	1,0	2,6
Italy	18,0	4,5	22,5
Cyprus	0,7	0,1	0,7
Latvia	2,2	0,2	2,5
Lithuania	2,8	0,4	3,2
Luxembourg	0,7	0,1	0,9
Hungary	7,2	2,4	9,6
Malta	0,3	0,0	0,3
Netherlands	5,8	1,9	7,7
Austria	4,5	2,2	6,7
Poland	19,0	4,5	23,5
Portugal	6,6	1,7	8,3
Romania	8,5	1,4	9,8
Slovenia	1,6	0,6	2,3
Slovakia	7,5	1,2	8,8
Finland	3,0	1,2	4,2
Sweden	4,8	2,0	6,8

## 6. Phase 4: Scaling approach

Following the identification of cost data, the next step was to ensure that the evidence could be applied consistently across all Member States. As many of the available estimates refer to a single country, a region, or even a specific project, a systematic approach was required to make them comparable at EU level. This chapter presents the methodology developed to achieve this through measure-specific scaling methods, the selection of appropriate proxies, and the assignment of confidence levels to each transposition. It should be noted that this scaling approach does not relate to cross-cutting measures outlined in the previous chapter.

This chapter provides a summary of the methodology and findings of the scaling approach phase. For more detailed reporting, please refer to the Selection and Scaling of Cost Data for Modelling Report (Methodology Report 4) and its Annexes.

### 6.1 Method

To move from heterogeneous cost datapoints, often reported for a single country, a region or even a project, to comparable estimates for each Member State, a measure- or cluster-specific scaling strategy was developed for every cost item.

Due to the high variability in cost data and available evidence, it was necessary to identify suitable proxies to scale unit cost estimates across countries. For each measure, a specific scaling rule was defined, linking the reference cost to a key 'element of interest', a proxy that reflects the main driver of effort for that measure. Currently, there is no standard methodology for scaling adaptation costs using a single metric. While previous studies often relied on broad indicators like GDP, this study developed more targeted, bottom-up proxies tailored to the specific characteristics of each intervention.

Alongside proxy selection, the scaling method specified price normalisation: costs were converted to Euros and expressed in a common reference price year, before applying either Purchasing Power Parity (PPP)<sup>12</sup> factors or sector-specific price indices (e.g. construction, agriculture) as appropriate to each Member State. Source values referring to different base years were re-indexed using the GDP deflator to the reference year.

Proxies were selected to match the nature of the intervention, typically extent/stock indicators for ecosystems and infrastructure (e.g. relevant land/forest area, coastline or exposed assets) and activity/output or exposure indicators for agriculture, health and related domains (e.g. cultivated area, livestock headcount, population at risk).

*Table 7 Examples of scaling approach definition for two measures*

Adaptation measure(s)	Cost description	Cost	Price adjustment approach	Rationale for selection	Scaling approach
Invasive species (non-native-plants and insects) management	Cost of the nationwide climate adaptation program for Romania from 2023 to 2030	35 million EUR	PPP	A nationwide cost from Romania's most recent official climate adaptation plan, with high representativeness as it specifically matches the defined measure.	Scaling approach confidence: MED  Costs will be updated from 2023 to 2024 euros, with an annual cost calculated for the 2023–2030 period. Scaling will be based on Romania's forest extent (km <sup>2</sup> ), using Eurostat's land cover data for "woodlands" <sup>13</sup> to derive a cost

<sup>12</sup> Eurostat & OECD. (2023). Eurostat-OECD Methodological Manual on Purchasing Power Parities (2023 edition). OECD Publishing. [https://www.oecd.org/en/publications/eurostat-oecd-methodological-manual-on-purchasing-power-parities-2023-edition\\_c9829192-en.html](https://www.oecd.org/en/publications/eurostat-oecd-methodological-manual-on-purchasing-power-parities-2023-edition_c9829192-en.html)

<sup>13</sup> Eurostat. Land cover statistics. Retrieved from [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Land\\_cover\\_statistics](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Land_cover_statistics)

					per km <sup>2</sup> . This per km <sup>2</sup> cost will then be adjusted for other European countries based on their forest coverage from the same source.
Urban Cooling and Infrastructure Resilience - Green & Hybrid	Nationwide cost for implementing green measures in French cities	500 million EUR/year	PPP	A well-recognised paper on climate adaptation costs, recently published, covering nationwide expenses and providing a specific cost estimate for the measures underpinning the cluster.	Scaling approach confidence: LOW  Cost already adjusted to 2024 value. It will be scaled to other countries using the number of people living in cities according to Eurostat definition. Data will be taken from Eurostat <sup>14</sup> or from National Statistical Offices.

Proxy data were drawn primarily from Eurostat, complemented by EU sources such as EEA land-cover/extent datasets and JRC targets (for restoration), and by sectoral sources where appropriate (e.g. DG MOVE/TEN-T for transport networks, OECD for water services, Eurostat LFS/DEGURBA for exposed workers and urbanization, and the EU Building Stock Observatory for building proxies). Where robust Member State coverage was already available from the source, no transposition was applied and reported values were carried forward after harmonisation.

To support interpretation of the resulting investment estimates, each scaling rule received a confidence label based on the strength of the evidence and the complexity of the transposition:

- High – comprehensive/authoritative sources and minimal or no transposition.
- Medium – a single, well-specified scaling step using a suitable proxy.
- Low – multiple assumptions or intermediate conversions (e.g. moving from unit costs to national totals before cross-country scaling).

This labelling makes the robustness of estimates explicit and underpins the sensitivity analysis presented in Phase 68. Detailed scaling choices for each measure are reported in the Appendix.

It is also important to note that the methodology has been designed to generate a harmonised estimate of adaptation investment needs across the EU. This required aligning national evidence to a consistent EUCRA-based risk framework and applying scaling rules to ensure comparability. While this allows for robust EU-wide results, it necessarily reduces the reliability of national estimates relative to dedicated Member State studies.

## 6.2 Findings

Across the catalogue, a scaling approach was defined for 49 of 55 measures. The remaining six were set aside because the EU-wide inputs needed to extend costs consistently to all Member States were unavailable. Two straightforward examples are seagrass meadows restoration, where comparable maps of seagrass extent are missing, and artificial recharge zones, where country-level indicators of required recharge volumes are not available; in both cases, a defensible proxy could not be established for transposition.

Given the heterogeneity of the cost evidence, scaling rules were designed measure-by-measure, aligning the proxy with the nature of the intervention. Clear sectoral patterns emerge:

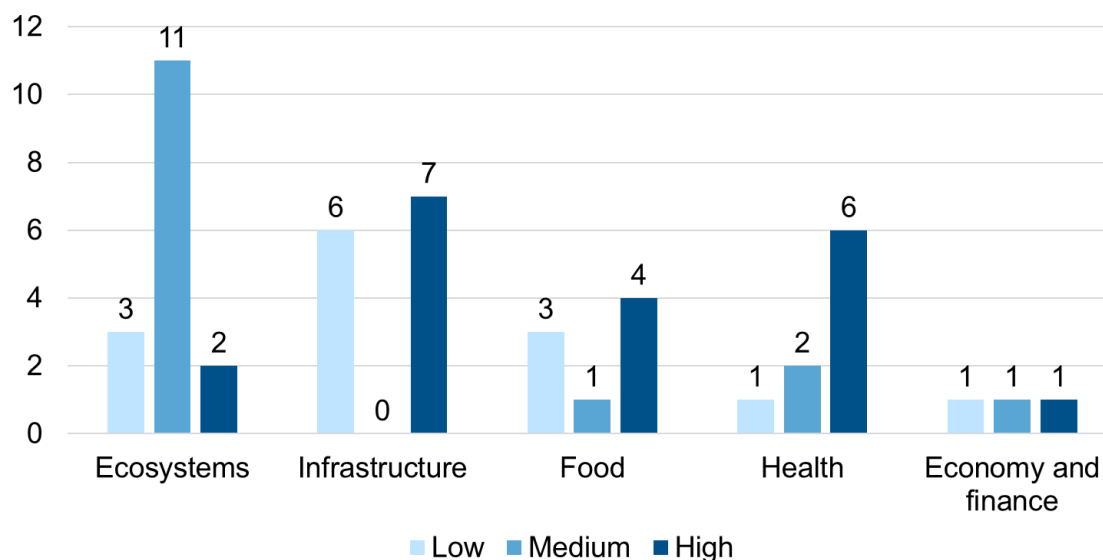
- Ecosystems. Scaling predominantly follows extent/stock indicators such as forest area for adaptive forest management and related forestry actions or agricultural land area for soil restoration related measures.

<sup>14</sup> Eurostat. Cities and greater cities database. Retrieved from: [https://ec.europa.eu/eurostat/databrowser/view/urb\\_cpop1/default/table?lang=en&category=urb.urb\\_cgc](https://ec.europa.eu/eurostat/databrowser/view/urb_cpop1/default/table?lang=en&category=urb.urb_cgc)

- Infrastructure. Several high-weight items already report per-Member-State values (no scaling required), particularly for flood protection; where scaling is needed, proxies include electricity generation (energy assets) and GDP for more generic measures such as protection of cultural heritage.
- Food. Where costs are national or EU-wide, scaling relies on agricultural output/area and livestock counts (e.g., climate-smart agriculture scaled with agricultural output; livestock measures scaled with bovines/sheep/pigs).
- Health. Approaches typically use population/exposure metrics (e.g., training and early-warning systems scaled by population; DEGURBA and LFS used where relevant).
- Economy & finance. Mixed approaches, including building stock and sector-specific datasets (e.g., ski areas for winter tourism), with some items available per MS.

To support interpretation, each transposition carries a scaling-approach confidence label. Overall, the 49 scaled measures distribute as High ~41% (20/49), Medium ~31% (15/49) and Low ~29% (14/49). In relation to sectors, Ecosystems concentrates in Medium (with some Low where multi-step assumptions are required), Food is mixed with a notable share of High, Health is predominantly High, Infrastructure bifurcates between High (where per-country data exist) and Low (for items needing broader assumptions), and Economy & finance shows a balanced but small set. Figure 9 displays this distribution by sector (Low/Medium/High), using consistent colours to aid comparison.

Figure 9 Distribution of scaling confidence levels by sector



## 7. Phase 5: Assessment of investment needs

This phase quantifies the climate adaptation investment needs across EU Member States. It builds directly on the outputs of the previous phases, which provided (i) the unit costs of adaptation measures, (ii) the scaling methodologies used to transpose those costs across Member States, and (iii) the indicators of national exposure to climate risks. Using these inputs, this phase estimates the investment need required to implement the portfolio of adaptation measures consistently across the EU.

In this context, investment needs are defined as the total cost that each Member State would need to bear to implement the set of adaptation actions identified as effective for reducing climate risks under a medium adaptation scenario (RCP4.5). They represent the resources required to achieve the level of adaptation consistent with the country's specific exposure profile and risk drivers, covering all relevant types of expenditure, capital, recurring, or cyclical investments as appropriate (see Figure 10).

*Figure 10 Target level of adaptation in national documents*

To estimate the investment needs, it is first necessary to define the overall adaptation/resilience goal associated with these needs. Identification of what might be an appropriate level of adaptation is methodologically complex, and there is no single approach. It involves balancing risk reduction – for example by identifying acceptable levels of exposure or residual risk or maintaining the status quo – societal priorities and resource efficiency, which should consider cost efficiency investments that do not waste public resources and avoid maladaptation.

The national documents that have been a key resource for this study *implicitly* include a desirable level of adaptation and/or resilience. However, Member States rarely include clear, quantified resilience or adaptation targets in their NAPs or NAS. Instead, most countries articulate broad, qualitative objectives such as increasing resilience or reducing vulnerability, but do not translate these into measurable and time-bound targets. As such it is difficult to say whether the adaptation actions included in a NAP/NAS for one Member State relate to a consistent goal/target as those in the NAP/NAS for another Member State. The same is true for the cost estimates, where information is generally lacking on the specific adaptation goal associated with the programme or project.

Moreover, even if the respective adaptation/resilience goals were clearly defined in the source documents, the adjustment of any estimates so that they reflect a consistent adaptation goal would be fraught with difficulty. It would require subjective judgement e.g. on how to scale costs for the achievement of different adaptation goals, and the outcomes are likely to be at least as uncertain as the methodologies that have been applied here.

Faced with these uncertainties, this study has identified and assessed adaptation needs based on the priorities stated by MS in their own strategic plans, with the assumption that these documents provide the best estimates of the adaptation needs for each respective MS. The cost estimates have been based on a range of sources, some of which are aligned with the MS plans. No attempts have been made to correct for differences in the overall adaptation goals that may be associated with these estimates; the implicit assumption when transferring the estimates is that the adaptation goals are equivalent for each region. This is recognised as a simplifying assumption and is one reason why the estimates derived in this study may differ from those published elsewhere. This could be an area of further research (see also Chapter 10 Policy recommendations).

The output of this phase is a detailed quantification of investment needs by measure and by Member State, expressed in both aggregate and annualised terms, reflecting the cumulative financial effort required over the 2026–2050 horizon.

In addition to the results presented in this section, the full set of underlying calculations will be made available in accompanying Excel files. These include sector-specific workbooks documenting the unit cost assumptions, scaling approaches, risk-exposure indicators and intermediate steps used to derive investment needs for each adaptation measure. For transparency, a representative country-level workbook is also provided for every Member State, consolidating the final investment needs by measure and presenting the full calculation trail from inputs to results.

## 7.1 Method

The estimation of investment needs was carried out in three steps.

First, investment needs were derived for those Member States where existing estimates of the costs of adaptation measures were available at either project, regional or national level. Reported costs were converted into constant 2024 Euros using Eurostat GDP deflators.

The identified investments were then allocated over the implementation horizon up to 2050 using an investment profile defined for each measure. These profiles do not represent a detailed adaptation investment plan or any specific views on the sequencing of the measures. Likewise, they do not provide a detailed distinction between up-front capital expenditure (CAPEX), periodic capital renewal and recurring operating costs (OPEX), as such granular information was generally not available in the underlying data. Instead, the objective of the investment profiles was to introduce temporal realism (i.e. recognising that investments cannot all happen at the same time, or continuously to 2050) into the projection of investment needs based on the nature of the expenditure data at hand, which typically consisted of budgetary information reported as annual or multiannual costs.

Accordingly, differentiated investment cycles were constructed to reflect the typical spending patterns associated with each measure. For example, infrastructure-type measures (such as building retrofitting or flood defences) were assumed to involve concentrated expenditure over a limited number of years, while measures characterized by ongoing or cyclical activity (such as wildfire prevention corridors or maintenance-intensive interventions) were modelled using periodic or recurrent spending profiles. In cases where the original sources did not distinguish between capital and operational components, the reported annual cost was treated as an average yearly expenditure implicitly incorporating replacement and maintenance needs. While this represents a simplification, it was a necessary assumption given the heterogeneity and limited level of detail in the available data.

This approach ensured that the investment estimates were consistent with the structure of the available data, while allowing expenditure patterns to be characterized more accurately in those cases where the underlying information was sufficiently detailed. At the same time, the absence of a harmonized dataset specifying CAPEX versus OPEX elements for each measure prevented a more granular, EU-wide breakdown of investment types. Likewise, as the profiles don't explicitly factor in any prioritisation or sequencing of specific investments, the timing of investments - in particular the CAPEX - will likely differ from Member States' own plans.

Second, the investment needs estimates were extrapolated to all other Member States. This was done through a scaling approach specifically developed for each measure, using a proxy that captures the main driver of effort (such as land area, population, coastal length or agricultural output - as explained in Phase 4: Scaling approach). The selected proxy was applied to transpose the investment figures across countries, ensuring that the relative scale of effort reflected national differences in exposure or activity levels.

For instance, if a cost estimate for a flood protection measure was available for one Member State, and coastline length was identified as the relevant proxy, the investment for another country was obtained by multiplying the reference cost by the ratio of coastline lengths between the two countries. This approach allowed for a consistent redistribution of investment needs across Member States while preserving the measure-specific logic of effort.

The resulting estimates were subsequently adjusted to account for cross-country differences in price levels by means of the purchasing power parity (PPP) matrix.

A further adjustment was then applied to reflect the differentiated level of climate risk exposure faced by each Member State. There is currently no established methodology for adjusting adaptation cost estimates according to exposure severity, and only limited empirical evidence on how costs vary with risk intensity. However, it is reasonable to assume that countries with higher exposure levels face greater investment needs, as they require larger-scale, more resilient, or more frequent interventions to achieve comparable levels of protection. On this basis, a pragmatic assumption was introduced: a proportional adjustment of  $\pm 20\%$  was applied for each shift in exposure class (e.g. from Limited to Substantial or from Critical to Catastrophic). Importantly, this adjustment is applied only when costs are extrapolated across Member States with different exposure classes; if there is no change in exposure class, no adjustment is applied. This adjustment was applied symmetrically across measures and exposure levels, ensuring internal consistency while maintaining comparability across Member States. The  $\pm 20\%$  factor is not empirically derived and should therefore be regarded as a simplifying assumption that introduces a degree of uncertainty into the results. The robustness of this parameter is further explored through the sensitivity analysis presented later in this report.

Finally, the results were consolidated and aggregated to produce cumulative investment needs at sector and Member State level. Outputs were organised in two complementary formats: (i) total investment needs expressed as Net Present Values, which provide a comparable picture of the overall financial effort required, and (ii) corresponding annual investment needs, which are more relevant for budget planning and financing strategies over the assessment horizon.

The three steps of the methodology are illustrated in *Figure 11* below.

*Figure 11 Investment need calculation methodology*



The calculation methodology for cross-cutting measures follows a different approach, which is described in detail in Chapter Phase 3: Identifying data on costs.

## 7.2 Results

### General overview

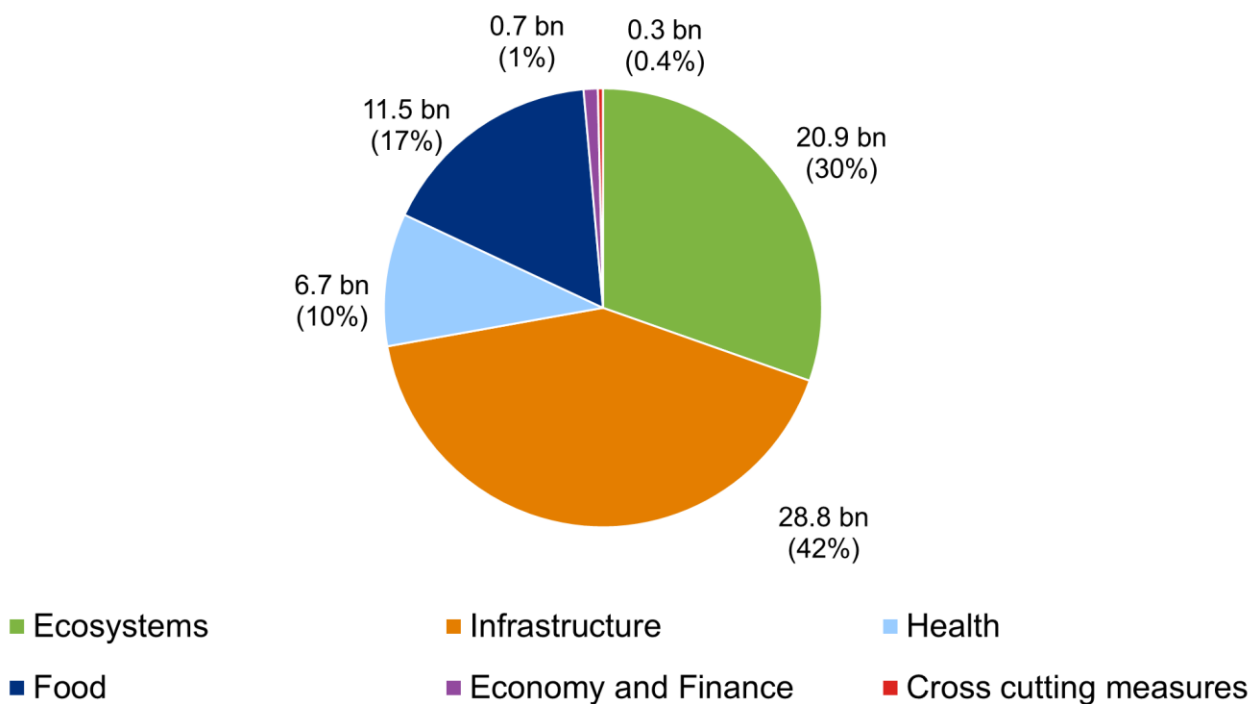
Annual and total investment needs to 2050 across all sectors are estimated at €69 billion per year and €1.2 trillion in cumulative net present value (NPV)<sup>15</sup>. These figures place the study at the higher end of existing international estimates, such as those from the World Bank.

As shown in Figure 12 infrastructure emerges as the largest sector of adaptation investment, requiring around €29 billion annually and €520 billion in NPV by 2050. Ecosystems follow with €21 billion per year and €365 billion NPV, reflecting the scale of restoration and management required for land, forests, and coastal areas. The food sector accounts for €11.5 billion annually, or €200 billion NPV, dominated by crop and livestock

<sup>15</sup> Net Present Value is calculated with a 3% discount rate.

adaptation measures. Health sector investment needs are estimated at around €7 billion per year, or €118 billion NPV, with the largest shares directed towards occupational health, wastewater treatment, and wildfire preparedness. The economy and finance sector shows the lowest investment needs around sectors, at €720 million annually and €12 billion NPV, although this likely underestimates the true need given the difficulty of costing financial and regulatory measures. Finally, cross cutting measures will require investments of around €300 million annually, or around €4.4 billion in NPV by 2050.

Figure 12 Estimated EU-wide annual adaptation investment needs by sector - EUR billion (% over total investment)



Investment needs vary significantly across Member States (See Figure 13). Larger countries such as France, Italy, Germany, Spain, and Sweden account for the majority of investments, while smaller Member States face much lower absolute requirements. Differences are also shaped by national contexts: Mediterranean countries have proportionately higher investment needs for wildfire prevention and crop adaptation, coastal nations such as the Netherlands and Italy face higher demands for coastal protection, and Central and Eastern European countries record higher relative investment needs for soil restoration and agricultural resilience.

Figure 13 Estimated annual adaptation investment needs by Member State and sector (EUR billion)

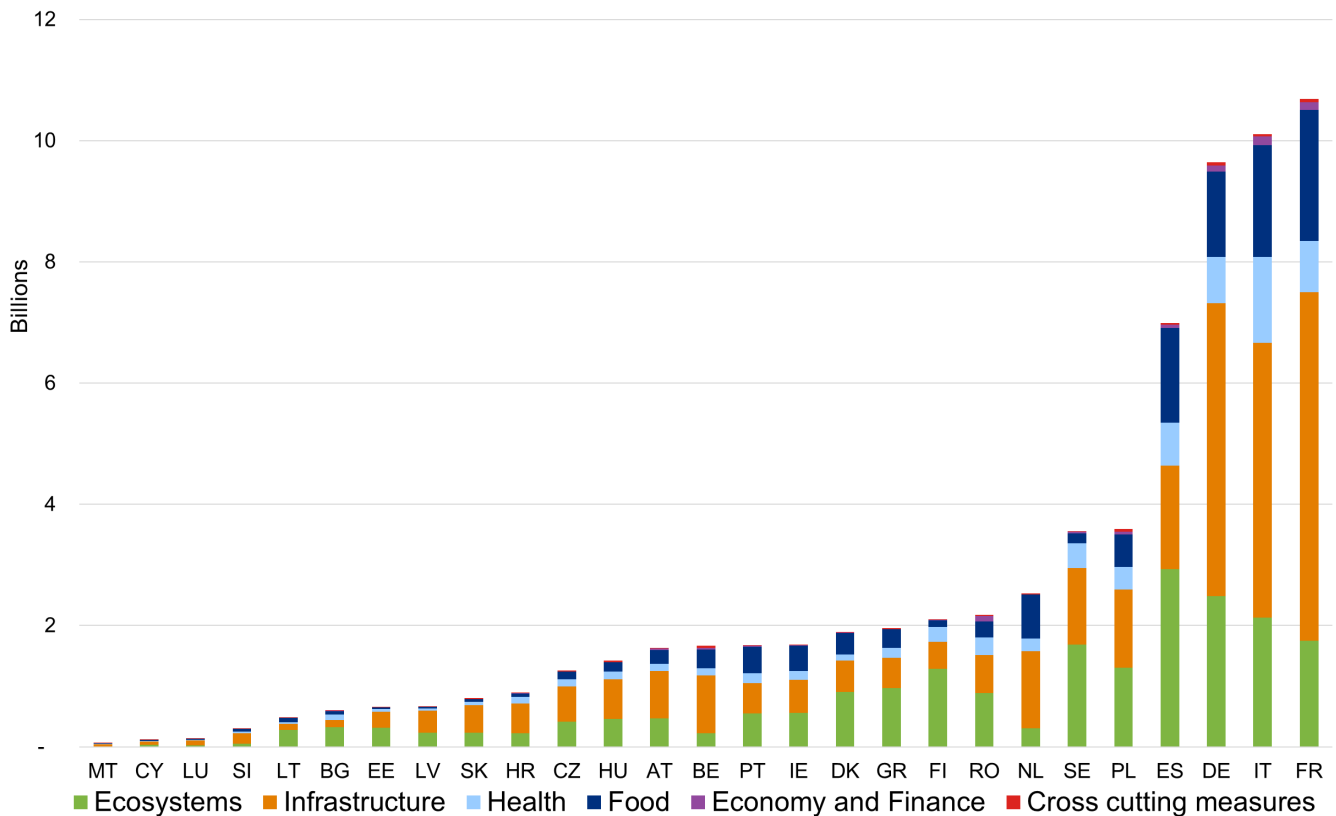
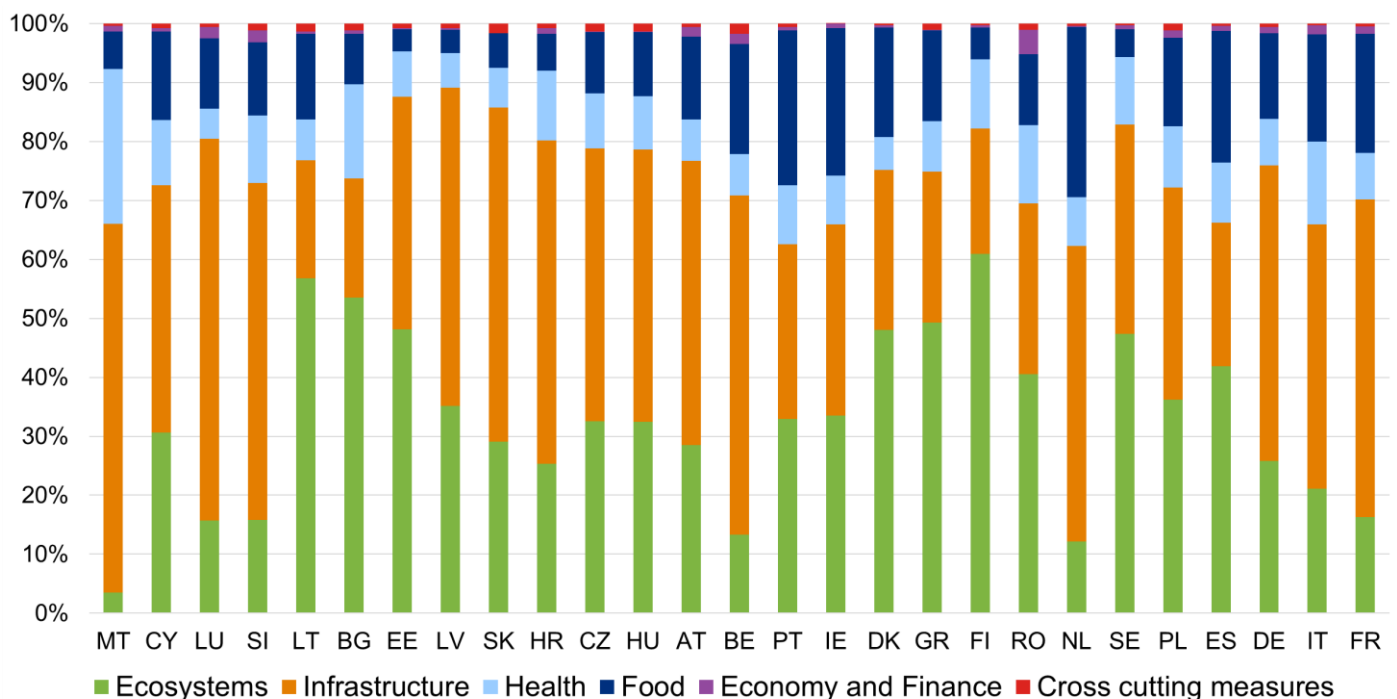


Figure 13 presents the share of total investment for each Member State by sector. The shares of adaptation investment needs by sector vary quite significantly across Member States, which reflects geo-physical conditions as well as population and territory size.

Figure 14 Estimated annual adaptation investment needs by Member State and sector (share of total investment need)



The above investment needs can also be expressed as a share of GDP by comparing the net present value (NPV) of adaptation investments up to 2050 with the NPV of projected GDP over the same period<sup>16</sup>. On this basis, the EU average annual requirement is around 0.46% of GDP (see Table 8Table 8). There is, however, a wide variation between Member States. The highest proportional burdens are observed in Estonia and Latvia, where investment needs exceed 1.2% of GDP, while Finland, Greece and Portugal are also above the EU average. In contrast, the largest economies, including Germany, France, Italy and Spain, record the greatest absolute totals but more moderate relative burdens, typically between 0.2 and 0.5% of GDP. Luxembourg shows the lowest ratio at 0.12%. These results indicate that although larger Member States carry the biggest needs overall, smaller economies often face proportionally heavier demands on their national resources. This has implications for modelling approaches that estimate adaptation investment needs based on GDP. While GDP scaling provides a reasonable first approximation, our results show that smaller Member States can face proportionally higher burdens, even if their absolute investment needs are lower. A bottom-up approach helps to reflect these differences more accurately.

*Table 8 Proportion of total adaptation investment needs against Member States' GDP.*

	Ecosystems	Infrastructure	Health	Food	Economy and Finance	Cross-cutting measures	Total
<b>EU 27</b>	0.167%	0.190%	0.043%	0.051%	0.003%	0.003%	0.459%
<b>Belgium</b>	0.029%	0.134%	0.015%	0.042%	0.004%	0.003%	0.228%
<b>Bulgaria</b>	0.239%	0.093%	0.071%	0.038%	0.003%	0.004%	0.449%
<b>Czechia</b>	0.102%	0.154%	0.030%	0.033%	0.000%	0.004%	0.323%
<b>Denmark</b>	0.189%	0.107%	0.022%	0.073%	0.002%	0.001%	0.394%
<b>Germany</b>	0.049%	0.099%	0.015%	0.028%	0.002%	0.001%	0.193%
<b>Estonia</b>	0.614%	0.524%	0.098%	0.048%	0.003%	0.006%	1.296%
<b>Ireland</b>	0.073%	0.072%	0.018%	0.055%	0.002%	0.000%	0.220%
<b>Greece</b>	0.344%	0.180%	0.060%	0.108%	0.000%	0.003%	0.699%
<b>Spain</b>	0.152%	0.089%	0.037%	0.081%	0.003%	0.001%	0.363%
<b>France</b>	0.051%	0.175%	0.025%	0.063%	0.004%	0.001%	0.320%
<b>Croatia</b>	0.205%	0.473%	0.096%	0.051%	0.007%	0.003%	0.839%
<b>Italy</b>	0.083%	0.182%	0.055%	0.072%	0.006%	0.001%	0.400%
<b>Cyprus</b>	0.083%	0.114%	0.030%	0.041%	0.001%	0.002%	0.270%
<b>Latvia</b>	0.467%	0.776%	0.078%	0.052%	0.005%	0.006%	1.388%
<b>Lithuania</b>	0.278%	0.104%	0.034%	0.071%	0.002%	0.004%	0.495%
<b>Luxembourg</b>	0.019%	0.078%	0.006%	0.014%	0.002%	0.001%	0.120%
<b>Hungary</b>	0.165%	0.242%	0.046%	0.056%	0.000%	0.005%	0.516%
<b>Malta</b>	0.006%	0.099%	0.042%	0.010%	0.001%	0.001%	0.158%
<b>Netherlands</b>	0.023%	0.094%	0.015%	0.054%	0.000%	0.001%	0.187%
<b>Austria</b>	0.078%	0.138%	0.019%	0.039%	0.004%	0.001%	0.280%
<b>Poland</b>	0.114%	0.116%	0.033%	0.047%	0.004%	0.003%	0.318%
<b>Portugal</b>	0.163%	0.154%	0.049%	0.130%	0.003%	0.003%	0.502%
<b>Romania</b>	0.184%	0.137%	0.060%	0.055%	0.019%	0.003%	0.460%
<b>Slovenia</b>	0.053%	0.203%	0.038%	0.042%	0.007%	0.003%	0.347%
<b>Slovakia</b>	0.138%	0.277%	0.032%	0.028%	0.000%	0.007%	0.483%
<b>Finland</b>	0.384%	0.141%	0.074%	0.034%	0.003%	0.002%	0.637%

<sup>16</sup> The net present value of GDP to 2050 is estimated based on the GDP growth projection of the European Commission's 2024 Ageing Report ([Underlying Assumptions and Projection Methodologies](#)).

<b>Sweden</b>	0.232%	0.186%	0.056%	0.023%	0.003%	0.001%	0.502%
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Note: The values represent the net present value of sectoral investment needs expressed as a percentage of each country's net present value GDP to 2050. The colour scale is applied within each column, highlighting which Member States are required to allocate a relatively higher or lower share of GDP to that sector (from red = higher to blue = lower).

The rest of this chapter provides an overview of findings for each sector.

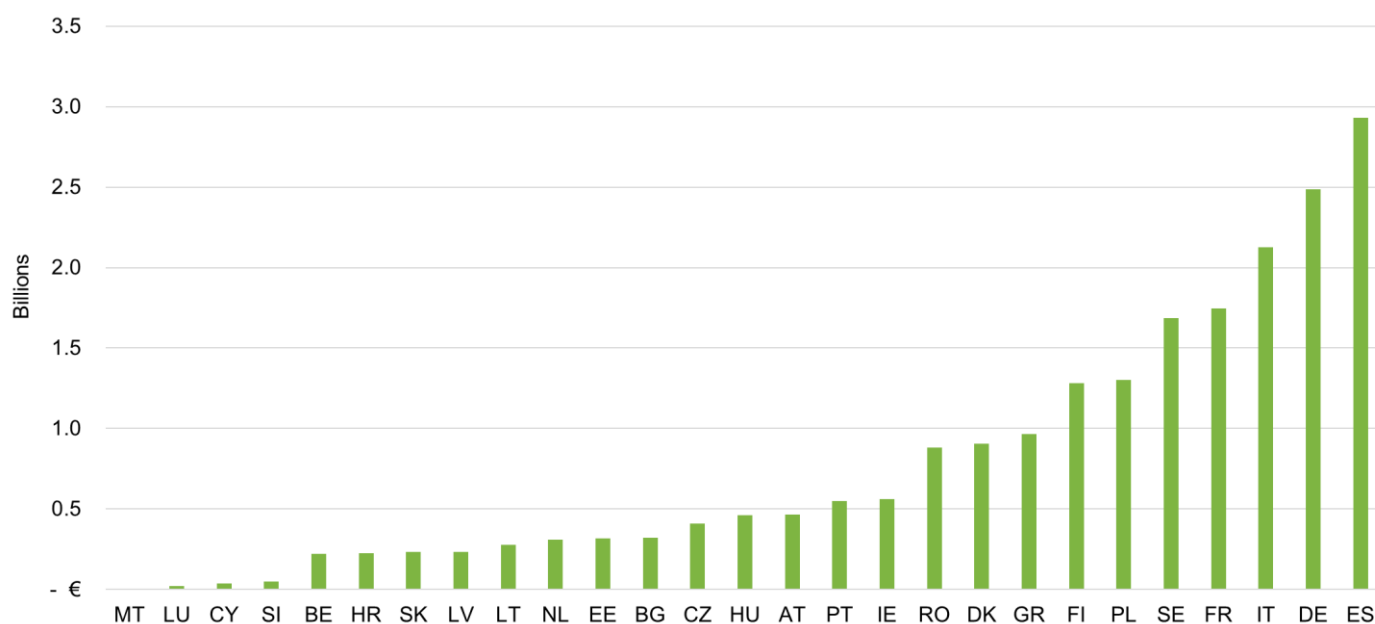
## Ecosystems

Table 9 Ecosystems investment needs – Annual and Net Present Value of investments to 2050

Sector	Annual	NPV (2050) <sup>17</sup>
Ecosystems	€21 billion	€366 billion

The ecosystems sector represents the second largest category of adaptation investment needs. Total investment needs across the Member State are estimated at around €21 billion per year, with a net present value of approximately €366 billion for the period up to 2050. Due to the scaling approach used for some measures in this sector, investment needs are closely linked to the size and extent of natural ecosystems, so larger countries such as Spain, Germany, Italy, France and Sweden record the highest values.

Figure 15 Annual ecosystem adaptation investment needs by Member State (EUR billion)



The most significant needs arise from soil restoration measures, which account for about €8 billion annually, or 38% of the total sector investment. Other important clusters include biodiversity protection and pollinator measures (together around €2.5 billion annually), wildfire prevention (about €2 billion annually), and coastal ecosystem restoration such as dune and saltmarsh measures, which collectively exceed €3.5 billion per year. Although smaller in absolute terms, measures such as habitat connectivity and grassland restoration still represent meaningful investment needs.

Investment needs also vary according to exposure to climate risks. Countries with extensive agricultural systems or large forested areas tend to face higher investment need for soil and forest management. Similarly, Member States with long and densely populated coastlines, such as Italy, carry larger shares of the investment

<sup>17</sup> Net Present Value is calculated with a 3% discount rate.

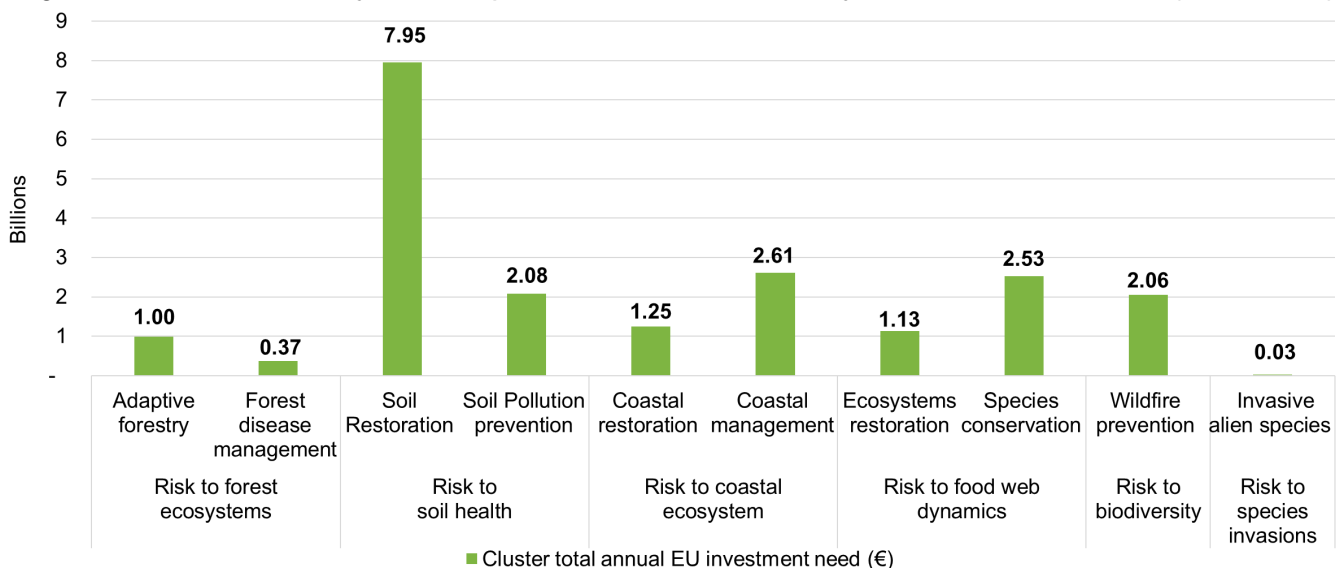
needs for coastal ecosystem restoration. Wildfire prevention is another high-value item, particularly for Mediterranean countries where the risk of fire is classified as critical or catastrophic.

The findings highlight the central role of ecosystems in Europe's adaptation challenge. With soil restoration emerging as the single largest investment item, the findings underline the importance of agricultural land management as a foundation for resilience. Investments in soil health will not only secure food production but also provide co-benefits for biodiversity and carbon sequestration.

The prominence of wildfire prevention and coastal restoration shows how geography shapes adaptation priorities. Southern Europe must contend with rising wildfire risks, while Mediterranean and North Sea states face growing pressures on coastal ecosystems. These patterns suggest that adaptation efforts cannot be pursued solely at the national level. There is scope for regional approaches where Member States face similar challenges, for example coordinated wildfire prevention strategies across the Mediterranean basin, soil restoration programmes in central and eastern agricultural regions, or joint coastal management initiatives in areas with high population density along the shore.

The *Figure* below provides a more granular view of how these investment needs are distributed across the main clusters of ecosystem-related measures and the specific climate risks they address.

*Figure 16 EU Annual ecosystem adaptation investment needs by cluster and climate risk (EUR billion)*



*Note: For visualization purposes, the names of certain clusters and climate risks have been shortened in the figure while preserving clarity on their thematic scope. The full definitions and detailed descriptions of each adaptation measure and risk category are provided in the preceding sections of the report and in the accompanying methodological annex.*

## Infrastructure

*Table 10 Infrastructure investment needs – Annual and Net Present Value of investments to 2050*

Sector	Annual	NPV (2050)
Infrastructure	€29 billion	€521 billion

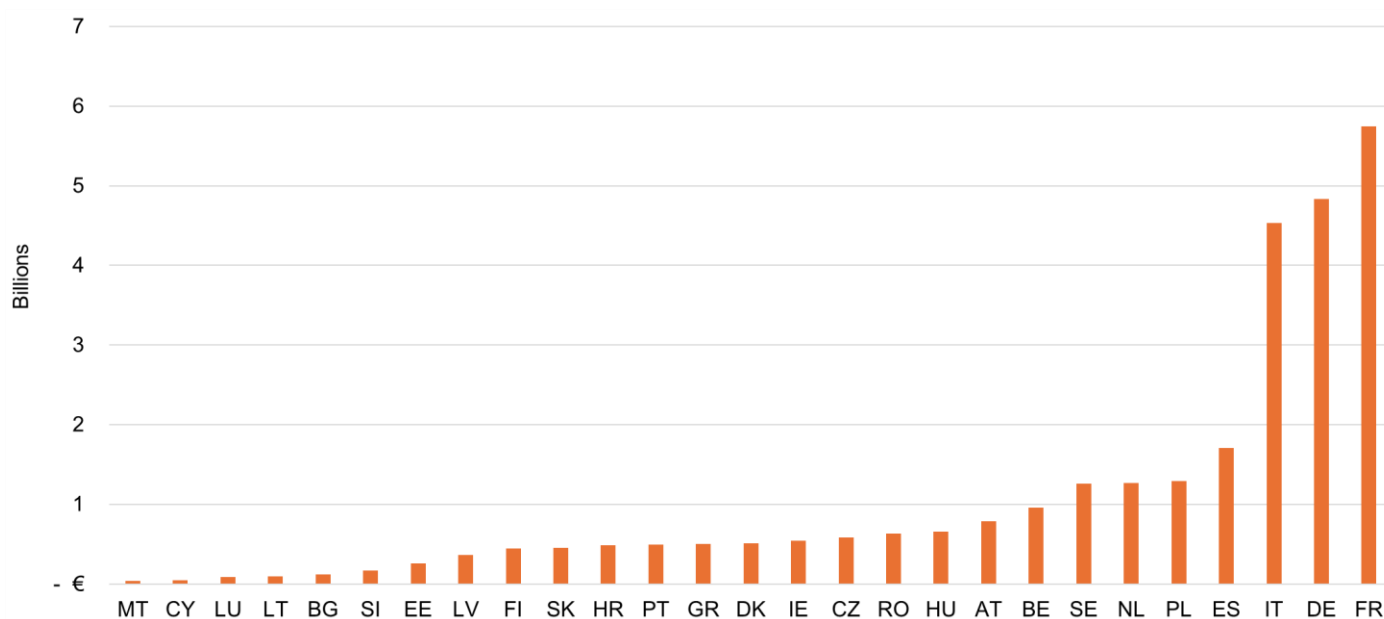
The infrastructure sector represents the largest estimated adaptation investment need across Member States. Annual investment requirements are around €29 billion, with a cumulative net present value of €521 billion to 2050. The scale of the investment needs reflect both the breadth of measures in this sector and the high vulnerability of infrastructure systems to climate-related risks.

The costliest measure within the sector is retrofitting of existing buildings and infrastructure, estimated at €6.6 billion per year, or almost €120 billion cumulatively in NPV terms to 2050. To avoid overstating adaptation-related expenditure, only the share of retrofitting cost that are more directly associated with climate-adaptation functions were included in this estimate. This adjustment was applied specifically in this case because the cost of retrofitting was particularly substantial, and using the full value would have risked significantly inflating the adaptation investment needs. Recent evidence (e.g. I4CE, 2024)<sup>18</sup> indicates that adaptation-specific additions to building retrofits typically amount to around 10% of the total cost of renovation works, which are otherwise largely driven by energy-efficiency or general refurbishment objectives. Given the magnitude of the cost, and the availability of a reliable benchmark, this 10% proxy was applied to an estimate of the total cost of retrofitting in order to derive the adaptation-relevant share of the cost.

Other high investment need items include coastal protection (around €3.9 billion annually), grey flood protection infrastructure (€3.3 billion annually), restoration of natural floodplains (€2.8 billion annually), and strengthening of road and rail networks (€2.4 billion annually). Measures to protect cultural heritage and historic buildings also contribute substantially, with estimated needs exceeding €3.5 billion per year. Smaller measures, such as flood early warning systems or legislative and regulatory adaptations, represent only a minor share of total investment need.

Investment needs are concentrated in the largest Member States. Germany, France, and Italy alone account for over half of the sector's needs. Within this, Italy faces the highest retrofitting needs, with an estimated €33 billion in NPV terms to 2050, compared to around €18–19 billion NPV in France and Germany. This reflects the emphasis Italy has placed on its national renovation strategies outlined in its National Energy and Climate Plan (NECP). Similarly, coastal protection measures are particularly costly for countries with extensive and densely populated coastlines, such as France, Spain, and the Netherlands. Differences reflect sector-specific drivers: infrastructure investments are driven by asset exposure and urban density, whereas ecosystem investments are linked to restoration targets and habitat extent. These differences, and priorities, are reflected in the strategic documents of Member States, although specific adaptation targets are generally lacking (see Figure 10 Target level of adaptation in national documents). Figure 17 below presents in details the annual infrastructure adaptation investment needs by each EU Member State.

Figure 17 Annual infrastructure adaptation investment needs by Member State (EUR billion)



The findings confirm that infrastructure represents the core of Europe's adaptation challenge. Retrofitting of residential and commercial buildings is the single largest investment need driver, highlighting the fiscal and

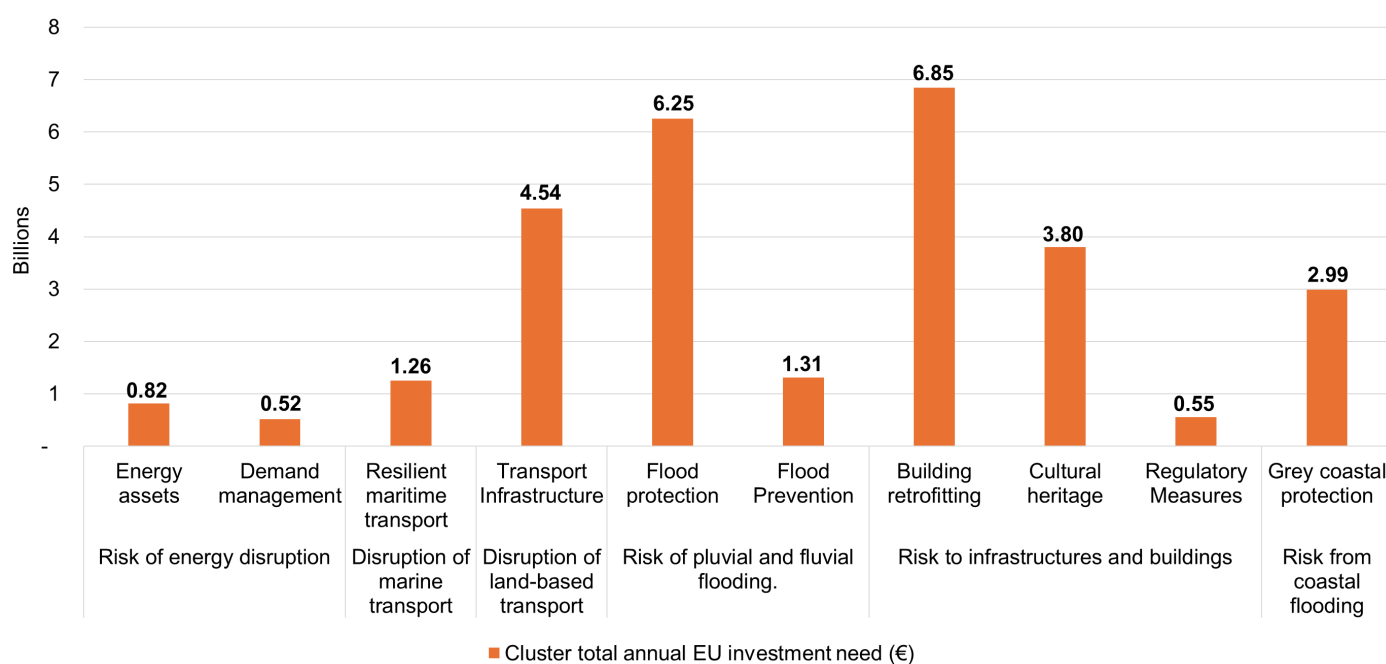
<sup>18</sup> <https://www.i4ce.org/wp-content/uploads/2024/06/Adapting-buildings-to-heatwaves-what-do-we-know.pdf>

policy challenge of climate-proofing Europe's ageing building stock. Beyond their role in strengthening the resilience of the built environment, retrofitting interventions often generate benefits that extend beyond adaptation. When combined with energy-renovation works aimed at improving thermal performance and reducing energy consumption, a share of the associated investments contributes simultaneously to mitigation objectives, delivering emission reductions and broader environmental benefits.

The significance of coastal and flood protection investment needs underlines the exposure of Europe's population and assets to water-related risks. Coastal nations such as the Netherlands, France and Italy face the highest burdens in this area, while floodplain restoration and river defence measures dominate in central and northern Member States. These results indicate that adaptation priorities will be shaped as much by geography as by economic scale, and that regional coordination of flood protection infrastructure could provide important efficiencies.

The sector also reveals how adaptation can extend beyond purely functional assets to cultural heritage. With investment needs of more than €3.5 billion per year, the adaptation of historic buildings demonstrates that climate risks threaten not only economic infrastructure but also Europe's cultural identity. This adds a further dimension to the case for adaptation, strengthening the argument for EU-level investment support where assets of shared cultural value are at risk. Full detail of annual infrastructure costs per cluster of measures and related climate risk is presented below (see Figure ).

Figure 18 EU Annual infrastructure adaptation investment needs by cluster and climate risk (EUR billion)



Note: For visualization purposes, the names of certain clusters and climate risks have been shortened and combined in the figure while preserving clarity on their thematic scope. The full definitions and detailed descriptions of each adaptation measure and risk category are provided in the preceding sections of the report and in the accompanying methodological annex.

## Food

Table 11 Food investment needs – Annual and Net Present Value of investments to 2050

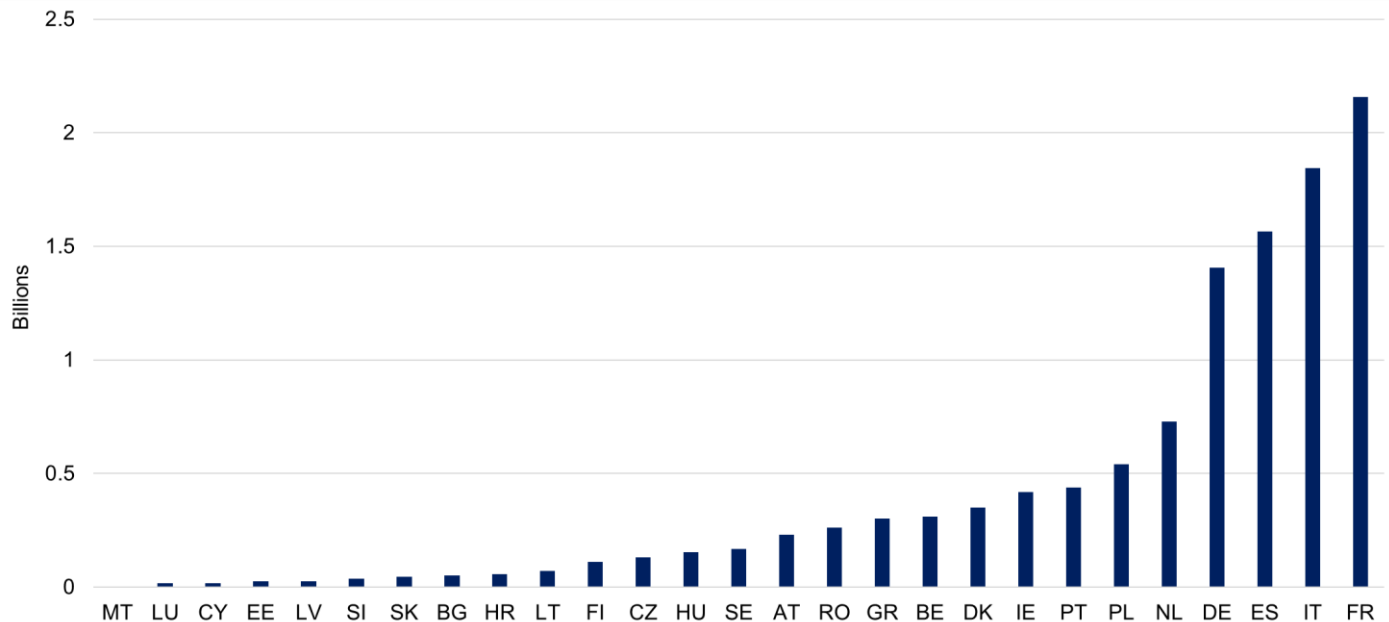
Sector	Annual	NPV (2050) <sup>19</sup>
Food	€11.5 billion	€200 billion

<sup>19</sup> Net Present Value is calculated with a 3% discount rate.

The food sector is estimated to require €11.5 billion per year in adaptation investments, with a cumulative net present value of around €200 billion to 2050. Investment needs are concentrated in a small number of Member States with large agricultural systems, particularly France, Italy, Spain, Germany, the Netherlands, and Poland. These six countries together account for roughly two-thirds of the sector's total needs.

Figure 19 below presents in details the annual food adaptation investment needs by each EU Member State.

*Figure 19 Annual food adaptation investment needs by Member State (EUR billion)*

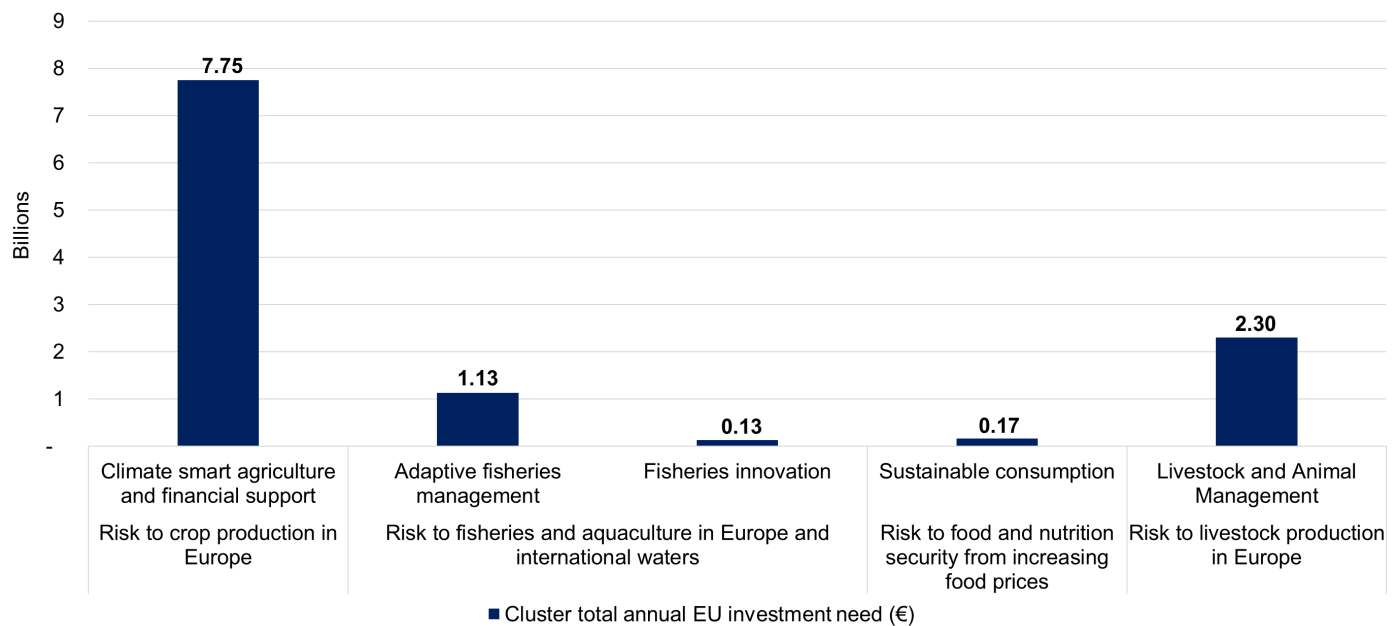


The majority of investment requirements arise from crop production measures. Climate-smart agriculture and related practices including drought-resistant crop varieties, irrigation upgrades, soil management, and improved water use efficiency, are estimated at nearly €7.8 billion annually, or €135 billion in NPV terms by 2050. This cluster of measures alone represents around 68 % of all food sector investment needs, highlighting its central role in shaping overall investment needs.

Livestock-related adaptation accounts for about 20 % of the sector total. The largest components are climate-proofing of barns and facilities (€1.2 billion annually, €21 billion NPV) and the development of heat-tolerant breeds and improved management practices (€1.1 billion annually, €19 billion NPV). Fisheries adaptation is of comparable magnitude, with adaptive management and innovation measures estimated at about €1.1 billion annually and €20 billion in NPV terms to 2050.

By contrast, sustainable production and consumption, and fisheries innovation make only a marginal contribution to sector investment needs. Sustainable production and consumption together account for less than €150 million annually, or under 2 % of the total, while fisheries innovation measures are similarly small at about €130 million per year. This indicates that the bulk of adaptation investment in the food sector will be driven by physical and productivity-focused measures, rather than softer interventions. Full detail of annual food costs per cluster of measures and related climate risk is presented below.

Figure 20 EU Annual food adaptation investment needs by cluster and climate risk (EUR billion)



Note: For visualization purposes, the names of certain clusters and climate risks have been shortened and combined in the figure while preserving clarity on their thematic scope. The full definitions and detailed descriptions of each adaptation measure and risk category are provided in the preceding sections of the report and in the accompanying methodological annex.

The results underline that adaptation in the food sector is primarily a matter of safeguarding agricultural productivity. Crop measures dominate the totals, reflecting both the scale of agricultural land in Europe and the severity of climate risks identified in the EUCRA analysis. Southern Europe in particular faces acute pressures from drought and heat, while central and eastern Member States face soil degradation risks. This explains why agricultural output is the key driver of investment needs.

Livestock adaptation, while smaller in aggregate terms, remains significant. The findings point to a need for investment in farm infrastructure and breeding programmes to reduce heat stress and disease risks. Countries with high livestock densities, such as Poland, carry larger relative burdens than some western European producers. This suggests that adaptation priorities within the food sector are not uniform, but depend on national production structures.

Regional coordination could bring benefits where adaptation needs are similar. Mediterranean countries, for example, share common risks to crop yields from drought and could cooperate on irrigation technologies and resilient crop varieties. Northern Member States may find shared value in livestock disease monitoring and adaptive breeding programmes. These results therefore point not only to sectoral investment priorities but also to opportunities for cooperation across regions facing similar agricultural risks.

## Health

Table 12 Health investment needs – Annual and Net Present Value of investments to 2050

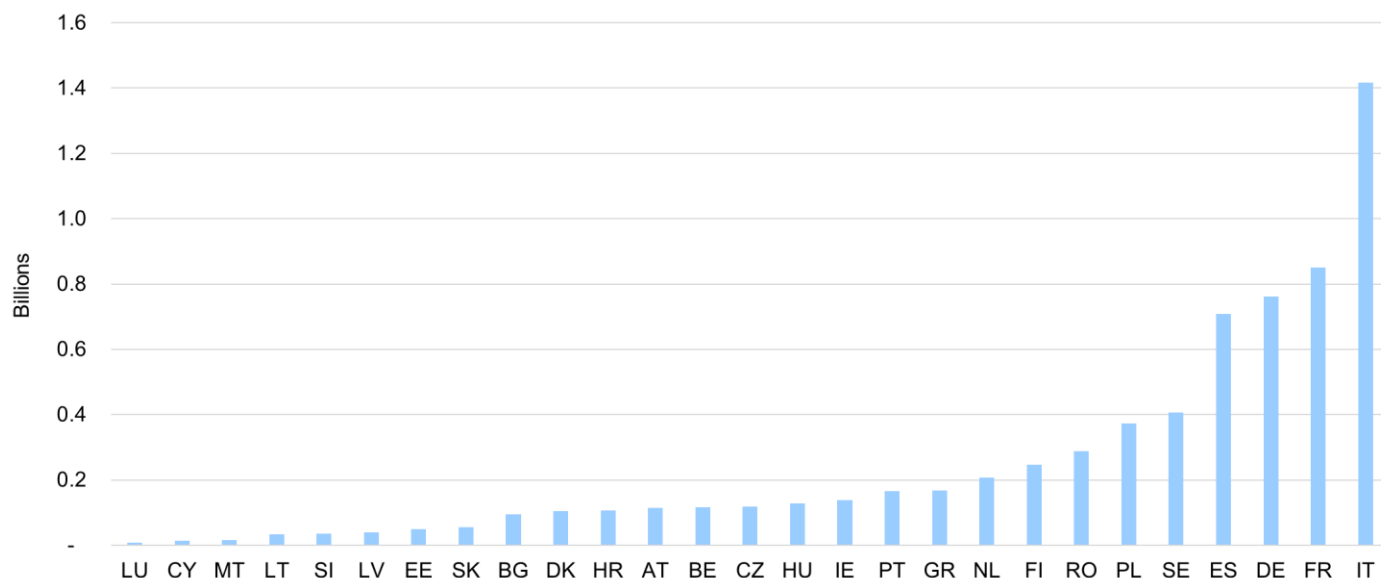
Sector	Annual	NPV (2050) <sup>20</sup>
Health	€7 billion	€118 billion

The health sector is estimated to require around €7 billion per year in adaptation investments, with a cumulative net present value of around €118 billion to 2050. Investment needs vary widely across Member States, with

<sup>20</sup> Net Present Value is calculated with a 3% discount rate.

Italy, France, Germany, and Spain together accounting for more than half of the sector total. Figure 21 below presents in details the annual Health sector adaptation investment needs by each EU Member State.

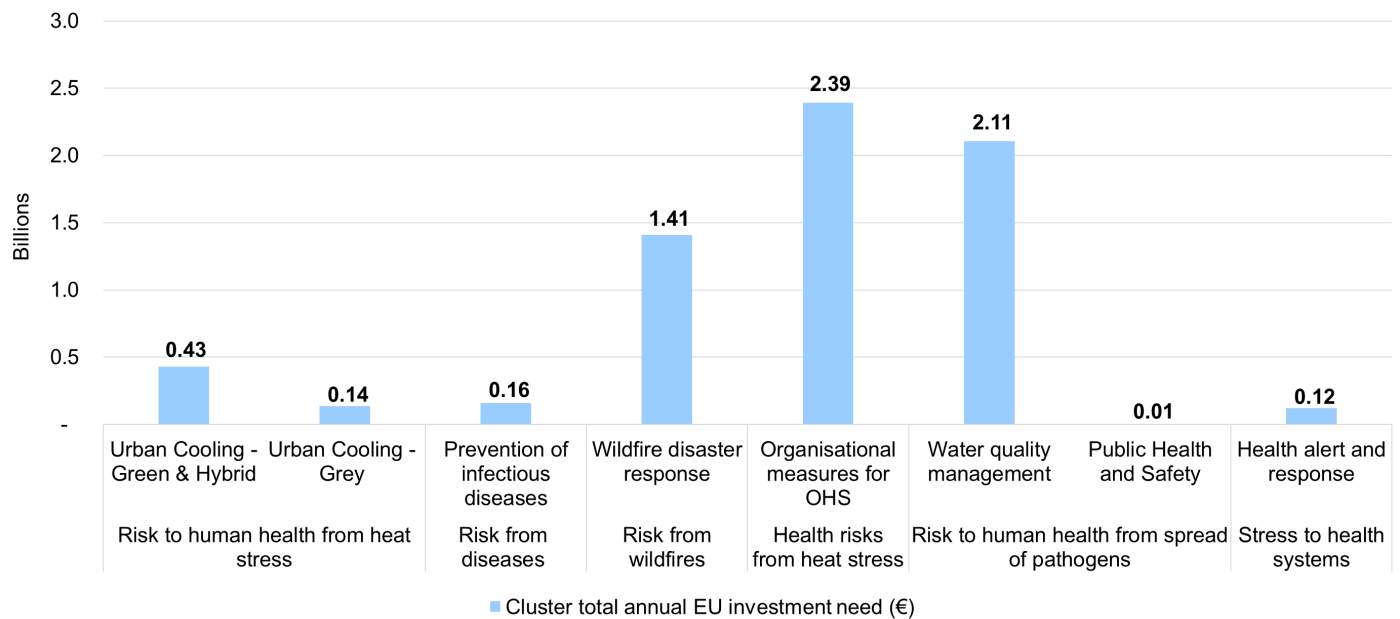
*Figure 21 Annual health adaptation investment needs by Member State (EUR billion)*



The largest share of investment needs is associated with occupational health and safety measures to protect workers from heat stress. These measures, which include modified work schedules, shaded rest areas, and protective equipment, are estimated at about €2.4 billion annually, or €42 billion (NPV) to 2050. Wastewater treatment upgrades are the second largest category at €1.6 billion annually, or €28 billion in cumulative NPV terms, reflecting both compliance requirements under EU legislation and climate-driven pressures on water systems. Wildfire disaster response is the third major cluster, requiring about €1.2 billion annually, or €22 billion in NPV terms to 2050.

Other measures are smaller in scale but not insignificant. Urban cooling and green infrastructure account for about €430 million annually, while infectious disease monitoring and early warning systems together total around €260 million per year. Training of health professionals in disaster management represents the lowest investment need, at under €20 million annually. Full detail of annual health sector investment needs across EU per cluster of measures and related climate risk is presented below (see Figure 22).

Figure 22 EU Annual health adaptation investment needs by cluster and climate risk (EUR billion)



Note: For visualization purposes, the names of certain clusters and climate risks have been shortened and combined in the figure while preserving clarity on their thematic scope. The full definitions and detailed descriptions of each adaptation measure and risk category are provided in the preceding sections of the report and in the accompanying methodological annex.

The results highlight that the primary health-related adaptation investments stem from protecting workers and safeguarding essential services. Occupational health measures dominate, reflecting the growing risks of heat stress for outdoor and manual workers, especially in Southern Europe where summer temperatures are projected to rise sharply. These findings underline the economic as well as social implications of climate risks, as labour productivity and workplace safety are directly affected.

Water-related adaptation also emerges as a central priority. Upgrading wastewater treatment facilities accounts for nearly a quarter of sectoral investment needs, concentrated in certain countries such as Italy whose investment needs are considerably higher than other MS (€714 million per year compared to the next highest €132 million for Spain, and €131 million for France). This suggests that climate change is intensifying existing infrastructure challenges, and that adaptation policy in health cannot be separated from water quality and sanitation strategies.

The importance of wildfire response shows how interconnected risks are. Health investment needs from fire events are not limited to immediate casualties but extend to emergency preparedness, medical capacity, and protective equipment. Southern Europe carries the greatest share of these costs, aligning with the risk profiles identified in national climate assessments.

## Economy and finance

Table 13 Economy and Finance investment needs – Annual and Net Present Value of investments to 2050

Sector	Annual	NPV (2050) <sup>21</sup>
Economy and Finance	€0.7 billion	€12 billion

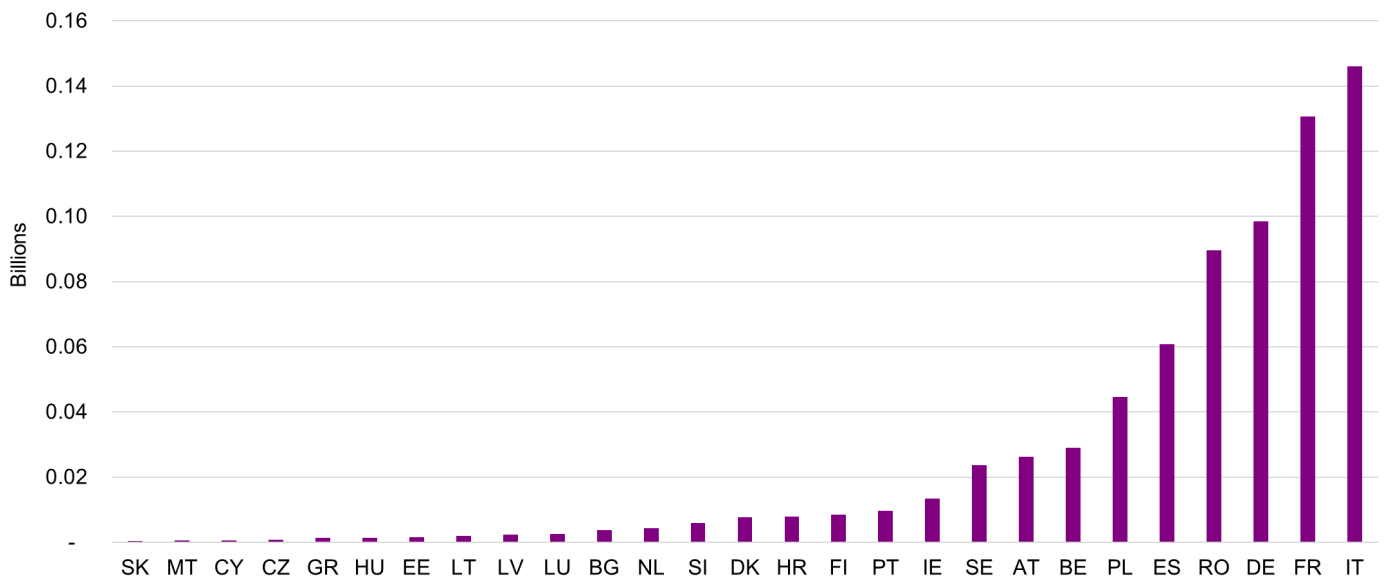
The economy and finance sector records the lowest investment needs among the five sectors, at an estimated €720 million per year and a cumulative net present value of around €12 billion to 2050. These figures are

<sup>21</sup> Net Present Value is calculated with a 3% discount rate.

modest compared to infrastructure, ecosystems, food, and health, reflecting both the nature of the measures in this sector and the limited availability of cost data.

The economy and finance sector, as defined in this study, covers a diverse set of risks and adaptation measures that cut across markets and economic activities. This includes adaptation of financial systems (e.g. property and insurance markets, risk transfer mechanisms and climate finance instruments), climate-sensitive industries (including winter tourism), and selected water-related economic services where data were available (e.g., water distribution networks, reuse and desalination). Because the evidence base is limited, the results presented here draw on those domains where cost data could be identified. Figure 23 below presents in details the annual economy and finance sector adaptation investment needs by each EU Member State.

*Figure 23 Annual economy and finance adaptation investment needs by Member State (EUR billion)*



Within the measures for which there was available data, water-related adaptations were the largest. Investment in water distribution networks, including leakage detection and repair, is the largest single item at around €280 million per year, or €4.8 billion (NPV) to 2050. Water supply management, such as reuse and desalination, follows with €130 million annually and €2.3 billion in cumulative NPV terms. Water demand management adds a further €190 million NPV, bringing the total for water-related measures to nearly two-thirds of all of the sector's investment needs.

Other measures are much smaller in scale. Adaptation of the winter tourism sector is estimated at €80 million annually, or €1.4 billion by 2050, concentrated in Alpine and Nordic countries. Property and insurance market adaptation amounts to €46 million annually, or about €800 million NPV to 2050. Several identified measures, such as blended finance strategies, climate bonds, and supply chain resilience, could not be costed due to lack of data and therefore do not appear in the totals.

The relatively low totals reflect the difficulty of costing measures that operate through financial systems, such as insurance, credit, and risk transfer mechanisms. These tools do not carry large direct expenditures but are essential for enabling adaptation investments in the higher-cost sectors. The small numbers in this sector should therefore not be misinterpreted as low importance.

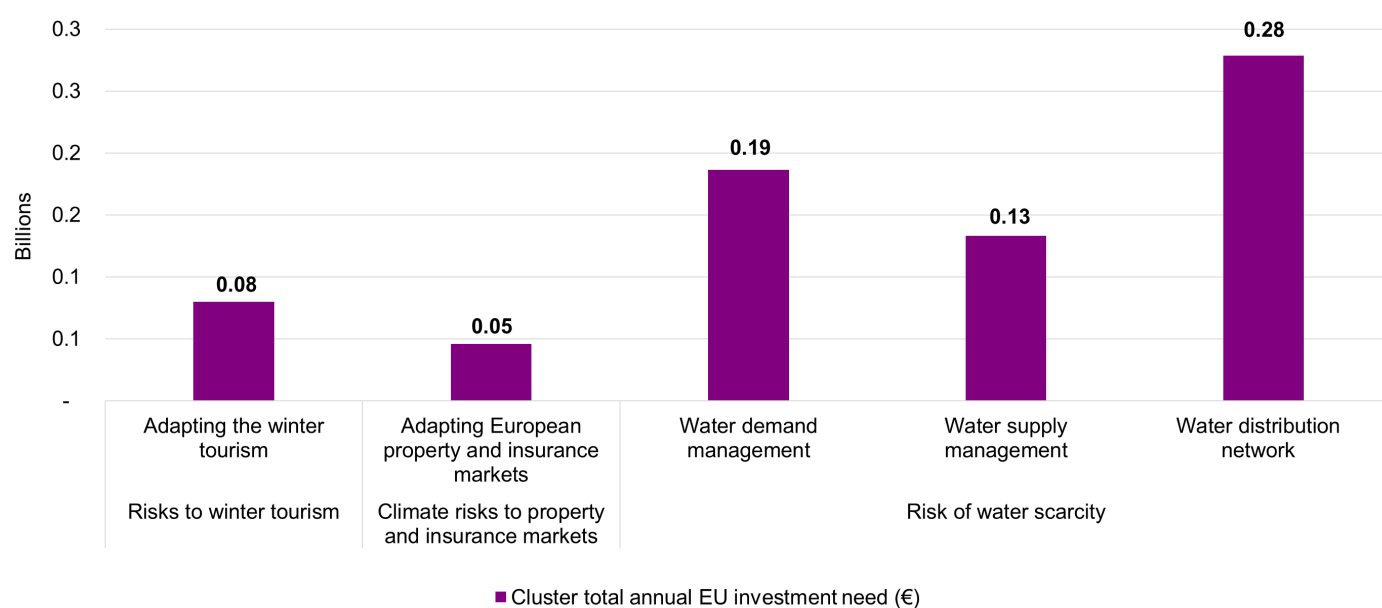
The dominance of water-related measures highlights the economic risks of scarcity and inefficiency in water use. Leakages, supply constraints, and demand pressures represent major challenges for both households and businesses, and adaptation investment in this area will have economy-wide benefits. The relatively even distribution of these investment needs across Member States indicates that water stress is a shared European concern, though its intensity and drivers vary by region.

The adaptation of winter tourism illustrates how climate change affects specific industries in geographically concentrated ways. Alpine regions in France, Italy, Austria, and Switzerland (outside the EU) are particularly vulnerable, while Nordic countries also face pressures. These findings underline that while the sector's overall totals are modest, climate risks to specialised industries can have disproportionate local impacts, hence the need to explain why certain industries, such as winter tourism, feature more visibly within this cluster.

Winter tourism appears here prominently for several methodological reasons. Across multiple national adaptation plans, risks to winter tourism are explicitly framed within the economy and finance context, unlike many other climate-sensitive sectors where costed measures are rarely specified. Winter tourism also presents highly visible and already quantifiable impacts, which are incorporated into national and regional adaptation budget lines, making it one of the few climate-sensitive industries for which cost estimates are available. By contrast, several domains central to this cluster, such as insurance markets, financial system resilience, supply-chain vulnerabilities, or climate-related financial risk disclosure, are recognised as significantly exposed to climate change but do not provide cost data specific enough to support the calculation of sectoral investment needs. The prevalence of low-cost or negligible-cost measures in the economy and finance cluster (e.g. blended finance instruments, green bonds, public-private partnerships, and the development of taxonomies or disclosure frameworks) further reduces the total identifiable investment needs. Together, these factors make winter tourism appear relatively more prominent in the totals, even though the sector's macroeconomic weight remains limited. Its investment needs should therefore be interpreted within this methodological and data-availability context, not as an indication of disproportionate economic importance.

Full detail of annual economy and finance sector investment needs across EU per cluster of measures and related climate risk is presented in Figure 25 below.

*Figure 24 EU Annual economy and finance sector adaptation investment needs by cluster and climate risk (EUR billion)*



Looking ahead, the main role of this sector will be to provide the financial and policy frameworks that make large-scale adaptation feasible. Insurance programmes, climate risk disclosure, and green finance instruments can unlock investment flows far exceeding the modest direct investment presented here. The implication is that adaptation in economy and finance should be seen as a lever for mobilisation, not as a cost category in its own right.

## Cross cutting measures

Cross-cutting measures, encompassing research and innovation (R&I) and education and awareness, represent a distinct category within the adaptation measures, aimed at strengthening systemic resilience rather than addressing individual risks. Estimated investment needs for these measures amount to approximately €257 million per year across the EU, with allocations split between R&I (€62 million) and education (€194 million), specifically for adaptation (as explained in the calculation methodology for these measures in Chapter 5). While smaller in size than sectoral investments, these measures contribute to the effectiveness of adaptation across all domains by fostering knowledge generation, technological innovation, and societal engagement. Countries with higher baseline expenditure on education and R&I, such as Germany, France, and Italy, record the largest absolute allocations, whereas smaller Member States exhibit proportionally higher cross-cutting investment needs as a share of their total estimated adaptation investment needs. These differences are influenced by underlying national priorities and economic characteristics and are coherent with the specific calculation approach used for cross-cutting measures, as outlined in Chapter 5.

*Table 9 – Cross-cutting measures investment needs – Annual and Net Present Value of investments to 2050*

Sector	Annual	NPV (2050) <sup>22</sup>
Cross-cutting measures (Education and R&D)	€0.26 billion	€4.4 billion

Although cross-cutting measures account for less than 0.4% of total adaptation investment needs, their strategic importance is disproportionately large compared to their financial weight. Investments in R&I accelerate the development of innovative adaptation technologies and monitoring frameworks, while education and awareness initiatives build the social capital required for behavioural change and policy uptake. These functions are critical for mainstreaming adaptation into governance and economic systems, reducing long-term costs through improved planning and risk anticipation. The relatively low investment needs estimates likely understate the true resource needs, given the difficulty of quantifying the cost of knowledge-based interventions and their indirect benefits. Future assessments might integrate metrics on adaptive capacity and innovation to better capture these contributions.

## 7.3 Urgent investment scenario

In the section above, the investment needs reflect an assessment of the resources required to build resilience across all identified climate risks by mid-century. The risks were aligned with the 36 climate risk categories in the EUCRA. In this section, an alternative scenario is explored that considers only those risks EUCRA classifies as requiring urgent action. This provides insight into the investment needs associated with only the most immediate and urgent adaptation measures.

A scenario identifying investments deemed ‘urgent’ was produced by filtering the EUCRA risks flagged as requiring urgent action. Of the 36 major climate risks for Europe, 21 require more action now, and eight are classified as particularly urgent. These include risks to coastal and marine ecosystems, biodiversity and carbon sinks due to wildfires, crop production, human health from heat stress, population and built environment from wildfires, inland flooding, and the viability of the EU solidarity mechanism. In this scenario, only measures linked to those ‘urgent action needed’ risks were included in the estimations (see Table 14).

*Table 14 EU-wide adaptation investment needs under scaling sensitivity scenarios (EUR billion€)*

<sup>22</sup> Net Present Value is calculated with a 3% discount rate.

Scenario	Annual (billion €)	NPV (billion €)	% of total investment need
Urgent investment scenario	25	436	36%

Under this scenario, the investment need is estimated as €25 billion per year across six main risks, equivalent to ~36% of the study's EU-wide annual requirement in the central case (€68.8 billion). Investment needs are concentrated in crop production (~31%), pluvial/fluvial flooding (~30%), coastal ecosystems (~15%), heat stress on general population (~9.5%), biodiversity/carbon sinks due to wildfires (~8%), and population/built environment due to wildfires (~5.5%).

The distribution of investment needs linked to urgent risks varies across Member States. On average, 36% of adaptation investment requirements in the EU are associated with urgent risks, but for several countries this share is substantially higher. France, Greece, Denmark, Estonia, Slovenia and Finland stand out with more than 40% of their total needs directly tied to urgent risks, underlining the immediate relevance of targeted action. By contrast, in countries such as Malta, Cyprus, Romania, Bulgaria and Ireland the share is notably lower, reflecting a different composition of climate risks and investment profiles. This heterogeneity highlights that, while urgent action is a common priority across the Union, its relative weight differs by country and risk context. It is important to note that urgency in this scenario is defined from an EUCRA perspective. A low share of EUCRA-defined urgent risks, such as observed for Malta, does not mean there are no nationally urgent investment priorities, but rather reflects differences in how risks are classified at EU versus national level.

*Table 15 Share of national adaptation investment needs associated with urgent risks*

Country	% of investment related to urgent risk	Country	% of investment related to urgent risk
<b>Total EU 27</b>	36%	<b>Latvia</b>	39%
<b>Belgium</b>	37%	<b>Lithuania</b>	28%
<b>Bulgaria</b>	25%	<b>Luxembourg</b>	36%
<b>Czechia</b>	41%	<b>Hungary</b>	30%
<b>Denmark</b>	45%	<b>Malta</b>	13%
<b>Germany</b>	32%	<b>Netherlands</b>	35%
<b>Estonia</b>	44%	<b>Austria</b>	41%
<b>Ireland</b>	25%	<b>Poland</b>	29%
<b>Greece</b>	46%	<b>Portugal</b>	31%
<b>Spain</b>	34%	<b>Romania</b>	23%
<b>France</b>	49%	<b>Slovenia</b>	45%
<b>Croatia</b>	37%	<b>Slovakia</b>	25%
<b>Italy</b>	33%	<b>Finland</b>	42%
<b>Cyprus</b>	24%	<b>Sweden</b>	36%

## 8. Phase 6: Sensitivity Analysis

Given the complexity of the methodology and the limited standardisation and availability of cost data across Member States, the assessment inevitably relies on a series of assumptions. These assumptions are grounded in established literature and expert judgement; however, they introduce a degree of uncertainty into the estimates presented in previous chapters.

To examine the robustness of the results, a sensitivity analysis was undertaken focusing on the two methodological components with the greatest influence on outcomes:

- (i) the scaling approach applied to transpose investment need evidence from one country to others (see Phase 4: Scaling approach), and
- (ii) the treatment of risk exposure within the costing framework (introduced in Phase 1: Climate risk identification and further discussed in Phase 5: Assessment of investment needs).

This chapter first presents the primary sensitivity exercise on scaling approaches, which defines lower and upper bounds for the estimates. It then introduces a secondary test on risk-exposure adjustments, designed to explore how alternative exposure-cost relationships could affect the results.

Cross-cutting measures are not included in the sensitivity analysis, as their investment needs were estimated through a distinct calculation framework. Given this different basis, applying the sensitivity adjustments would not be methodologically consistent, and results are therefore reported only for sector-specific measures.

### 8.1 Sensitivity to scaling approaches

#### Method

For each adaptation measure, the costing framework applies a scaling approach to extrapolate observed investments from a reference country to other Member State. As outlined in Section 2 and implemented in Section 6, this approach is measure-specific and depends on the nature of the available evidence. Investment needs are transferred using a suitable scaling proxy (an 'element of interest') that reflects the main driver of effort for the measure.

*Example: For adaptive forest management, a unit cost identified for France was scaled to other Member States using a forest-area share proxy (i.e. the ratio of forest area in the target country to that in France).*

While this approach provides a practical way to transfer investment need, the selected proxies inevitably simplify reality and may not fully capture differences in the underlying drivers of effort across countries. As an example, the scaling of costs for the cluster soil restoration and management uses agricultural area as the element of interest. While this proxy is practical, as good data on agricultural area is available for all Member State, the proxy itself does not describe differences in degraded soil across the EU.

Because scaling designs vary in complexity and evidence strength, each measure was assigned a confidence level based on the depth of assumptions required:

- High confidence – no scaling required (pan-EU data or country-specific costs items available for all MS) and/or evidence drawn from authoritative sources (e.g. Commission/JRC studies).
- Medium confidence – a single scaling step from the reference country to other MS using a well-defined proxy.
- Low confidence – multiple steps and assumptions required (e.g. project-level evidence scaled to national level, then extrapolated to other MS).

To test the sensitivity of results to these structural choices, the model was re-run under two alternative scenarios by adjusting scaling proxies according to confidence level. Measures classified as high confidence were left unchanged. For measures with medium and low confidence, scaling factors were varied by  $\pm 15\%$  and  $\pm 25\%$ , respectively. These variation ranges were defined through expert judgement, intended to represent plausible deviations from the baseline values given the uncertainty in the underlying data.

Low scaling scenario:

- Low confidence measures: -25% adjustment to the proxy outcome;
- Medium confidence measures: -15% adjustment;
- High confidence measures: 0% (no adjustment).

High scaling scenario:

- Low confidence measures: +25% adjustment;
- Medium confidence measures: +15% adjustment;
- High confidence measures: 0% (no adjustment).

This design directly stress-tests the model's largest source of structural uncertainty ('the scaling step') by varying proxy values proportionally to evidence strength. The resulting low and high scenarios define an empirical lower and upper bounds around the central estimates reported in previous chapters.

Results

Table 16 presents the EU-wide annual and net present value (NPV) estimates for the Low, Central and High scaling scenarios, both total and sector specific.

*Table 16 EU-wide adaptation investment needs under scaling sensitivity scenarios (EUR billion)*

Scenario	Annual (billion €)			NPV (billion €)		
	Low	Central	High	Low	Central	High
<b>Total</b>	<b>60.9 €</b>	<b>68.8 €</b>	<b>78.3 €</b>	<b>1077.1 €</b>	<b>1220.9 €</b>	<b>1381.6 €</b>
Ecosystems	18.3 €	21.0 €	24.4 €	318.0 €	365.7 €	424.7 €
Infrastructure	25.6 €	28.9 €	32.2 €	463.0 €	520.6 €	578.1 €
Food	5.9 €	6.8 €	7.7 €	102.0 €	117.7 €	133.3 €
Health	10.0 €	11.5 €	12.9 €	174.6 €	199.9 €	225.1 €
Economy and finance	0.7 €	0.7 €	0.7 €	12.2 €	12.6 €	13.0 €

Note: in grey highlighted the case central (or baseline) case presented in past chapter of the report. Cross-cutting measures are not included in the analysis, as they were not subject to scaling and therefore could not be meaningfully tested under the sensitivity scenarios.

The sensitivity analysis shows that varying the scaling proxies within the confidence-based adjustments produces only a moderate range around the central estimate. Annual investment needs decrease from

€68.8 billion in the baseline to €60.9 billion in the Low scenario (–12 %) and increase to €78.3 billion in the High scenario (+13 %). The corresponding cumulative net present value (NPV) shifts from €1,220 billion in the central case to €1,077 billion in the Low scenario and €1,381 billion in the High scenario.

These variations are smaller than the adjustments applied to the proxies ( $\pm 25\%$  for low-confidence measures and  $\pm 15\%$  for medium-confidence measures), indicating that overall results are driven mainly by measures with medium or high confidence scaling rules and robust data coverage. Uncertainty in the limited set of low-confidence measures does not materially affect the aggregate picture. The central estimate therefore remains the preferred reference point, with the Low and High scenarios providing a credible range for planning purposes.

The Table 17 below complements the EU-wide and sectoral overview by presenting total adaptation investment needs by Member State under the Low, Central, and High scaling scenarios. Figures are expressed in billion euros and illustrate the sensitivity of national totals to different exposure scaling assumptions.

*Table 17 Total adaptation investment needs by Member State under exposure sensitivity scenarios (EUR billion)*

Scenario	Annual (billion €)			NPV (billion €)		
	Low	Central	High	Low	Central	High
<b>Belgium</b>	1.47 €	1.63 €	1.86 €	26.30 €	29.24 €	33.18 €
<b>Bulgaria</b>	0.53 €	0.59 €	0.67 €	9.26 €	10.36 €	11.71 €
<b>Czechia</b>	1.16 €	1.24 €	1.37 €	20.73 €	22.27 €	24.37 €
<b>Denmark</b>	1.72 €	1.88 €	2.17 €	29.96 €	32.80 €	37.75 €
<b>Germany</b>	8.39 €	9.59 €	10.94 €	149.28 €	170.24 €	193.78 €
<b>Estonia</b>	0.58 €	0.65 €	0.74 €	10.29 €	11.50 €	13.05 €
<b>Ireland</b>	1.48 €	1.68 €	1.89 €	25.94 €	29.34 €	33.03 €
<b>Greece</b>	1.77 €	1.94 €	2.24 €	30.80 €	33.80 €	39.13 €
<b>Spain</b>	6.08 €	6.97 €	7.99 €	106.00 €	121.51 €	139.25 €
<b>France</b>	9.51 €	10.63 €	11.96 €	169.98 €	189.52 €	212.55 €
<b>Croatia</b>	0.81 €	0.88 €	0.98 €	14.59 €	15.94 €	17.61 €
<b>Italy</b>	8.72 €	10.07 €	11.62 €	153.70 €	177.27 €	204.22 €
<b>Cyprus</b>	0.10 €	0.12 €	0.13 €	1.82 €	2.05 €	2.32 €
<b>Latvia</b>	0.61 €	0.66 €	0.73 €	11.09 €	12.05 €	13.20 €
<b>Lithuania</b>	0.42 €	0.48 €	0.55 €	7.43 €	8.47 €	9.73 €
<b>Luxembourg</b>	0.12 €	0.13 €	0.15 €	2.07 €	2.36 €	2.67 €
<b>Hungary</b>	1.26 €	1.40 €	1.57 €	22.31 €	24.70 €	27.73 €
<b>Malta</b>	0.05 €	0.06 €	0.06 €	0.87 €	0.97 €	1.07 €
<b>Netherlands</b>	2.15 €	2.52 €	2.92 €	37.58 €	44.00 €	50.99 €
<b>Austria</b>	1.47 €	1.62 €	1.79 €	26.24 €	28.85 €	31.79 €
<b>Poland</b>	3.15 €	3.55 €	4.03 €	55.40 €	62.37 €	70.77 €

<b>Portugal</b>	1.43 €	1.66 €	1.94 €	25.34 €	29.34 €	34.11 €
<b>Romania</b>	1.89 €	2.15 €	2.46 €	33.29 €	37.90 €	43.30 €
<b>Slovenia</b>	0.27 €	0.30 €	0.33 €	4.90 €	5.34 €	5.89 €
<b>Slovakia</b>	0.69 €	0.79 €	0.91 €	12.33 €	13.96 €	16.02 €
<b>Finland</b>	1.85 €	2.10 €	2.37 €	32.58 €	36.94 €	41.63 €
<b>Sweden</b>	3.18 €	3.55 €	3.97 €	56.97 €	63.36 €	70.78 €

Cross-cutting measures are not included in the analysis, as they were not subject to scaling and therefore could not be meaningfully tested under the sensitivity scenarios.

## 8.2 Sensitivity to risk exposures factors

### Method

After defining low and high ranges through the scaling sensitivity, a second source of uncertainty was examined: how differences in risk exposure between the reference country (from which a unit cost is taken) and the target country affect estimated investment needs. The working hypothesis was that adaptation investment needs increase with exposure severity, as higher exposure levels generally require larger-scale, more robust, or more frequent interventions to achieve comparable levels of protection. Damage statistics provide only partial guidance and are not directly transferable to investment needs.

In the baseline specification (see Phase 5: Assessment of investment needs), a simple rule based on expert judgement was applied: for each step up or down in exposure class, the cost item is adjusted by  $\pm 20\%$  relative to the reference (for example, moving from Substantial to Critical adds  $+20\%$ , while moving from Substantial to Limited subtracts  $-20\%$ ).

To test the model against this uncertainty, all other modelling choices were held at their central settings and only the exposure-to-cost adjustment was varied. This diagnostic exercise is not intended to define lower or upper bounds but to show how sensitive aggregate estimates are to alternative exposure–cost mappings and to identify where results are most responsive to this assumption.

Adjustments were applied symmetrically per exposure step (Limited  $\leftrightarrow$  Substantial  $\leftrightarrow$  Critical  $\leftrightarrow$  Catastrophic) and accumulated over multiple steps. Four gradients were tested:

- Conservative ( $\pm 10\%$  per step): small sensitivity to exposure differences
- Elevated ( $\pm 40\%$  per step): stronger, yet still plausible, sensitivity
- Steep ( $\pm 100\%$  per step, 50 % floor on reductions): high sensitivity; downward adjustments capped so costs never fall below 50 % of the reference
- Extreme ( $\pm 200\%$  per step, 50 % floor): very high sensitivity; same floor applied to prevent implausibly low values.

The 50 % floor was introduced because zero or near-zero adaptation investment needs are not plausible even under lower exposure. This design isolates the exposure–cost mapping while preventing artefactual results, allowing observation of how totals respond to progressively stronger gradients.

### Results

Table 18 reports EU-wide annual and NPV estimates under four alternative exposure–cost gradients, compared with the baseline ( $\pm 20\%$  per exposure step). All other modelling choices are held at their central settings.

Table 18 EU-wide adaptation investment needs under scaling sensitivity scenarios (EUR billion)

Risk adjustment factor	Annual (billion €)	NPV (billion €)	% over baseline
<b>Conservative - x0.1</b>	69.1	1,219.5	0.3%
<b>Baseline - x0.2</b>	68.8	1,216.5	-
<b>Elevated - x0.4</b>	66.7	1,178.8	-3.1%
<b>Steep - x1</b>	71.3	1,259.3	3.6%
<b>Extreme - x2</b>	80.5	1,419.3	17.0%

Note: in grey highlighted the case central (or baseline) case presented in past chapter of the report. The lower estimate in the Elevated (x0.4) scenario compared to the Baseline (x0.2) reflects that many reference cost items originate from higher-exposure countries. When multipliers are applied, downward adjustments (to lower-exposure targets) outweigh upward ones, reducing the aggregate investment need. In the Steep (x1) and Extreme (x2) scenarios, a cap of 50% was introduced to limit the maximum downward adjustment and avoid negative cost values that would otherwise result from exposure multipliers greater than 1. This methodological correction mitigates the downward effect observed in the Elevated case, leading to higher total values in the Steep and Extreme scenarios. Cross-cutting measures are not included in the analysis, as they were not subject to exposure risk adjustments and therefore could not be meaningfully tested under the exposure factors sensitivity scenarios.

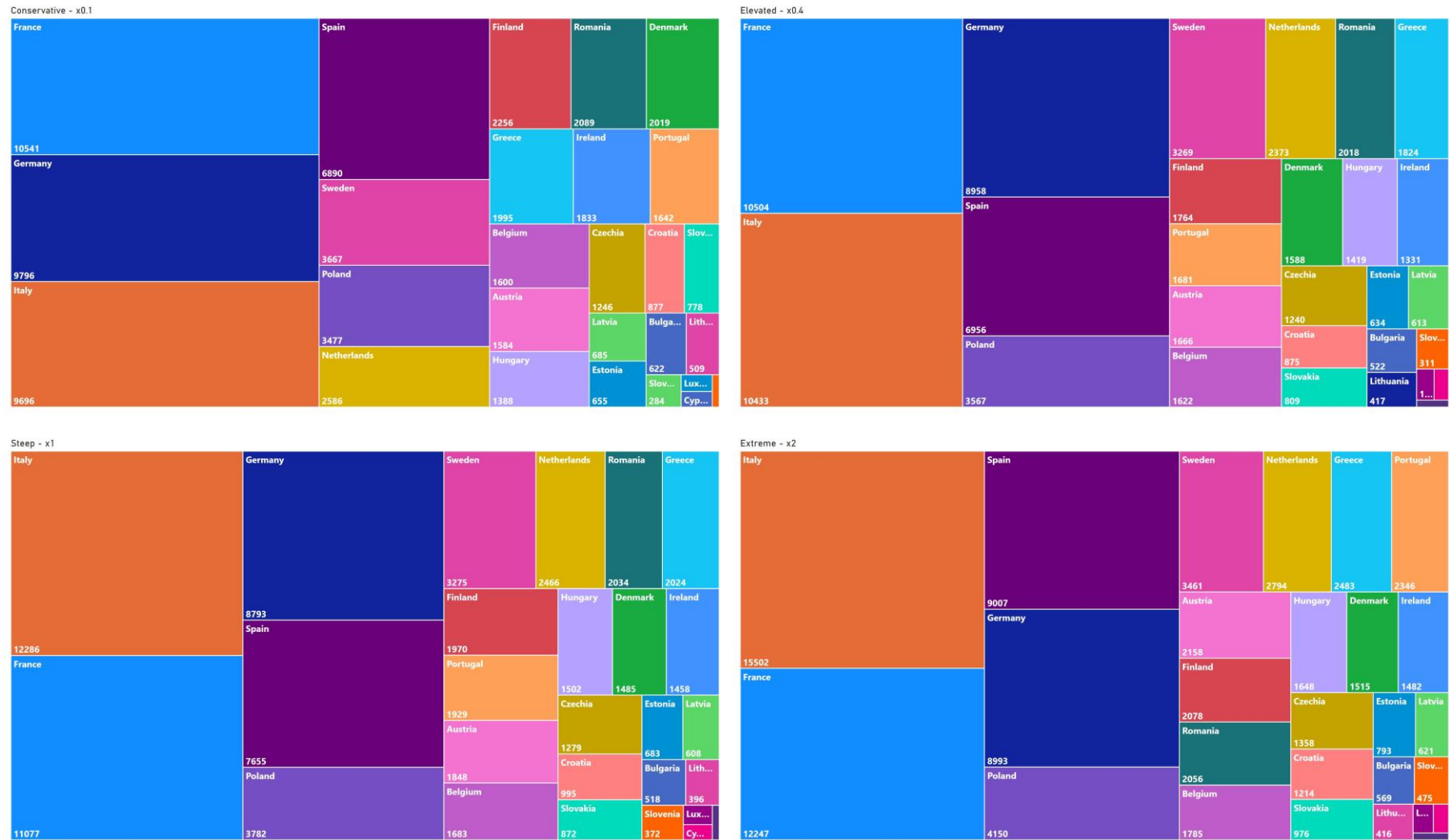
EU-wide annual investment needs under alternative gradients range from €66.7 billion in the Elevated scenario (–3.1 % relative to baseline) to €80.5 billion in the Extreme scenario (+17 %). The baseline estimate remains €68.8 billion. Net present values (NPV) follow a similar pattern, from a cumulative €1.18 trillion in the Elevated case to €1.42 trillion in the Extreme case.

The Conservative scenario (+0.3 %) sits slightly above the baseline, while the Elevated scenario reduces totals. This pattern reflects the fact that reference costs items often come from higher-exposure countries: when multipliers are applied, downward adjustments (to lower-exposure targets) outweigh upward ones, reducing aggregate investment need. Conversely, a smaller multiplier dampens these downward adjustments, yielding a modest increase. In the Steep and Extreme scenarios, totals rise because the 50 % floor limits downward reductions while upward adjustments remain uncapped.

Even under the most aggressive assumptions, results remain within a policy-relevant range and the overall ranking of sectors and Member States is preserved. These findings confirm that the exposure component of the model behaves consistently and that the central estimate provides a robust basis for planning.

Beyond the aggregate results, the distribution of investment needs across Member States is affected by the exposure gradient. The figure below illustrates how relative shares evolve across scenarios, with some countries gaining weight as a result of higher prevalence of critical and catastrophic risks, while others see their share decrease where such risks are less prominent.

Figure 25 Comparative view of Member States' annual adaptation investment needs across risk exposure scenarios (EUR million)



Looking at the maximum deviations from the baseline, most Member States remain within a relatively narrow corridor of change, with shifts generally below  $\pm 20\%$ . A few countries, however, display more pronounced adjustments. Italy shows the largest relative increase (+53 %), reflecting the stronger weight of risks classified as critical or catastrophic. Croatia (+37 %) and Portugal (+41 %) also gain importance as the exposure gradient steepens, for similar reasons. By contrast, Denmark (-20 %), Lithuania (-13 %) and Ireland (-12%) register the largest downward revisions, as their investment needs are less strongly driven by high-severity risks. The Table 19 below presents the annual investment need values per Member State across the different exposure sensitivity scenario evaluated.

*Table 19 Adaptation investment needs per Member State across exposure sensitivity scenarios (EUR billion)*

Scenario	Conservative - x0.1	Baseline - x0.2	Elevated - x0.4	Steep - x1	Extreme - x2
<b>Total EU 27</b>	69.02 €	68.85 €	66.69 €	71.31 €	80.50 €
<b>Belgium</b>	1.60 €	1.63 €	1.62 €	1.68 €	1.79 €
<b>Bulgaria</b>	0.62 €	0.59 €	0.52 €	0.52 €	0.57 €
<b>Czechia</b>	1.25 €	1.24 €	1.24 €	1.28 €	1.36 €
<b>Denmark</b>	2.02 €	1.88 €	1.59 €	1.49 €	1.51 €
<b>Germany</b>	9.80 €	9.59 €	8.96 €	8.79 €	8.99 €
<b>Estonia</b>	0.66 €	0.65 €	0.63 €	0.68 €	0.79 €
<b>Ireland</b>	1.83 €	1.68 €	1.33 €	1.46 €	1.48 €
<b>Greece</b>	2.00 €	1.94 €	1.82 €	2.02 €	2.48 €
<b>Spain</b>	6.89 €	6.97 €	6.96 €	7.65 €	9.01 €
<b>France</b>	10.54 €	10.63 €	10.50 €	11.08 €	12.25 €
<b>Croatia</b>	0.88 €	0.88 €	0.88 €	1.00 €	1.21 €
<b>Italy</b>	9.70 €	10.07 €	10.43 €	12.29 €	15.50 €
<b>Cyprus</b>	0.12 €	0.12 €	0.11 €	0.11 €	0.13 €
<b>Latvia</b>	0.69 €	0.66 €	0.61 €	0.61 €	0.62 €
<b>Lithuania</b>	0.51 €	0.48 €	0.42 €	0.40 €	0.42 €
<b>Luxembourg</b>	0.13 €	0.13 €	0.13 €	0.14 €	0.17 €
<b>Hungary</b>	1.39 €	1.40 €	1.42 €	1.50 €	1.65 €
<b>Malta</b>	0.06 €	0.06 €	0.05 €	0.06 €	0.07 €
<b>Netherlands</b>	2.59 €	2.52 €	2.37 €	2.47 €	2.79 €
<b>Austria</b>	1.58 €	1.62 €	1.67 €	1.85 €	2.16 €
<b>Poland</b>	3.48 €	3.55 €	3.57 €	3.78 €	4.15 €
<b>Portugal</b>	1.64 €	1.66 €	1.68 €	1.93 €	2.35 €
<b>Romania</b>	2.09 €	2.15 €	2.02 €	2.03 €	2.06 €
<b>Slovenia</b>	0.28 €	0.30 €	0.31 €	0.37 €	0.47 €
<b>Slovakia</b>	0.78 €	0.79 €	0.81 €	0.87 €	0.98 €
<b>Finland</b>	2.26 €	2.10 €	1.76 €	1.97 €	2.08 €
<b>Sweden</b>	3.67 €	3.55 €	3.27 €	3.28 €	3.46 €

Overall, while these differences illustrate that exposure assumptions matter for the distribution of investment needs across Member States, the magnitude of changes remains moderate for the majority of countries. This confirms that the central scenario provides a robust reference point, while highlighting specific cases where higher exposure substantially increases relative importance.

## 9. Discussion

This study has produced a bottom-up assessment of the EU's adaptation investment needs. Three themes emerge from the analysis that help frame how the findings should be understood and applied. First, it is important to place the findings in the context of previous studies and other EU investment priorities. Second, the results raise several methodological considerations, particularly around climate scenarios, cascading risks, and the relationship between EU-level and national perspectives. Finally, there are broader observations about data gaps, economic opportunities, and the distributional and systemic dimensions of adaptation. Together these themes help frame both the strengths and limitations of the study and point to directions for future work.

### 9.1 Contextualizing adaptation investment needs

As outlined earlier, previous studies place the scale of EU adaptation investment needs in the range of tens of billions annually, depending on scenarios and methodologies. This study's central estimate of €69 billion per year sits towards the middle of that range. While substantial, this figure is modest compared to the scale of investment needed for the energy transition and climate mitigation. The European Commission estimates that achieving the EU's 2030 climate and energy targets will require around €565 billion in annual investment in the energy system from 2021 to 2030, rising to around €660 billion per year until between 2031 and 2050.<sup>23</sup> This comparison underscores that while adaptation is essential for climate resilience, its financial footprint is an order of magnitude smaller than mitigation, reflecting the systemic nature of the energy transition.

At the same time, several adaptation measures generate mitigation co-benefits. For example, climate-resilient retrofits undertaken together with energy-renovation works can reduce energy demand and associated emissions, while nature-based solutions for flood or coastal protection, such as wetland or dune restoration, enhance resilience and support carbon sequestration. In addition, the financing landscape differs markedly. Mitigation investment is largely driven by private capital mobilised by market incentives and regulation, whereas the implementation of adaptation involves a mix of actors – national governments, private businesses, and households – depending on the nature of the investment. Some adaptation measures, such as building retrofits or water-efficient technologies, may generate sufficient private returns to be undertaken by firms or individuals, while others, such as large-scale flood defences or ecosystem restoration, deliver social benefits that cannot be fully monetised and will require public intervention. Moreover, adaptation investments are often harder to clearly identify and separate, as they are frequently embedded within broader projects rather than standalone measures. They also depend on investment horizons and risk ownership: public sources are natural investors in measures with wide societal benefits, while site-specific actions, such as those for individual plants or facilities, typically fall to private actors. This complexity underscores why mobilising finance for adaptation can be challenging: unlike mitigation, adaptation continues to depend predominantly on public funding sources. These dynamics merit further discussion when contextualising investment needs and identifying pathways for implementation (see Chapter 10 Policy Recommendations).

Adaptation investment needs are also lower than the estimated €830 billion per year required for overall infrastructure investment in the EU, which includes transport, energy, water, and social infrastructure.<sup>24</sup> This difference is explained by scope: infrastructure estimates cover the full spectrum of economic and social needs, whereas adaptation focuses on incremental measures to address climate risks identified in the EUCRA. Nevertheless, the integration of adaptation into infrastructure renewal cycles offers opportunities for cost efficiency and co-benefits.

<sup>23</sup> Climate Action Progress Report 2023 at: [https://climate.ec.europa.eu/eu-action/climate-strategies-targets/progress-climate-action\\_en](https://climate.ec.europa.eu/eu-action/climate-strategies-targets/progress-climate-action_en)

<sup>24</sup> Bridging the investment gap in EU infrastructure. Brussels: European Parliamentary Research Service [https://www.europarl.europa.eu/RegData/etudes/BRIE/2018/628245/EPRS\\_BRI\(2018\)628245\\_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/BRIE/2018/628245/EPRS_BRI(2018)628245_EN.pdf)

Crucially, the costs of failing to act are far higher than the costs of adaptation. Recent analyses by the EEA<sup>25</sup> estimate that economic losses from weather- and climate-related extremes in the EU already exceeded €800 billion between 1980 and 2024, with over €208 billion (25%) in the last four years. These losses have been increasing 3.4% per year in the last 30 years and are projected to rise sharply under high-warming scenarios. The COACCH project<sup>26</sup> finds that, without adaptation, climate damages could reach €100 billion annually under a 2°C pathway and close to €200 billion per year under 4°C warming by 2100. Similarly, JRC's PESETA IV study shows that adaptation measures for water-related risks alone could avoid damages of up to €122 billion per year by mid-century<sup>27</sup>, while IPCC AR6 underscores that residual risks and irreversible losses escalate rapidly beyond 2°C. These findings confirm that adaptation is not only a resilience imperative but also an economically efficient strategy: the avoided damages from timely action outweigh investment needs.

## 9.2 Methodological considerations

Beyond the headline figures, the results highlight a number of methodological considerations that shape the robustness and interpretation of the analysis. These relate to the treatment of climate scenarios, the extent to which cascading risks and spillovers are captured, and the balance between EU-wide harmonisation and Member State specificity.

### Scenarios

For consistency with EUCRA and the wider project, risks were harmonised to mid-century (2050) under a medium pathway (RCP4.5), with national severity scales mapped to EUCRA. By contrast, the cost evidence underpinning investment needs could not be fully aligned to a single climate scenario or horizon, as sources differ in scope and timing. Studies, such as the World Bank's '*Climate Adaptation Costing in a Changing World*'<sup>28</sup> report near-term, policy-first measures or planned budgets in this fashion. It is therefore important to note that the investment need presented here are representative of immediate to near-term adaptation under moderate warming, rather than of higher-end futures.

Climate scenarios are nevertheless important. Adaptation investment needs rise with warming and with higher protection standards. EU studies such as the aforementioned JRC PESETA IV and COACCH illustrate how needs increase markedly under 2–3°C warming compared with today's levels, but our central estimates largely reflect the near-term evidence base available. This means totals are likely conservative relative to higher-warming pathways. Our sensitivity tests provide a bounded range based on methodological assumptions, but they do not substitute for explicit climate-scenario scaling, which might be proposed as a next step. Furthermore, protection standards and residual risk levels are not explicitly considered in this analysis, yet these factors can significantly influence investment needs and represent an important avenue for future research (see Chapter 10 Policy recommendations).

### Cascading risks and spillovers

A further limitation is that the costing approach does not fully capture cascading risks, where one climate impact triggers secondary consequences in other sectors or regions (for example, flooding that disrupts energy and transport simultaneously, or drought reducing agricultural output and in turn affecting food prices and trade). Similarly, international spillovers through global supply chains are not explicitly included. This omission means that the investment needs reported here might be considered as a lower bound, since systemic and cross-border risks are likely to require additional adaptation measures. Future work could explore these through integrated risk modelling.

<sup>25</sup> [Economic losses from weather- and climate-related extremes in Europe | Indicators | European Environment Agency \(EEA\)](#)

<sup>26</sup> [COACCH - European Commission](#)

<sup>27</sup> [Microsoft PowerPoint - 2020\\_11\\_04\\_DeRoo\\_PESETA.pptx](#)

<sup>28</sup> World Bank (2022). *Climate adaptation costing in a changing world: Valuing climate adaptation helps us orient our compass toward effective and resilient pathways*. Available at:

<https://documents1.worldbank.org/curated/en/099050224072021662/pdf/P179070140a07209a1b5d012d978862b4ff.pdf>

## EU versus Member State perspective

The investment needs have been assessed using bottom-up methodology that was applied consistently to all 27 Member State. This means the results for individual Member State, and sectors, can be compared on an equal basis. It also means that the estimated investments needs at EU level, as derived by aggregating the Member State level estimates, were based on a consistent and transparent set of methodological assumptions. Inevitably, some of the detail and nuance of national-level evidence was simplified or modified to ensure consistency. As a result, national-level estimates presented in this study should be considered indicative. In countries where detailed national studies have already costed adaptation measures, those estimates may be more accurate for national policy purposes. At the same time, in Member States where no such studies exist, the results here provide a useful basis for developing national estimates, by highlighting key investment areas and their approximate magnitude.

## Timing of investments

The investment needs are assessed annually up to 2050, with investment profiles reflecting measure-specific implementation cycles rather than a uniform profile across all measures, therefore capturing differences between long-lived infrastructure projects and shorter programme costs. In addition, the urgent investment scenario provides a complementary view by categorising costs associated with those risks that EUCRA identifies as requiring urgent action. While this does not directly assess the benefits of early versus delayed action, it highlights which risk areas would demand priority attention if adaptation investments were sequenced according to urgency. While we did not explicitly test delayed action pathways, the wider literature indicates that postponing adaptation generally raises long-term costs and damages, reinforcing the economic case for timely and proactive investment.<sup>29</sup>

## 9.3 Broader observations

In addition to methodological issues, several broader observations emerge from the analysis. These concern the availability and consistency of data, the potential for adaptation to stimulate economic opportunities, the distributional implications of investment need across Member States, and the wider co-benefits and risks of maladaptation.

### Data gaps

The study's bottom-up approach exposed notable gaps in cost data and the absence of a standardised taxonomy for adaptation measures across Member States. These gaps are not only technical but reflect fragmented governance and inconsistent national reporting. The reliance on proxies and scaling introduces uncertainty, even though the sensitivity analysis points to the robustness of the model's estimates. Improving the evidence base will require investment in monitoring, evaluation, and learning systems, as well as harmonised EU guidance on risk assessment and adaptation investment needs evaluation.

### Distributional and Equity Dimensions

The analysis reveals significant asymmetries in the relative burden of adaptation investment needs. While large economies such as Germany and France carry the highest absolute totals, smaller Member States such as Estonia and Latvia face investment needs exceeding 1.6% of GDP, compared to an EU average of 0.6%. This raises questions of fairness and solidarity. Without targeted measures to address these disparities, these countries risk underinvesting in resilience, increasing vulnerability and potential reliance on assistance.

<sup>29</sup> Breton, M., Sbragia, L. Adaptation to Climate Change: Commitment and Timing Issues. *Environ Resource Econ* 68, 975–995 (2017). <https://doi.org/10.1007/s10640-016-0056-9>

## Interdependencies and Co-Benefits

Adaptation measures often generate benefits beyond their primary objective. Retrofitting buildings for climate resilience overlaps with energy efficiency goals, while soil restoration supports biodiversity and carbon sequestration. Urban cooling measures reduce health risks and energy demand. These synergies create opportunities for integrated investment strategies that deliver multiple policy objectives under the European Green Deal. At the same time, the risk of maladaptation such as hard coastal defences undermining ecosystems highlights the need for systemic planning and robust environmental safeguards.

# 10. Phase 7: Policy Recommendations

The final phase of this study aims to present a discussion on challenges and possible ways forward to promote the implementation of adaptation investment, as well as formulate policy recommendations based on the findings of the research.

## 10.1 Method

This Chapter builds on the research and outputs completed so far and combines a contextual assessment of the adaptation financing landscape with the evidence generated in previous phases of this study.

The methodology of this final phase includes:

- A review of the adaptation financing landscape, analysing how investment mobilisation is evolving at EU and national levels within the existing policy frameworks;
- An interpretation of this study's investment findings to derive considerations to support increased adaptation investments; and
- An integration of contextual observations and overall lessons learnt from the implementation of this study.

The resulting review offers to provide context to the findings of this study, and a discussion on how Europe's adaptation policy landscape can continue to evolve to enable timely, well-targeted, and adequately financed adaptation action in light of the findings of this research.

This study's findings show that the adaptation investments needs in the EU up to 2050 are estimated at around €69 billion per year, corresponding to more than €1 trillion in net present value (NPV) terms, over the period 2026-2050.

### ***Sectoral findings from the research***

Infrastructure emerges as the largest sector of adaptation investment, requiring around €29 billion annually and €520 billion in NPV over the period 2026-2050. Ecosystems follow with €21 billion per year and €365 billion NPV over the same period, reflecting the scale of restoration and management required for land, forests, and coastal areas. The food sector accounts for €11.5 billion annually, or €200 billion NPV (2026-2050), dominated by crop and livestock adaptation measures. Health sector investment needs are estimated at around €7 billion per year, or €118 billion NPV over the period 2026-2050, with the largest shares directed towards occupational health, wastewater treatment, and wildfire preparedness. The economy and finance sector shows the lowest investment needs around sectors, at €720 million annually and €12 billion NPV over 2026-2050, although this likely underestimates the true need given the difficulty of costing financial and regulatory measures. Finally, cross cutting measures will require investments of around €300 million annually, or around €4.4 billion in NPV over 2026-2050.

More details on the study's findings across sectors and Member States are found in the results section of Phase 5: Assessment of investment needs above.

The sensitivity analysis on the model suggests that the annual figure of €69 billion per year is the central estimate of a range varying from €60.9 billion to €78.3 billion, considering potential variability and confidence in the data. Phase 6: Sensitivity Analysis comprehensively describes the sensitivity analysis carried out.

To set this level of investment needs in context, it is useful to understand the current levels of investment in adaptation projects across the EU, the barriers to increasing adaptation investment and the role of EU policies. These issues are explored in the following sections.

This Chapter is structured into two sections. The next section describes the current adaptation finance landscape, along with the current challenges and considerations to support increased adaptation investments and the role of EU policies. This is essential to set in context the level of adaptation investment needs derived from the research. The final section presents key issues and overall lessons learnt from the implementation of this study and offers policy recommendations that could help address the identified challenges.

## 10.2 Adaptation finance landscape

### **Key message 1: The supply of adaptation finance in the EU, across public and private sources at both EU and national level, remains insufficient relative to identified needs**

The landscape of adaptation finance in the European Union reflects a layered system in which EU-level institutions, Member States, and private actors interact to support climate resilience objectives. EU public finance continues to anchor the system, with key funds of the EU MFF, such as the European Structural and Investment Funds (ESIF), and the Neighbourhood, Development and International Cooperation Instrument (NDICI–Global Europe) playing a critical role in supporting partner countries with high vulnerability.

In addition to EU-level funding, national and subnational public budgets constitute a major, yet poorly captured, source of adaptation finance. In most Member States, adaptation-related investments are not channelled through dedicated budget lines but are embedded within routine public expenditure and sectoral programmes, such as water management, civil protection, transport, or urban development. This integration into public budgets, signals a shift toward mainstreaming adaptation considerations across sectors and reducing reliance on external sources of finance over time. However, the availability and consistency of information on adaptation investments and budget allocation across Member States is a persistent challenge, which makes it difficult to quantify aggregate contributions to adaptation and compare across countries.

The Commission proposal for the EU Multiannual Financial Framework (MFF)<sup>30</sup> for 2028–2034 allocates 35% of the overall budget (EUR 700 billion) to climate and environment spending, including for climate mitigation, adaptation and resilience and sustainable growth. The proposal includes a new “climate resilience by design” principle and furthermore, the “do no significant harm” principle is proposed to be continued to be integrated. For the 2021–2027 period, the EU has committed roughly €662 billion (about 34% of the total 2021–2027 budget envelope) to support climate-relevant actions<sup>31</sup> across programs such as the Recovery and Resilience Facility (RRF), the Common Agriculture Policy (CAP), the European Regional Development Fund (ERDF), the Cohesion Fund and the Connecting Europe Facility (CEF). These resources, often delivered through grants and concessional lending by the European Investment Bank (EIB) and other implementing partners, provide an essential first layer of support for national and local adaptation priorities.

Estimating the overall share of EU climate-related expenditure that can be attributed to adaptation remains challenging. As discussed further below, many climate investments deliver both mitigation and adaptation benefits, making precise attribution difficult. Indicative estimates from official Commission sources suggest that around 21% of EU climate-related expenditure in MFF 2021–2027<sup>32</sup> may relate to climate change adaptation, while an additional 14% may contribute jointly to adaptation and mitigation, with the remainder primarily linked

<sup>30</sup> Climate mainstreaming - [https://commission.europa.eu/strategy-and-policy/eu-budget/long-term-eu-budget/eu-budget-2028-2034\\_en](https://commission.europa.eu/strategy-and-policy/eu-budget/long-term-eu-budget/eu-budget-2028-2034_en)

<sup>31</sup> Climate mainstreaming - [https://commission.europa.eu/strategy-and-policy/eu-budget/performance-and-reporting/horizontal-priorities/green-budgeting/climate-mainstreaming\\_en](https://commission.europa.eu/strategy-and-policy/eu-budget/performance-and-reporting/horizontal-priorities/green-budgeting/climate-mainstreaming_en)

<sup>32</sup> Climate mainstreaming - [https://commission.europa.eu/strategy-and-policy/eu-budget/performance-and-reporting/horizontal-priorities/green-budgeting/climate-mainstreaming\\_en](https://commission.europa.eu/strategy-and-policy/eu-budget/performance-and-reporting/horizontal-priorities/green-budgeting/climate-mainstreaming_en)

to mitigation or not readily attributable. Applied to the approximately €662 billion in climate-related expenditure<sup>33</sup> committed under the EU budget for the 2021–2027 period, these indicative shares point to a broad range of expenditure potentially contributing to adaptation, on the order of €139-231 billion (or roughly €20-33 billion per year), but these figures should be interpreted as illustrative rather than definitive due to methodological limitations. Another recent assessment was carried out by the European Court of Auditors (ECA) which highlights<sup>34</sup> that while the EU budget earmarks around €26 billion specifically for adaptation in 2021-2027 (up from about €8 billion in 2014-2020), reporting and monitoring systems remain insufficient to reliably track adaptation-related expenditure across instruments. The ECA estimate of €26 billion for adaptation under the 2021–2027 EU budget is not directly comparable to the broader indicative range derived from Commission climate-tracking shares. The ECA figure refers only to spending explicitly labelled as adaptation across a limited number of programmes and reported through existing EU budget tracking systems. By contrast, the €139–231 billion range reflects much wider categories of climate-related expenditure that may deliver adaptation benefits, including measures recorded as climate-relevant but not specifically tagged as adaptation. Because the underlying methodologies differ substantially in terms of scope, these numbers should be interpreted as complementary but not equivalent. However, these differences underscore the difficulty of quantifying adaptation finance and the continued gap between strategic ambitions and practical implementation.

Private sector engagement in adaptation finance, although still emerging, is progressively shaped by evolving EU regulatory frameworks, such as the EU Taxonomy for Sustainable Activities, the Corporate Sustainability Reporting Directive (CSRD), and climate-risk disclosure requirements under the Sustainable Finance Disclosure Regulation (SFDR). These signals, along with rising awareness of physical climate risks, have started to open investment opportunities in resilient infrastructure, climate-smart agriculture, early-warning and risk-management systems, and nature-based solutions (NbS). Several studies and initiatives, such as the EIB's work on climate-resilient infrastructure<sup>35</sup>, OECD research on private finance mobilisation<sup>36</sup>, and UNEP Finance Initiative pilot projects on adaptation finance<sup>37</sup> highlight growing potential in sectors where climate resilience investments can generate financial, operational, and social returns. Nonetheless, scaling such investments remains constrained by persistent uncertainties around adaptation returns, limited proof-of-concept business models, and incomplete or inconsistent climate-risk information.

Innovative financing instruments continue to expand, supporting efforts to bridge the gap between current financial flows and the scale of adaptation needs. According to the OECD's 2025 input paper for the G20<sup>38</sup>, key levers to scale private investment include: stronger capacity on climate data, more transparent risk disclosure, and the use of blended finance or innovative instruments tailored to adaptation. Blended finance facilities, guarantees, PPP (public-private partnership) structures, insurance schemes, and thematic or resilience-linked bonds are increasingly being deployed to mobilize additional private capital and mitigate financial risks associated with adaptation projects. PPP models, in particular, offer promising avenues to share risks and align incentives among public authorities, private investors, and service providers, especially in infrastructure projects where resilience benefits accrue over long horizons and across multiple stakeholders. These instruments are especially relevant in sectors where traditional financing models have difficulty pricing climate risks or capturing distributed adaptation benefits.

The current level of investment in adaptation projects from private sources is uncertain, and this represents a gap in the current knowledge base. However, it is unlikely that the levels of investment, taking into account both public and private sources, are sufficient to meet the identified needs.

<sup>33</sup>Climate mainstreaming - [https://commission.europa.eu/strategy-and-policy/eu-budget/performance-and-reporting/horizontal-priorities/green-budgeting/climate-mainstreaming\\_en](https://commission.europa.eu/strategy-and-policy/eu-budget/performance-and-reporting/horizontal-priorities/green-budgeting/climate-mainstreaming_en)

<sup>34</sup> Climate adaptation in the EU special report - [https://www.eca.europa.eu/ECAPublications/SR-2024-15/SR-2024-15\\_EN.pdf](https://www.eca.europa.eu/ECAPublications/SR-2024-15/SR-2024-15_EN.pdf)

<sup>35</sup> EIB- Climate Resilient Infrastructure Framework (2021) available at <https://www.eib.org/en/publications/supporting-climate-resilient-infrastructure>

<sup>36</sup> OECD – Scaling up Private Finance for Climate Adaptation (2022) available at <https://www.oecd.org/environment/scaling-up-private-finance-for-climate-adaptation-and-resilience-cc9e0f16-en.htm>

<sup>37</sup> UNEP FI – Adaptation Finance Project Pilots (2022) available at <https://www.unepfi.org/publications/climate-change-publications/adaptation-finance-project/>

<sup>38</sup> OECD (2025) Scaling finance and investment for climate adaptation available at [https://www.oecd.org/en/publications/scaling-finance-and-investment-for-climate-adaptation\\_be6892fb.html](https://www.oecd.org/en/publications/scaling-finance-and-investment-for-climate-adaptation_be6892fb.html)

## Key message 2: The challenges of adaptation finance are multi-faceted

Recent assessments by EU institutions show that Member States continue to face major obstacles in translating adaptation priorities into investment-ready pipelines. This is partly due to the often small-scale, local, and heterogeneous nature of adaptation solutions, which makes aggregation and standardisation difficult. As a result, project pipelines are still limited, risk–return profiles are often unclear, and resilience considerations are not consistently integrated into sectoral strategies or infrastructure planning. A key barrier is the continued under-pricing of physical climate risks in valuation and planning processes. Because forward-looking climate scenarios are not consistently integrated into lifecycle assessments, resilience measures often appear costlier than they are in net-benefit terms, distorting investment decisions and weakening incentives for both private and public actors to prioritise adaptation.

The European Environment Agency and the European Court of Auditors<sup>39</sup> both highlight that gaps in monitoring systems, risk analytics, and integration of adaptation into sectoral planning slow down the mobilisation of finance, even where national strategies are comprehensive. Despite existing national strategies and plans, the mobilisation of finance for their implementation remains fragmented. Public authorities often struggle with inconsistent climate risk data, limited project preparation capacity, and weak cross-institutional coordination. At the same time, private investors face unclear and uncertain return on adaptation investments and incomplete methodologies for assessing climate-risk exposure. These challenges are compounded by knowledge and understanding gaps on both sides of the investment interface: public authorities often face challenges in articulating adaptation needs in investment-ready terms<sup>40</sup>, while private investors frequently lack the tools, metrics, and confidence to evaluate adaptation-related financial returns or risk-mitigation benefits. Further complexity arises from inconsistencies in how adaptation finance is defined, tracked, and reported, reflecting ongoing debates around methodologies and transparency requirements at EU and international levels.

Responsibilities for climate risk ownership across sectors and asset classes remain blurred, especially in sectors dominated by long-lived assets such as buildings and infrastructure<sup>41</sup>. This disconnect between risk and decision-making weakens incentives for climate resilience, encourages risk-shifting to the public sector or moral hazard and leads to insufficient allocation of resources to resilience investments.

Existing insurance and risk transfer systems are also misaligned with accelerating climate risks<sup>42</sup>. Protection gaps are widening, and most mechanisms remain reactive and insufficient, focusing on post-disaster compensation rather than risk reduction<sup>43</sup>. Limited integration of climate risk data limits the development of incentive-based insurance products.

Despite progress, adaptation remains insufficiently integrated into sectoral policies and public investment frameworks at the EU and national level. This leads to fragmented implementation, maladaptation and missed opportunities to steer both public and private investment towards climate resilience. Evidence shows that when adaptation is systematically embedded in public policies and investment frameworks<sup>44</sup>, projects become more bankable and predictable, creating clearer conditions for mobilising private capital<sup>45</sup>.

Addressing climate change impacts and fostering climate resilience require a substantial increase in both the level and quality of investment. Integrating climate resilience objectives into public infrastructure planning and management is critical to protect communities and reduce future fiscal risks. It can also serve as a catalyst for and complement private investment in resilience. Embedding climate resilience as a priority in public investment management means integrating resilience criteria across the entire investment cycle - from project identification and appraisal to selection, budgeting, implementation and asset management.

<sup>39</sup> Climate adaptation in the EU Special report - [https://www.eca.europa.eu/ECAPublications/SR-2024-15/SR-2024-15\\_EN.pdf?utm\\_source=chatgpt.com](https://www.eca.europa.eu/ECAPublications/SR-2024-15/SR-2024-15_EN.pdf?utm_source=chatgpt.com)

<sup>40</sup> Adaptation Gap Report 2025 - <https://www.unep.org/resources/adaptation-gap-report-2025>

<sup>41</sup> EUCRA - <https://www.eea.europa.eu/en/analysis/publications/european-climate-risk-assessment>

<sup>42</sup> EIOPA Annual report 2023 - [https://www.eiopa.europa.eu/publications/annual-report-2023\\_en](https://www.eiopa.europa.eu/publications/annual-report-2023_en)

<sup>43</sup> [Final report of the Climate Resilience Dialogue](#)

<sup>44</sup> EC Technical Guidance on Climate Proofing of Infrastructure - <https://ec.europa.eu/newsroom/cipr/items/722278/en>

<sup>45</sup> Unlocking private investment in climate adaptation and resilience - <https://www.worldbank.org/en/news/feature/2021/03/04/unlocking-private-investment-in-climate-adaptation-and-resilience>

[Is Europe on track towards climate resilience? Status of reported national adaptation actions in 2023 | Publications | European Environment Agency \(EEA\)](#)

### **Key message 3: Investing in adaptation delivers additional co-benefits for other policy objectives**

A large share of adaptation investments also delivers mitigation and other co-benefits, such as health and social benefits, but also economic and security gains arising from investments in climate-resilient buildings, which enhance population security and reduce the risk of supply chain disruptions. These synergies are particularly evident in sectors such as buildings, infrastructure and nature-based solutions, yet they remain structurally underexploited in planning and financing frameworks. Because adaptation needs are driven largely by the retrofitting and upgrading of existing assets rather than new construction. Asset renewal cycles represent the most cost-effective opportunity for mainstreaming climate resilience and avoiding long-term lock-in of climate vulnerability.

Adaptation generates economic benefits that exceed private financial returns. Many high-impact measures produce broad economic, environmental and social benefits, including ecosystem restoration, improved health outcomes and territorial stability. These benefits are rarely captured by market mechanisms, leading to structural underinvestment. The returns from adaptation benefit both public authorities and private actors. Acknowledging this broader spectrum of returns would ensure that EU and national investment appraisal frameworks accurately reflect the full economic value of adaptation. It would also help justify greater public involvement in adaptation finance, strengthen the case for blended finance, and support the prioritisation of measures that deliver multi-actor benefits, whether through infrastructure resilience, risk reduction for businesses, or ecosystem-based solutions that enhance overall economic performance.

### **Key message 4: Investment decisions should reflect the full social costs and benefits of adaptation**

Experience across Member States shows that adaptation choices are often made without a clear, comparable assessment of costs, benefits and avoided damages from adaptation actions. The absence of these elements can lead to fragmented investment decisions and reduces the overall efficiency of public spending. The use of decision-making frameworks that systematically compare adaptation options based on economic efficiency, social value, and avoided damages will improve the value for money of investments and investment allocation efficiency. Public resources should be directed first toward measures that deliver the greatest resilience gains relative to cost, particularly in sectors facing high risk or rapid climate impacts.

Despite their strong economic rationale, no- and low-regret measures remain insufficiently prioritised. These actions, typically low-cost, incremental, and delivering both immediate and long-term resilience benefits tend to receive less visibility and political traction than large-scale infrastructure projects. Because they do not offer the same symbolic or political value, they are often overlooked in national planning and public budgets, despite their proven cost-effectiveness and ability to reduce current climate risks while preparing for future impacts. Strengthening their integration into adaptation portfolios requires clearer prioritisation frameworks and stronger incentives within public spending decisions.

### **Areas for further considerations**

These challenges underscore that the delivery of the investment needed requires actions at different levels and reinforces the interface between policy and investment.

Some recommended actions to improve the current adaptation financing landscape include:

- Improve the enabling conditions for adaptation financing: strengthening multi-actor governance and institutional capacities to support adaptation investment; clarify climate risk ownership and responsibilities to climate-proofing investments between public and private actors.
- Systematically integrate climate resilience into public investments. Integrate resilience and adaptation across sectoral policies, major EU funding and national programmes and infrastructure standards. Aligning with the EU Taxonomy, climate-proofing requirements, and key investment instruments strengthens the predictability of the policy environment, reduces long-term risks, and supports the

mobilisation of private capital. Binding resilience criteria across Cohesion Policy, InvestEU, and CAP can ensure that public investment consistently accounts for climate risks.

- Promote innovative financing instruments tailored to diverse risk profiles. Consistent, harmonised climate-risk data and indicators are essential to enable products that reward preventive adaptation and reduce long-term fiscal exposure for public authorities. This includes repositioning insurance and risk transfer as proactive resilience/climate risk management instruments, promoting risk-based pricing and resilience-linked financing instruments.
- Systematically capture synergies between adaptation, mitigation and other environmental objectives. Prioritise investments generating co-benefits, such as climate-resilient and energy-efficient building upgrades, urban cooling solutions, and nature-based approaches. Consider asset renewal cycles as a cost-effective entry point for mainstreaming climate resilience and avoiding long-term lock-in of climate vulnerability.
- Develop prioritisation frameworks that systematically compare adaptation options based on economic efficiency, social value, and avoided damages. Prioritise and scale up no- and low-regret adaptation measures that deliver immediate resilience benefits while preparing for long-term climate impacts. Guidance and funding channels should be reinforced to elevate these measures as first-order priorities, including through the stronger integration of NbS, climate-risk disclosure, and taxonomies of climate-adapted products and services into sectoral policies and financing frameworks.
- Improve consistency in the way adaptation finance is estimated and reported and ensure that investment decisions are grounded in robust and context-specific evidence will be crucial.

These actions can contribute to closing the adaptation finance gap, and providing a fostering environment for financing adaptation investment required for a resilient EU in 2050.

## 10.3 Recommendations from the research

The work undertaken for this study has brought to light several observations, which in turn revealed opportunities to enhance adaptation planning, coordination, and reporting across Member States.

### **Lesson 1: Need for better data on adaptation costs**

A persistent challenge encountered throughout the study relates to the limited availability and consistency of information on adaptation costs and budgetary allocations across Member States. Existing repositories and knowledge platforms, such as Climate-ADAPT, provide valuable case-specific insights, but the data they contain are predominantly project-level and often too granular to meaningfully support macro-level planning or strategic decision-making at national or regional scale.

According to the Regulation on the Governance of the Energy Union and Climate Action<sup>46</sup> (referred to as the “Governance Regulation” thereafter), Member States are required to report regularly on their national climate-change adaptation planning and strategies, as part of their National Energy and Climate Plans (NECPs). However, this reporting includes limited information on the costs or investments planned for climate adaptation at the MS level. In addition, recent evaluations highlight that adaptation remains insufficiently embedded, and the reporting on adaptation shows that many countries do not have binding and measurable adaptation targets, and there is a lack of harmonisation across Member States. From a policymaking perspective, this limits their ability to estimate aggregate investment needs, identify financing gaps, or prioritise measures based on expected costs and benefits.

The upcoming European Integrated Framework for Climate Resilience will aim to provide a framework for improving the EU and MS climate preparedness and resilience. It will address, among others, ‘climate resilience by design’ as a way to proactively consider plausible high-impact risks and losses from the very beginning

<sup>46</sup> Regulation (EU) 2018/1999. Article 19

when conceiving policies, investments and other measures; determining a common baseline for adaptation decisions that EU and national public policy and investments should consider, for example through common EU climate reference scenarios; defining climate resilience and adaptation targets; developing a limited number of performance indicators; or enhancing the competitiveness of EU companies and key economic sectors by improving adaptive capacity and opening new export markets.<sup>47</sup>

***Policy recommendation 1.1 – Strengthen the role of NECPs in framing adaptation-related investment needs***

NECPs could provide a clearer and more structured overview of adaptation-related investment needs by integrating indicative cost estimates, funding sources, and links to national priorities. Enhancing this dimension would improve coherence and forward-looking planning, particularly in the context of the forthcoming revision of the Governance Regulation.

Similarly, the review of National Adaptation Plans (NAPs) and related documentation retrieved as part of Phase 2 of this study, revealed substantial variability in how financial information on adaptation measures is reported across Member States. In many cases, projected costs, allocated budgets or indicative investment needs were incomplete, difficult to interpret or entirely absent. This reflects the absence of common reporting guidance and complicates efforts to compare progress, assess financing gaps or align national plans with EU objectives.

This lack of consistency was also evident in the structure and timing of the reported costs. Across both national planning documents and project-level sources, information was often unclear on whether figures referred to one-off or recurring expenditures, and rarely differentiated between capital and operational costs, maintenance needs or the expected lifespan of investments. Such gaps limit the ability to develop realistic investment pathways and hinder the integration of adaptation needs into medium- and long-term budgetary processes. A more coherent, transparent and harmonised approach to reporting adaptation investment needs would significantly improve the usability of available data and strengthen the evidence base for strategic planning.

***Policy recommendation 1.2 – Develop a harmonised EU framework for reporting adaptation finance and strengthen financial information in NAPs***

A more harmonised approach to reporting and tracking adaptation finance would improve transparency and comparability across Member States and help identify investment gaps. Building on existing EU climate finance tracking practices, such guidance could standardise key cost categories (e.g. CAPEX, OPEX, maintenance and replacement), clarify how to report investment cycles and timelines, and set minimum requirements for presenting budget information in NAPs. Strengthening the expectations for explicit and coherent financial information in NAPs and ensuring alignment with national sectoral plans and relevant financial instruments, would improve the consistency and usability of reported investment needs. Together, these improvements would support EU-level consolidation of data and reinforce the evidence base for

**Lesson 2: Need to integrate adaptation investment needs and climate risks in national budgetary planning**

The implementation of adaptation measures identified in Phase 2 of the study is a shared responsibility for the public sector, businesses and households. Although this report did not seek to assess the relative investment shares of each economic agent, the public sector will have to play an important role as a direct investor in adaptation measures and as a catalyst for investment by businesses and households. Private financing of adaptation will also need to increase significantly to cover the estimated adaptation investment needs.

<sup>47</sup> [Open Public Consultation for the new European climate resilience framework](#)

However, in many cases, private returns on investment may be too limited, too dispersed or too uncertain to trigger private investment, even if the benefits to society are significant.

Based on the research and analysis of national adaptation policy documents (Phase 1-3 of this study), it is clear that public authorities give greater attention to the direct climate risks, and much less to the fiscal risks arising from climate change. These risks relate to national authorities' role as insurer following extreme events. Additionally, government revenues can also be negatively affected as climate hazards reduce economic activity and employment. As global warming increases and climate hazards become more frequent and sizeable, their potential negative impacts on public finances and long-term debt sustainability therefore also increase.

This, together with the role of the public sector in building climate resilience, suggests that climate risks and adaptation needs must be better integrated in national budgetary planning. In 2021, the EU Strategy on Adaptation to Climate Change called for integrating climate adaptation into macro-fiscal policy. In 2024, amendments to Council Directive 2011/85/EU on Requirements for Budgetary Frameworks of the Member States<sup>48</sup> introduced requirements for Member States to assess and report from 2026 onwards, to the extent possible, on (i) how the macro-fiscal risks from climate change may affect the medium- and long-term sustainability of public finances<sup>49</sup> and on (ii) disaster- and climate-related contingent liabilities and the fiscal costs of disasters and climate-related shocks. These requirements are an important step towards embedding 'climate resilience by design' in national fiscal frameworks.

The Directive allows flexibility in the methodologies used to conduct assessments, acknowledging the diversity of existing approaches, and differences in data availability and country-specific contexts. To support implementation of these climate-related amendments, the European Commission recently published a report outlining possible methodological approaches and a gradual framework for conducting assessments, as well as some tools and country practices that illustrate emerging approaches across Europe.<sup>50</sup>

***Policy recommendation 2.1 – Fully integrate climate risks and adaptation investment needs into national budgetary planning***

The assessment of public sector adaptation investment needs and the integration of climate risks in national budgetary planning and long-term fiscal sustainability assessments are still at an early stage. The transposition and comprehensive implementation by all Member States of the requirements under the amended EU Directive 2011/85/EU on National Budgetary Frameworks is a priority. Common methodologies deserve to be developed, with strong coordination between Member States on lessons learned and best practices.

### **Lesson 3: Need for harmonisation of climate risk and adaptation information**

A further lesson emerging from the analysis carried out in Phase 1 of this study concerns the fragmentation of national risk assessment practices. Although the study was able to map almost all risks identified in national documents to the EUCRA framework, the underlying national assessments themselves differed substantially in scope, methodology and level of detail. Member States used different climate scenarios and risk severity scales, varied in the sectors they assessed, and applied diverse criteria and time horizons when evaluating risks. This lack of consistency limits comparability across countries and reduces the reliability of aggregated results, making it more difficult to develop a coherent EU-wide picture of climate risks and associated investment needs.

<sup>48</sup> OJ L 306, 23.11.2011 ELI: <http://data.europa.eu/eli/dir/2011/85/2024-04-30>

<sup>49</sup> Article 9(2)(d) covers both the fiscal implications of climate change impacts and of adaptation and mitigation efforts.

Salmon-Genel, M. (2025), '[Assessing the Macro-Fiscal Risks from Climate Change: Concepts, Methodological Approaches, and Insights from Country Practices](#)', European Economy Discussion Paper No. 224, Publications Office of the European Union.

The issue of harmonisation and quality of reporting has also been highlighted by the 2024 evaluation of the Governance Regulation<sup>51</sup>. The evaluation confirms that the Regulation provides a robust integrated framework ensuring regular monitoring (defined in Article 19 of the Regulation (EU) 2018/1999) and increases the baseline of climate-energy governance across the EU, but it calls for improvement to enhance completeness and quality of reporting and harmonise reporting obligations to improve comparability. The future European Integrated Framework for Climate Resilience will aim to tackle this challenge by proposing common EU reference scenarios and a degree of harmonisation among risk assessment frameworks to ensure comparability and collective understanding of risks.

***Policy recommendation 3.1 – Enhance harmonisation of reporting risk assessments through the revised Energy Union Governance Regulation***

The forthcoming revision of the Energy Union Governance Regulation provides an opportunity to strengthen the adaptation reporting framework by introducing clearer and more harmonised requirements for national risk assessments. This could include guidance on severity scales, sectoral coverage and methodological criteria. Embedding such elements within the Regulation would help ensure greater consistency across Member States, support more robust EU-wide analyses, and facilitate the integration of climate risk information into national planning and investment processes.

Results from Phase 1 of this study also revealed that risks with transboundary or cross-border dimensions, such as disruptions to international supply chains, impacts transmitted through financial systems, or climate risks originating outside Europe, remain difficult to translate into quantified adaptation investment needs. Although many of these risks were identified in national assessments, they could rarely be translated into investment estimates due to insufficient cost data and the absence of methodologies for assessing measures that require coordination across multiple Member States.

**Lesson 4: Areas for future work**

Several topics emerged during the development of this study that, while beyond its analytical scope, appear particularly relevant for future work and for strengthening the evidence base supporting adaptation policy. The following points outline areas where additional analysis could provide meaningful guidance for policymakers and improve the design and prioritisation of adaptation measures.

***Policy Recommendation 4.1 – Provide EU-level guidance on resilience targets***

The EU should establish a common framework to help Member States set coherent and measurable resilience targets. This framework should outline how to convert qualitative adaptation goals into quantified benchmarks grounded in climate-risk assessments and clarify acceptable levels of residual risk. It should also define principles for cost-effectiveness and avoidance of maladaptation, enabling Member States to link investment needs to expected resilience outcomes. A shared EU approach would ensure greater comparability, improve the robustness of adaptation planning, and support more consistent monitoring of progress across the EU.

The definition of adaptation and climate resilience targets remains a major unresolved methodological and policy gap. While Member States implicitly refer to desired levels of resilience in their NAPs and NAS, these are rarely translated into clear, quantified and time-bound targets. This makes it difficult to assess the consistency and comparability of national adaptation efforts and significantly limits the interpretation of investment needs. The absence of harmonised climate resilience benchmarks also constrains the ability to link

<sup>51</sup> SWD(2024) 200 final

cost estimates to specific adaptation outcomes and introduces additional uncertainty into EU-level assessments.

The quantification of avoided costs and the assessment of cost/benefit ratios is one such area. While not included within the analytical scope of this study, examining the potential economic costs avoided as a result of reduced climate-related damages, together with the broader range of benefits associated with adaptation, such as health benefits, environmental and ecosystem benefits, improved energy efficiency, and wider social and economic co-benefits, would substantially enrich the economic assessment of adaptation measures. This would also strengthen the financial arguments to finance measures publicly or privately and help assess where each type of funding would be most appropriate. Across the material reviewed, avoided-cost estimates were rarely integrated into national planning processes or used to inform investment prioritisation, despite their potential to highlight the long-term value of adaptation. Further work in this field could therefore support policymakers by providing clearer evidence on the benefits of adaptation and by strengthening the basis for comparing alternative measures and directing resources towards the most effective options.

***Policy recommendation 4.2 – Strengthen the integration of avoided-cost assessments in adaptation planning***

Member States should progressively integrate avoided-cost considerations, together with the wider range of economic and non-market benefits typically associated with adaptation measures, including health benefits, environmental and ecosystem benefits, improved energy efficiency, and wider social and economic co-benefits, into their assessment frameworks. Doing so would improve the economic basis for prioritising measures and strengthen their rationale. Introducing indicative EU-level guidance or reference approaches would support greater consistency and comparability, helping to demonstrate the long-term value of adaptation and to direct investment towards the most effective options.

Another area with significant potential for further analysis concerns the timing and structuring of adaptation investments. Although highly relevant for understanding financial feasibility and sequencing, the information available across Member States was limited and often lacked clarity on how reported budgets were intended to be allocated, including whether they referred to one-off or recurring expenditures. Similar gaps emerged in project-level data, where cost estimates rarely distinguished between capital and operational components, nor provided details on maintenance needs or the expected lifespan of the investments. Developing a clearer and more harmonised understanding of investment cycles, cost structures and implementation timelines would support more realistic planning and facilitate the integration of adaptation needs into medium- and long-term budgetary processes.

A final area where future work could add significant value concerns the treatment of residual risks, or the level of residual risk that remains after all feasible or planned adaptation measures have been implemented. This study did not assess residual risks due to both methodological choices and data limitations. Because the analysis focused on identifying Member State risks, linking them to relevant adaptation measures, and estimating the cost of implementing those measures, it did not evaluate how these actions would change risk levels or determine the degree of risk that would remain thereafter. Incorporating residual risk would have required defining risk-tolerance thresholds, estimating the risk-reduction effects of individual measures, and modelling outcomes under different climate scenarios, all of which were beyond the project's scope.

The information available in national planning documents also did not support such an approach. Reported adaptation measures rarely specify quantitative risk-reduction targets, acceptable residual risk levels or evidence on how they reduce hazard, exposure or vulnerability. Without these elements, it is not possible to determine whether planned measures would reduce risks to acceptable levels or identify the impacts that would remain. Future work integrating residual-risk assessment would provide a clearer view of where adaptation may reach its limits, reveal long-term vulnerabilities under higher-warming futures and support more strategic, forward-looking investment planning.

## 10.4 Conclusion

This study has shed further light into some of the already known challenges in relation to climate adaptation financing and provided further information about possible ways in which EU policy can help to tackle these issues. By surfacing existing barriers and potential opportunities, the findings reinforce the importance of continued progress in financing climate adaptation. At the same time, the work also highlights a clear need for further research to deepen the understanding of adaptation needs and support more effective solutions moving forward. Some recommendations for further areas of research were suggested to support this.

# Appendix

## Sectoral analysis of risks identified under Phase 1

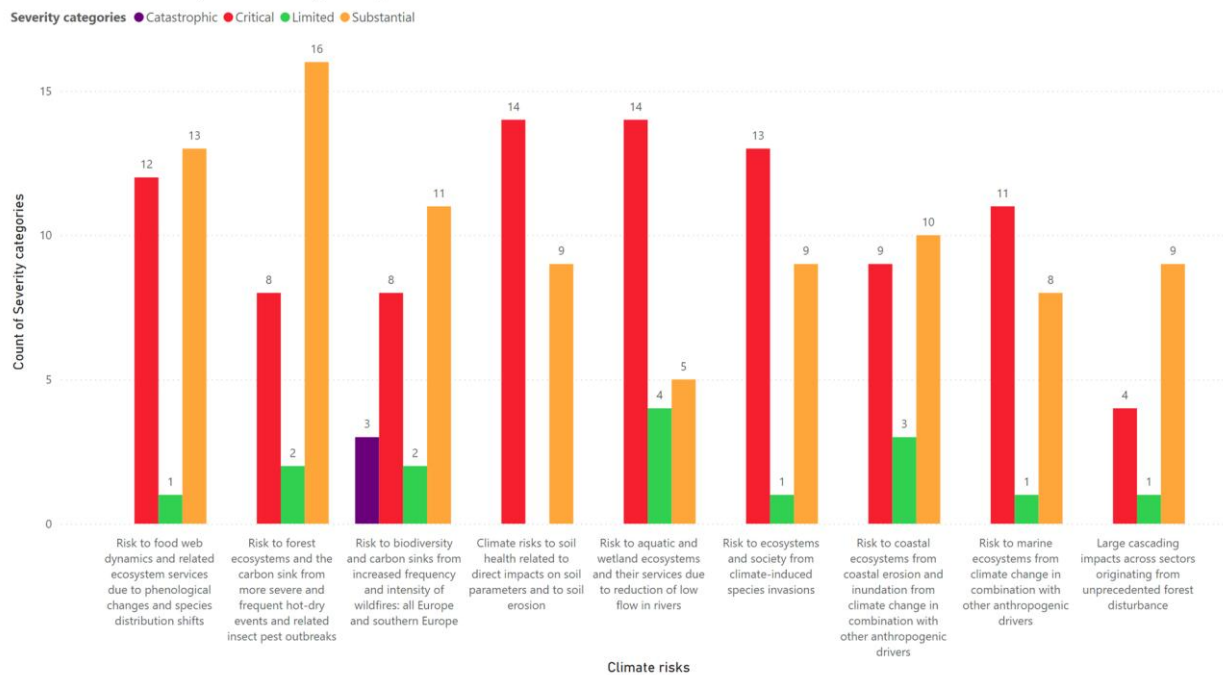
### Ecosystem and biodiversity

Along with the infrastructure sector, the ecosystem and biodiversity sector is the sector that is associated with the largest number of individual risks, nine, identified in national assessments.

Our analysis identified a significant number of climate risks related to ecosystems across Member States (MS), with the most common being “Risk to food web dynamics and related ecosystem services due to phenological changes and species distribution shifts,” followed by “Risk to forest ecosystems and the carbon sink from more severe and frequent hot-dry events and related insect pest outbreaks”. “Risk to aquatic and wetland ecosystems and their services due to reduction of low flow in rivers,” and “Risk to coastal ecosystems from coastal erosion and inundation from climate change in combination with other anthropogenic drivers,” were next. The figure below shows the classification by severity of climate risks in the Ecosystem sector,

- Regarding the driver of risks, across various countries, the primary driver of risks to food web dynamics stems from shifts in species distribution and changes in the timing of natural cycles (phenology). In terms of severity, this risk is considered critical by 12 Member States (MS), substantial by 13, and limited only by Romania.
- The primary drivers of risk to forest ecosystems are linked to more severe and frequent hot-dry weather events such as droughts and heatwaves, which also threaten the carbon sink through related insect pest outbreaks; this risk is classified as critical by 8 MS, substantial by 16, and limited by Lithuania and Greece.
- The increasing frequency and intensity of wildfires in Europe, driven by hotter, drier summers and prolonged droughts, is linked to the catastrophic severity assigned to the risk to biodiversity and the carbon sink by Croatia, Slovenia, and Spain, while Bulgaria and Lithuania rated it as limited.
- The spread of invasive species across Europe is driven by warmer temperatures, milder winters, and changes in precipitation, enabling the spread of new pests, diseases, and invasive species, which are disrupting ecosystems and reducing biodiversity. Member States are divided between critical (13 MS) and substantial (9 MS) in assessing this risk, with Romania being the only country to classify it as limited.
- Coastal ecosystems are increasingly vulnerable to climate change-induced coastal erosion and inundation, driven primarily by rising sea levels, with 8 MS rating this risk as critical, 10 as substantial, and Cyprus, Finland, and Lithuania as limited.
- The reduction of low flow in rivers, which threatens aquatic and wetland ecosystem services, is driven by changes in precipitation patterns, increased temperatures, and glacial retreat. This risk is classified as critical by 14 MS, substantial by 5, and limited by Bulgaria, Finland, Greece, and Romania.
- Marine ecosystems across Europe are experiencing significant impacts from rising sea temperatures, shifts in primary productivity, and disruptions to provisioning, regulating, and cultural services, with this risk classified as critical by 9 MS, substantial by 8, and limited by Bulgaria.
- The primary drivers of soil health risks include erosion due to natural factors like increased rainfall variability and extreme events (e.g., flash floods), as well as human-induced factors such as land use changes; there is broad agreement on its severity, with 14 MS rating it as critical and 9 as substantial.
- Finally, forest ecosystems face disruption from storms, ice break, and tree uprooting, with cascading impacts rated as critical by 4 MS, substantial by 9, and limited by Bulgaria.

Climate risks for the Ecosystems sector by severity level



## Food

Within the food sector, our analysis found a large number of risks related to “Risk to crop production in Europe from adverse weather conditions due to climate change”. The second most frequent risk identified in original assessments is related to risk to livestock production in Europe (by 25 Member States).

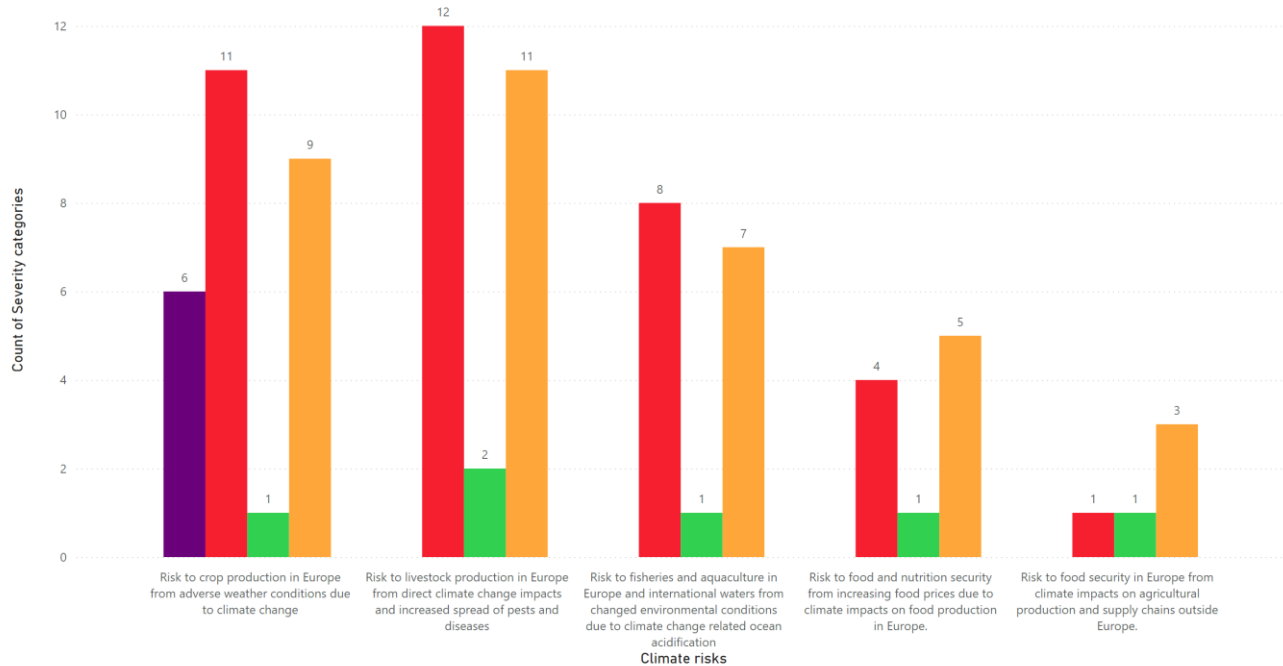
In terms of severity of the five risks under the Food sector, the highest severity is given to **Risk to crop production**, evaluated as catastrophic in six MS in the Southern Europe region (Croatia, Greece, Italy, Malta, Portugal and Slovenia).

MS are divided between critical and substantial categories for the other two most frequently identified risks: **Risk to fisheries and aquaculture**, and **Risk to livestock production**. Risk to fisheries and aquaculture is related to migration and growth of some species (such as cold-loving fish and shellfish in Croatia and Germany); spread of exotic fish diseases and bacteria; conditions of the water such as lack of oxygen, acidification, and rising temperature; reduction of water supply and issues with aquaculture site suitability (Ireland); extreme events at sea affecting artisanal and industrial fleet and aquaculture facilities. With regards to livestock productivity, drivers include heatwaves impacting directly farm animals, increasing temperature fostering pathogens and exotic diseases; warmer winters leading to challenging herding conditions and affecting animal food availability (Finland); insect infestations affecting animals’ health (Sweden); changing in grazing patterns due to climate impact on vegetation and crop prices.

Finally, there is heterogeneity in the severity assigned to **Risk to food and nutrition security from increased food prices**, and **Risk to food security from climate impacts outside Europe**. The former assessed by 10 MS is associated with increased investment need on food and beverages for consumers, connected to risks to agriculture sector and supply chains. The latter is connected to increased uncertainty in the structure of exports/imports for raw materials in the sector due to agro-climatic conditions in other countries (Lithuania).

## Climate risks for the Ecosystems Food sector by severity level

Severity categories ● Catastrophic ● Critical ● Limited ● Substantial



## Health

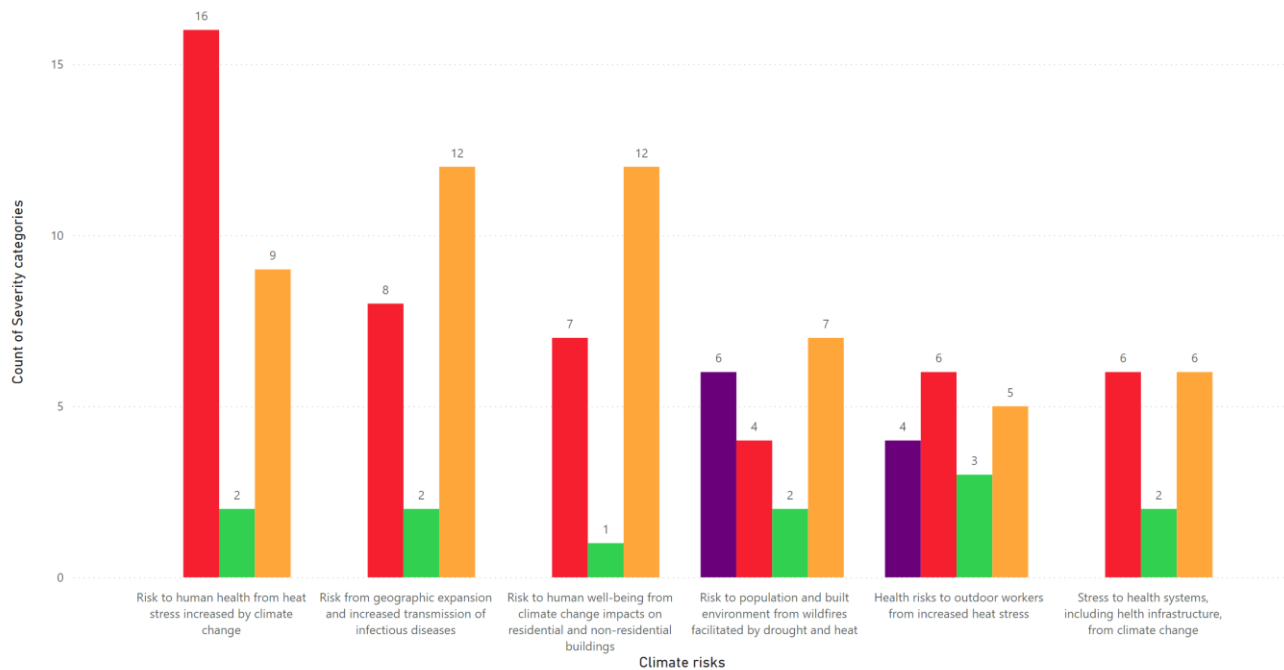
Among the seven risks under the health sector, the most identified were Risk to human health from heat stress increased by climate change and Risk from geographic expansion and increased transmission of infectious diseases. The risk severity assigned to this risk varies across countries and geographical areas.

Among the 20 MS that identified **Risk to human well-being from climate change impacts on residential and non-residential buildings in their assessment**, 12 assigned a substantial severity level to it. This risk's main drivers have been identified in rising temperature affecting buildings and risk to indoor overheating, increased precipitation and resulting risk of damp and mould in buildings, deterioration of comfort and habitability. **Risk to human health due to algal blooms and pathogens** has been classified under the Health sector, but in national risk assessments, this risk is also connected to impacts in the Tourism sector (threats to summer tourism due to water quality).

Three risks within the health sector were less frequently assessed by MS. **Health risks to outdoor workers** have been identified by 21 MS. Southern Europe assessed it as catastrophic (increased from critical as it is in hotspot region). The risks identified mostly relate relation to workers in the construction industry. **Risk to population and built environment due to wildfires** was identified by 19 MS. Risks at the MS level included impact on local IT and transport (Netherlands), rural buildings, and tourism demand (Malta). In the case of Greece, Croatia, Italy, Slovenia, Spain, Cyprus, Portugal and Malta the severity of this risk has been increased as Southern Europe is a hotspot region for wildfires. This resulted in a catastrophic ranking for Croatia, Greece, Spain, Italy and Malta, critical for Portugal and Cyprus. **Stress to health systems** has been linked to disruption of emergency health services and its infrastructure due to extreme events, such as storms, floods; resourcing of emergency aid from abroad; increased demand for care/health services; increase in the investment need on services, including maintenance, and operating costs of health system.

## Climate risks for the Health sector by severity level

Severity categories ● Catastrophic ● Critical ● Limited ● Substantial



## Infrastructure

In terms of severity, the Risk of damage to infrastructure and buildings due to slow-onset climate change and extreme climate events has been categorised as critical by 15 MS, substantial by 8 MS, and limited by 3 MS, with the limited severity assigned by Bulgaria, Estonia, and Finland. The Risk of electricity disruption due to the impacts of heat and droughts on energy production and peak demand has been classified as catastrophic by Italy and Croatia, critical by 5 MS, substantial by 12 MS, and limited by 5 MS.

For the Risk to population, infrastructure, and economic activities from pluvial and fluvial flooding, 16 MS rated it as critical, 10 as substantial, and only Finland classified it as limited.

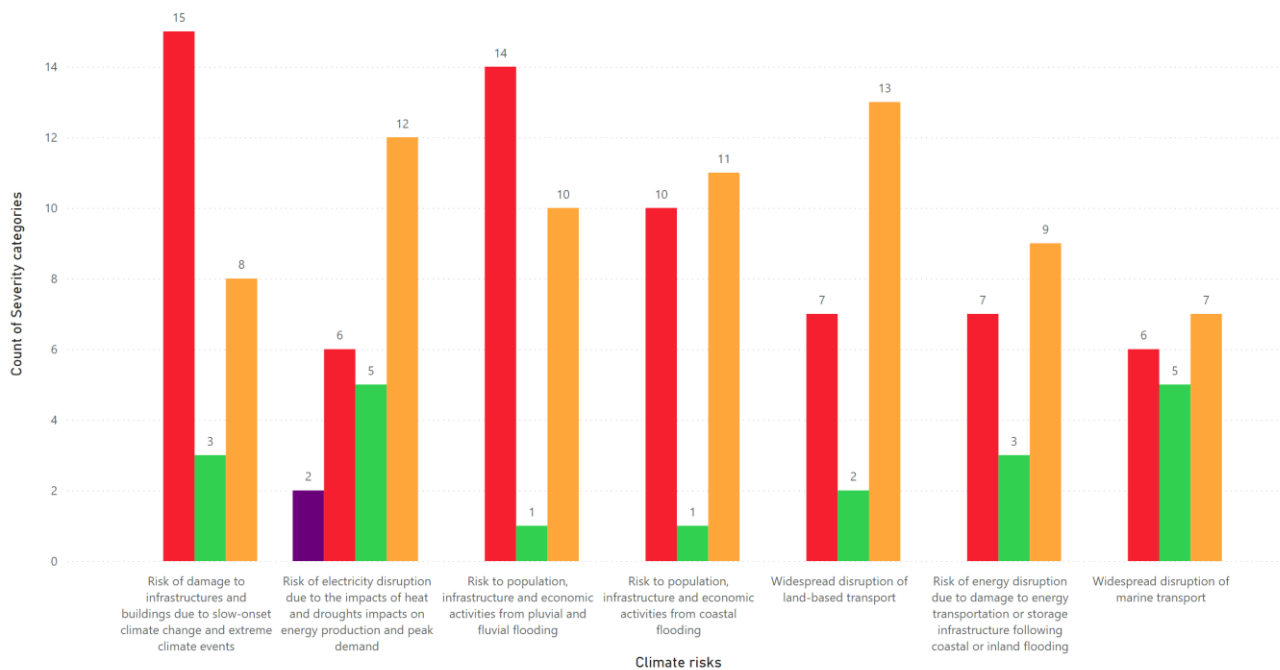
Similarly, the Risk to population, infrastructure, and economic activities from coastal flooding was considered critical by 9 MS, substantial by 11 MS, and limited by Finland.

The Widespread disruption of marine transport was rated as critical by Ireland, Malta, Netherlands, Italy, Portugal, and Spain. Additionally, 7 MS assigned substantial severity, while 5 MS, including Cyprus, Finland, Germany, Latvia, and Sweden, rated this risk as limited. For the Risk of energy disruption due to damage to energy transportation or storage infrastructure following coastal or inland flooding, 7 MS rated it as critical, , while 9 MS rated it as substantial, and Cyprus, Finland, and Germany classified it as limited.

Finally, the Widespread disruption of land-based transport was categorised as critical by 7 MS (Austria, Hungary, Italy, Malta, Portugal, Croatia and Slovakia), substantial by 14 MS, and limited by Finland and Cyprus.

Climate risks for the Infrastructure sector by severity level

Severity categories: Catastrophic Critical Limited Substantial



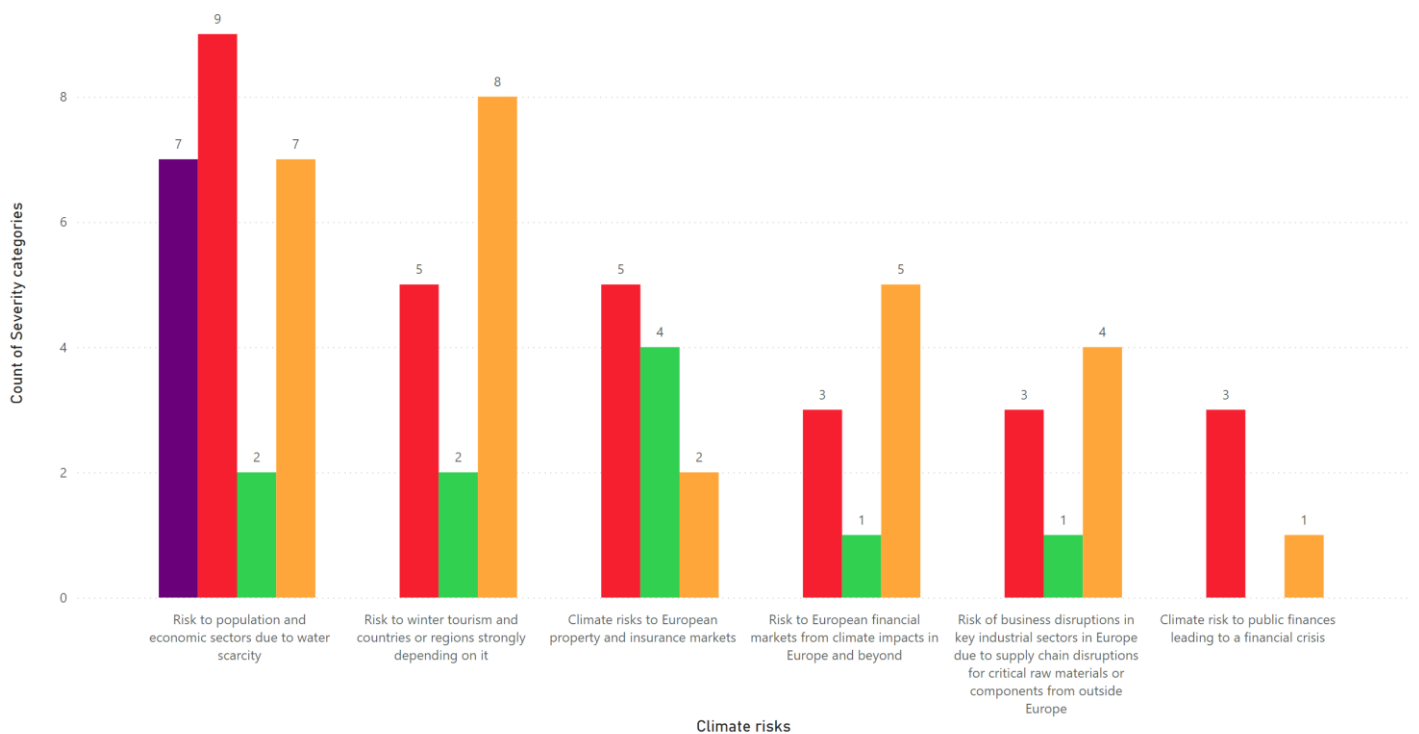
## Economy and Finance

The economy and finance sector groups 8 risks, however only 6 have been identified in national assessments. The most frequently documented risk was the “Risk to population and economic sectors due to water scarcity,” highlighting the widespread concern about the impacts of water shortages on both people and the economy. The second most frequently recorded risk was the “Risk to winter tourism and countries or regions strongly depending on it,” reflecting the growing vulnerability of this sector to climate change. Following this, the “Risk of business disruptions in key industrial sectors in Europe due to supply chain disruptions for critical raw materials or components from outside Europe”, pointing to the challenges European industries face in maintaining supply chains in a changing global climate.

In terms of severity across Member States (MS), the **Risk to population and economic sectors due to water scarcity** is considered catastrophic by 7 MS. **Water scarcity** poses a significant risk to both populations and economic sectors across Europe. The drivers of this risk are primarily linked to increasing drought frequency, reduced groundwater supply, and regional disparities in water availability. The **Climate risks to European property and insurance markets** have been classified as critical by 5 MS, risk largely driven by the increased frequency and intensity of extreme weather events, particularly flooding and unpredictable weather patterns. Similarly, the **Risk of business disruptions in key industrial sectors in Europe due to supply chain disruptions for critical raw materials or components from outside Europe** is rated as critical by Austria, Malta, and Portugal and Germany, Ireland, Netherlands, and Slovakia assessed it as substantial. This risk is primarily driven by climate-induced impacts on the availability of critical raw materials and components, particularly from outside Europe. The **Risk to winter tourism and countries or regions strongly depending on it** has been rated as critical by Austria, Czechia, France, Slovakia, and Spain, with 8 countries considering it substantial, and it is primarily driven by a decrease in snowfall, particularly in low-lying and mid-altitude areas, which is directly impacting tourism-dependent regions. Finally, the **Risk to European financial markets** from climate impacts in Europe and beyond is considered critical by Luxemburg, Malta, and Poland, substantial by Estonia, France, Germany, the Netherlands, and Sweden, and limited by Slovakia. This risk is driven by a range of climate-related disruptions, including depreciating assets in carbon-intensive industries, increased operational costs, and financial risks linked to changing market conditions

## Climate risks for the Economy &amp; Finance sector by severity level

Severity categories ● Catastrophic ● Critical ● Limited ● Substantial



## Conclusions

The heterogeneity and inconsistencies of results across MS provided a challenge in extracting patterns of risks in Europe and a clear alignment with the EUCRA findings, which assessed climate risks for Europe overall. Where possible, a comparison with the EUCRA was performed. Some of the key considerations follow.

- In alignment with the EUCRA, the highest number of climate risks identified by MS fall into the ecosystem and infrastructure cluster.
- At times, MS assessments undervalued and overvalued risk severity compared to the EUCRA. This is due to different scenarios and timeframes as well as methods used in the assessments.
- Few countries analyse direct/indirect financial or macroeconomic impacts, highlighting an underrepresentation of the risks pertaining to the economy and finance sector. In line with the EUCRA, financial and macroeconomic impacts are often more difficult to assess and are less frequently identified by Member States. This is due to the complexity of cascading and compounding financial risks, as well as insufficient stress tests and monitoring of supply chain vulnerabilities, making these risks harder to quantify.
- Infrastructure vulnerability is consistently identified as a critical concern across Europe due to slow-onset events like sea-level rise, and extreme weather such as storms and heatwaves. Both our analysis and the EUCRA highlight a mix of coastal and inland vulnerabilities, with infrastructure in coastal regions facing significant risks from sea-level rise, storm surges, and coastal erosion, while inland areas are more exposed to risks like extreme heat, flooding, and droughts.
- Our analysis identifies widespread threats to ecosystems, particularly due to extreme weather events, habitat degradation, and changing climatic conditions, all of which disrupt ecosystems and threaten species diversity. These findings align with the EUCRA, which highlights biodiversity loss as one of the most urgent climate risks, with a focus on the vulnerability of ecosystems to slow-onset changes like temperature rises, shifts in precipitation patterns, and sea-level rise.

## Scaling approach phase - tables

Tables below report the identified scaling approach for all the measures or cluster of measures for which a cost data has been found.

Table 20 Overview of ecosystems selected costs and scaling approach

Adaptation measure(s)	Cost description	Cost	Price adjustment approach	Rationale for selection	Scaling approach
Adaptive forest management	Additional costs for adaptive forest management practices due to climate change in France	100 million EUR/year	PPP	Cost data confidence: HIGH A well-recognised paper on climate adaptation costs, recently published, covering nationwide expenses and providing a specific cost estimate for the measures underpinning the cluster.	Scaling approach confidence: MED  Cost will be updated from 2019 to 2024 euros and scaled using France's forest extent (km <sup>2</sup> ). A per- km <sup>2</sup> cost will be derived from Eurostat's land cover data for "woodlands" <sup>52</sup> and then adjusted for each European country based on its forest coverage from the same source.
Early Monitoring System for Pest and Disease Outbreaks in Forests	Cost of the nationwide climate adaptation program for Romania from 2023 to 2027	50 million EUR	PPP	Cost data confidence: HIGH A nationwide cost from Romania's most recent official climate adaptation plan, highly representative as it specifically matches the defined measure.	Scaling approach confidence: MED  Cost will be updated from 2023 to 2024 euros. It will be calculated as cost per year (now covers 2023-2027) then it will be scaled using Romania's forest extent (km <sup>2</sup> ), using land cover data from Eurostat "woodlands" <sup>53</sup> to calculate a cost per km <sup>2</sup> . This cost per km <sup>2</sup> will be adjusted to other European countries using land covered by forest for each Member State from the same source.
Invasive species (non-native-plants and insects) management	Cost of the nationwide climate adaptation program for Romania from 2023 to 2030	35 million EUR	PPP	Cost data confidence: HIGH A nationwide cost from Romania's most recent official climate adaptation plan, with high representativeness as it specifically matches the defined measure.	Scaling approach confidence: MED  Costs will be updated from 2023 to 2024 euros, with an annual cost calculated for the 2023–2030 period. Scaling will be based on Romania's forest extent (km <sup>2</sup> ), using Eurostat's land cover data for "woodlands" <sup>54</sup> to derive a cost per km <sup>2</sup> . This per km <sup>2</sup> cost will then be adjusted for other European

<sup>52</sup> Eurostat. Land cover statistics. Retrieved from [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Land\\_cover\\_statistics](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Land_cover_statistics)

<sup>53</sup> Eurostat. Land cover statistics. Retrieved from [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Land\\_cover\\_statistics](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Land_cover_statistics)

<sup>54</sup> Eurostat. Land cover statistics. Retrieved from [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Land\\_cover\\_statistics](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Land_cover_statistics)

					countries based on their forest coverage from the same source.
Soil Restoration and Management	Cost of the nationwide climate adaptation program for Romania from 2023 to 2030	540 Million EUR/ Year	PPP	Cost data confidence: HIGH A nationwide cost from Romania's most recent official climate adaptation plan, with high representativeness as it specifically matches the defined measure.	Scaling approach confidence: MED  Costs will be updated from 2023 to 2024 euros, with the annual cost already determined (totalling 3.788 million for 2023–2030). Scaling will be based on Romania's agricultural land area (km <sup>2</sup> ), using Eurostat data <sup>55</sup> to derive a cost per km <sup>2</sup> . This per km <sup>2</sup> cost will then be adjusted for other European Member States based on their respective total land areas from the same source.
Soil Pollution prevention and control	Additional nationwide cost for adaptation need for Austria	40 - 60 Million EUR/year	PPP	Cost data confidence: HIGH A well-recognised paper on climate adaptation costs, published in 2017, estimating nationwide specific investment cost value for the measures underpinning the cluster.	Scaling approach confidence: MED  The cost will be adjusted from 2017 to 2024 euros and scaled using Austria's agricultural land area (km <sup>2</sup> ) based on data from Eurostat <sup>56</sup> to calculate a cost per km <sup>2</sup> . This per km <sup>2</sup> cost will then be adjusted for other European Member States by using each country's total land area, also sourced from Eurostat.
Dune restoration	Nationwide EU funded project cost in Belgium	7.1 million EUR	PPP	Cost data confidence: MED  A project-specific cost directly relevant to climate adaptation, corresponding to the measure in scope, and derived from a recent and ongoing project.	Scaling approach confidence: LOW  The costs will be adjusted from 2021 to 2024. The cost per hectare will be determined by dividing the total project cost by the target area of 3,800 hectares. Next, the ratio of hectares restored to the total land area covered by coastal dunes in Belgium will be calculated. This ratio will be used to estimate the number of hectares to restore in each country, based on data from EEA <sup>57</sup> . Finally, the total cost for each country will be calculated by multiplying the number of hectares to be restored by the cost per hectare.
Saltmarsh restoration	Per hectares cost for saltmarsh restoration from academic paper focus on US	151,129 USD/ha	PPP	Cost data confidence: LOW	Scaling approach confidence: LOW  The cost of saltmarsh restoration will be adjusted from 2010 to 2024 values and scaled to European price

<sup>55</sup> Eurostat. Land cover statistics. Retrieved from [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Land\\_cover\\_statistics](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Land_cover_statistics)

<sup>56</sup> Eurostat. Land cover statistics. Retrieved from [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Land\\_cover\\_statistics](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Land_cover_statistics)

<sup>57</sup> [https://tableau-public.discomap.eea.europa.eu/views/ART17\\_Habitat\\_types\\_distribution\\_2013\\_2018\\_EU27/Article17habitattypesdistributionandareas?%3Aiid=1&%3AisGuestRedirectFromVizportal=y&%3Aembed=y](https://tableau-public.discomap.eea.europa.eu/views/ART17_Habitat_types_distribution_2013_2018_EU27/Article17habitattypesdistributionandareas?%3Aiid=1&%3AisGuestRedirectFromVizportal=y&%3Aembed=y)

				The only cost found, it comes from a reliable source but is at project level, is old and related to the US.	levels. The UK's target of restoring 25,000 hectares by 2050 (source: WWT <sup>58</sup> ) will serve as a benchmark for estimating proportional restoration needs across EU Member States. A ratio will be calculated based on the UK's target relative to its total saltmarsh area (from Eurostat) and applied to each country's saltmarsh extent to determine national restoration targets. The total investment cost for the EU will then be estimated by multiplying these targets by the adjusted per-hectare cost.
Beach nourishment	Unit cost (€/m <sup>3</sup> ) from CLIMATE ADAPT platform, the cost applies Europe-wide	5 - 7 EUR/m <sup>3</sup>	PPP	Cost data confidence: MED  Cost data coming from a recent local European project and reliable climate adaptation focus database (Climate adapt).	Scaling approach confidence: LOW  The cost will be adjusted from 2017 to 2024 euros and scaled based on the Netherlands' objective to nourish 12 million m <sup>3</sup> (approximately 60 km, though they have used 5 million m <sup>3</sup> per year covering 20 km) annually to maintain its shoreline <sup>59</sup> . This data can then be applied to other countries by creating a ratio between the quantity of nourishment needed (12 million m <sup>3</sup> ) and the coastline length. This ratio can be used to estimate the nourishment needs for each country, ultimately determining the total investment required.
Grassland maintenance and restoration	Additional Nationwide cost for adaptation need for Austria	5–40 Million EUR/year	PPP	Cost data confidence: HIGH  A well-recognised paper on climate adaptation costs, published in 2017, estimating nationwide specific investment cost value for the measures underpinning the cluster.	Scaling approach confidence: HIGH  Cost will be adjusted from 2017 to 2024 euros. It will be scaled using Austria's grassland extent (km <sup>2</sup> ), using land cover data from Eurostat "grassland" <sup>60</sup> to calculate a cost per km <sup>2</sup> . This cost per km <sup>2</sup> will be adjusted to other European countries using land covered by grassland for each Member State from the same source.
Heath, steppe & scrub restoration	Per hectares cost for heath and scrub ecosystems restoration from academic paper focus on UK	350 - 588 GBP/ha	PPP	Cost data confidence: MED	Scaling approach confidence: MED  The cost will be adjusted from 2021 to 2024 values and aligned with European price levels. To estimate

<sup>58</sup> WWT. (2024, September 19). Economic benefits of saltmarsh creation for carbon storage. Wildfowl & Wetlands Trust. Retrieved from <https://www.wwt.org.uk/uploads/documents/2024-09-19/economic-benefits-of-saltmarsh-creation-for-carbon-storage-wwt.pdf>

<sup>59</sup> Brand, Ramaekers, Lodder. (2021). Dutch experience with sand nourishments for dynamic coastline conservation – An operational overview. Science of the Total Environment, Retrieved from [https://www.sciencedirect.com/science/article/pii/S0964569121004919?fr=RR-2&ref=pdf\\_download&rr=9170c114ad49ef0b](https://www.sciencedirect.com/science/article/pii/S0964569121004919?fr=RR-2&ref=pdf_download&rr=9170c114ad49ef0b)

<sup>60</sup> Eurostat. Land cover statistics. Retrieved from [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Land\\_cover\\_statistics](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Land_cover_statistics)

				Unit cost from a relatively recent academic source, with a context close to Europe.	the total investment, the 6,600 km <sup>2</sup> restoration target <sup>61</sup> will be allocated among EU Member States based on the proportion of Heath, steppe, and scrub habitats in each country, using EEA land use <sup>62</sup> . The investment requirement for each country will be calculated by applying a cost per hectare estimate to its restoration target. Finally, the annualised cost will be determined by dividing the total investment by the remaining years until 2030.
Peatlands & marshlands restoration	Per hectares cost for peatlands ecosystems restoration from academic paper focus on UK	172–8,037 EUR/ha	PPP	Cost data confidence: MED  The unique cost identified is a unit cost derived from an academic source, with a context closely related to Europe, and is based on recent data	Scaling approach confidence: MED  The cost will be adjusted from 2019 to 2024 values and aligned with European price levels. To estimate the total investment need, the 10,900 km <sup>2</sup> restoration target for Bogs, mires, and fens <sup>63</sup> will be distributed among EU Member States based on land use data per country from the Joint Research Centre (JRC) <sup>64</sup> . The investment requirement for each country will be calculated by applying a cost per hectare estimate to its respective restoration target. Finally, the annualised cost will be determined by dividing the total investment by the remaining years until 2030.
Freshwater system restoration	Per hectares cost for freshwater ecosystems restoration from academic paper focus on UK	122 GBP/ha	PPP	Cost data confidence: MED  It is the only cost identified, presented as a unit cost from an academic source, with a context closely aligned to Europe, and based on recent data.	Scaling approach confidence: MED  The cost will be adjusted from 2021 to 2024 values and aligned with European price levels. To estimate the total investment, the 13,500 km <sup>2</sup> restoration target for freshwater habitats <sup>65</sup> will be distributed among EU Member States in proportion to the area of “freshwater habitats”, based on EEA land cover data <sup>66</sup> . The investment requirement for each country will then be calculated by applying a cost per hectare to its restoration target. Finally, the annualised cost will be determined by dividing the total investment by the remaining years until 2030.

<sup>61</sup> European Commission. (n.d.). Steppe, heath and scrub habitats to be restored. European Commission. Retrieved from <https://biodiversity.europa.eu/europes-biodiversity/habitats-to-be-restored/steppe-heath-scrub>

<sup>62</sup> European Environment Agency. (n.d.). Habitat types of distribution and areas. European Environment Agency. Retrieved from [https://tableau-public.discomap.eea.europa.eu/views/ART17\\_Habitat\\_types\\_distribution\\_2013\\_2018\\_EU27/Article17habitattypesdistributionandareas?%3Aiid=1&%3AisGuestRedirectFromVizportal=y&%3Aembed=y](https://tableau-public.discomap.eea.europa.eu/views/ART17_Habitat_types_distribution_2013_2018_EU27/Article17habitattypesdistributionandareas?%3Aiid=1&%3AisGuestRedirectFromVizportal=y&%3Aembed=y)

<sup>63</sup> European Environment Agency. (2020). State of nature in the EU 2020. European Environment Agency. Retrieved from <https://www.eea.europa.eu/en/analysis/publications/state-of-nature-in-the-eu-2020>

<sup>64</sup> European Commission Joint Research Centre. (n.d.). Peatland per country. European Commission. Retrieved from [https://esdac.jrc.ec.europa.eu/ESDB\\_Archive/octop/Resources/Peatland\\_Per\\_Country.pdf](https://esdac.jrc.ec.europa.eu/ESDB_Archive/octop/Resources/Peatland_Per_Country.pdf)

<sup>65</sup> European Environment Agency. (2020). State of nature in the EU 2020. European Environment Agency. Retrieved from <https://www.eea.europa.eu/en/analysis/publications/state-of-nature-in-the-eu-2020>

<sup>66</sup> European Environment Agency. (n.d.). Habitat types of distribution and areas. European Environment Agency. Retrieved from [https://tableau-public.discomap.eea.europa.eu/views/ART17\\_Habitat\\_types\\_distribution\\_2013\\_2018\\_EU27/Article17habitattypesdistributionandareas?%3Aiid=1&%3AisGuestRedirectFromVizportal=y&%3Aembed=y](https://tableau-public.discomap.eea.europa.eu/views/ART17_Habitat_types_distribution_2013_2018_EU27/Article17habitattypesdistributionandareas?%3Aiid=1&%3AisGuestRedirectFromVizportal=y&%3Aembed=y)

Enhanced habitat connectivity, including creation of buffer zones, ecological corridors and refuges	Nationwide program cost for Bulgaria specific for climate adaptation for the measure in scope	25.0 Million EUR/year	PPP	<p>Cost data confidence: HIGH</p> <p>A nationwide cost derived from the most recent official climate adaptation plan of Bulgaria, providing a comprehensive estimate aligned with the country's current climate adaptation strategy.</p>	<p>Scaling approach confidence: MED</p> <p>Cost to be adjusted from 2021 to 2024 euros. Cost per year already calculated (total cost was 135 million EUR for 2021-2026), It will be scaled using Bulgaria's country total area (km<sup>2</sup>), using data from Eurostat<sup>67</sup> to calculate a cost per km<sup>2</sup>. This cost per km<sup>2</sup> will be adjusted to other European Member States using country total area for each Member State from the same source.</p>
Pollinators	Cost of the nationwide climate adaptation program for Romania from 2023 to 2026	34.8 Million EUR/year	PPP	<p>Cost data confidence: HIGH</p> <p>A nationwide cost from Romania's most recent official climate adaptation plan, with high representativeness as it specifically matches the defined measure.</p>	<p>Scaling approach confidence: MED</p> <p>Cost to be adjusted from 2023 to 2024 euros. Cost per year already calculated (total cost was 140 million EUR for 2023-2026), It will be scaled using Romania's country total area (km<sup>2</sup>), using data from Eurostat<sup>68</sup> to calculate a cost per km<sup>2</sup>. This cost per km<sup>2</sup> will be adjusted to other European Member States using country total area for each Member State from the same source.</p>
Wildfire prevention	Cost of the nationwide climate adaptation program for Romania from 2023 to 2030	375 million EUR	PPP	<p>Cost data confidence: HIGH</p> <p>A nationwide cost from Romania's most recent official climate adaptation plan, with high representativeness as it specifically matches the defined measure.</p>	<p>Scaling approach confidence: MED</p> <p>Cost to be adjusted from 2023 to 2024 euros. It will be calculated a cost per year (now covers 2023-2030) then it will be scaled using Romania's forest extent (km<sup>2</sup>), using land cover data from Eurostat "woodlands"<sup>69</sup> to calculate a cost per km<sup>2</sup>. This cost per km<sup>2</sup> will be adjusted to other European countries using land covered by forest for each Member State from the same source.</p>
Management of invasive alien species	Additional Nationwide cost for adaptation need for Austria	0–1 Million EUR/year	PPP	<p>Cost data confidence: HIGH</p> <p>A well-recognised paper on climate adaptation costs, published in 2017, estimating nationwide specific investment</p>	<p>Scaling approach confidence: HIGH</p> <p>Costs to be adjusted from 2017 to 2024 euros. It will be scaled using Austria's non-built environment (km<sup>2</sup>), using land cover data from Eurostat "built environment"<sup>70</sup> and subtracting it from the total land</p>

<sup>67</sup> Eurostat. Land cover statistics. Retrieved from [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Land\\_cover\\_statistics](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Land_cover_statistics)

<sup>68</sup> Eurostat. Land cover statistics. Retrieved from [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Land\\_cover\\_statistics](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Land_cover_statistics)

<sup>69</sup> Eurostat. Land cover statistics. Retrieved from [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Land\\_cover\\_statistics](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Land_cover_statistics)

<sup>70</sup> Eurostat. Land cover statistics. Retrieved from [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Land\\_cover\\_statistics](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Land_cover_statistics)

				cost value for the measures underpinning the cluster.	area of the country to calculate a cost per km <sup>2</sup> . This cost per km <sup>2</sup> is adjusted to other European countries using the same calculation of the non-built environment for each Member State from the same source.
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Table 21 Overview of food selected costs and scaling approach

Adaptation measure(s)	Cost description	Cost	Price adjustment approach	Rationale for selection	Scaling approach
Climate smart agriculture and financial support	Total foreseen annual costs for climate adaptation practices (from adapting crop rotation, optimisation of management of water, crops and soil) for the whole French agricultural sector	1,500 million EUR/year	PPP	Cost data confidence: HIGH A well-recognised paper on climate adaptation costs, recently published (2024), covering nationwide costs and providing a specific value for all measures underpinning the two clusters.	Scaling approach confidence: MED Cost already in 2024 price value. Cost already at national level, it will be scaled to other countries using "Output of the agricultural industry - basic and producer prices" <sup>71</sup> ratios for each country from Eurostat. Economic value will be then adjusted using "Purchase price indices, total means of agricultural production" <sup>72</sup> .
Adaptive fisheries management	The annual cost estimate for managing Mediterranean MPAs is from the total 10-year financing gap of €7 billion (2010–2020) for the "ideal management scenario" across 49,000 km <sup>2</sup> of MPAs.	700 Million EUR/year	PPP	Cost data confidence: MED This was the only cost estimate identified, specifically addressing additional climate adaptation expenses within a European context. While not strictly European, it is highly relevant as it pertains to a Mediterranean setting.	Scaling approach confidence: LOW The cost will be adjusted from 2015 to 2024 values and calculated based on an affected area of 49,000 km <sup>2</sup> in the Mediterranean Sea. To estimate the cost for a specific EU Mediterranean country, we will allocate a share of the total cost based on the proportion of its Exclusive Economic Zone (EEZ) relative to the total EEZ of all Mediterranean countries <sup>73</sup> . This proportionate share will provide a country-specific cost estimate. To extend this approach to other EU countries, we will first derive a per km <sup>2</sup> cost by dividing each Mediterranean country's estimated cost by the extent of its EEZ. This unit cost will then be applied to the EEZs of other EU countries, ensuring a consistent

<sup>71</sup> European Commission. Eurostat - Agricultural Output, Price Indices, and Income. Available at: [https://ec.europa.eu/eurostat/databrowser/view/tag00102/default/table?lang=en&category=t\\_agr.t\\_aact](https://ec.europa.eu/eurostat/databrowser/view/tag00102/default/table?lang=en&category=t_agr.t_aact)

<sup>72</sup> European Commission. Eurostat - Agricultural Price Indices (Input and Output). Available at: [https://ec.europa.eu/eurostat/databrowser/view/tag00052/default/table?lang=en&category=t\\_agr.t\\_apri](https://ec.europa.eu/eurostat/databrowser/view/tag00052/default/table?lang=en&category=t_agr.t_apri)

<sup>73</sup> Vivid Maps, Exclusive Economic Zones Maps. Available at: <https://vividmaps.com/exclusive-economic-zones-maps/>

					scaling method while accounting for geographical differences.
Fisheries innovation	The annual cost of European Maritime, Fisheries and Aquaculture Fund (EMFAF) to support sustainable fisheries, aquaculture, and maritime policies, fostering innovation and environmental protection between 2021-27	870 Million EUR/year	PPP	<p>Cost data confidence: LOW</p> <p>A European fund with explicit objectives on climate adaptation in the fisheries sector, providing a general cost estimate that can be attributed to individual countries. While the data is recent, it relates to a budget and not the actual cost of the measure. For this reason, the confidence level is assigned as low.</p>	<p>Scaling approach confidence: HIGH</p> <p>The cost will be adjusted from 2021 to 2024 values. In line with the Green Deal's goal of dedicating 30% of the Maritime Fisheries Fund to climate action<sup>74</sup>, only 30% of the total cost will be considered for this purpose. To allocate costs to each country, the total adjusted cost will be multiplied by a country-specific ratio, which is calculated by dividing the value of each country's fisheries products by the total value of fisheries products in Europe<sup>75</sup>.</p>
Incentives and subsidies for sustainable food consumption	Program for sustainable consumption, focusing on food as one of its three key topics, has a total budget of ~9 million EUR for 2017–2025, with the food component estimated to account for one-third of the cost.	9.42 million EUR	PPP	<p>Cost data confidence: LOW</p> <p>The only available cost estimate pertains to a recent European project, aimed at building the know-how required to incentivise a shift in consumer behaviour. This cost does not specifically relate to subsidies, as those are mainly regulatory in nature and do not directly represent a financial outlay.</p>	<p>Scaling approach confidence: LOW</p> <p>Cost will be adjusted from 2017 to 2024 price levels. The cost found covers a multiyear program (2017-2025), "one off" cost for a program to build knowledge on what is needed for a sustainable food consumption shift, and as such it does not need to be repeated in time. GDP values<sup>76</sup> will be used to scale to other countries.</p>
Ecolabelling and energy labelling	Project involving partners from Spain, Germany, and the Netherlands, aims to develop a harmonised eco-food label for all of Europe (2023-2027)	2.95 million EUR/year	PPP	<p>Cost data confidence: MED</p> <p>This cost was selected based on its relevance to the development of the expertise required for designing and establishing an ecolabelling system. The information comes from a recent European project that focused on fostering this specific know-how, rather than the actual</p>	<p>Scaling approach confidence: LOW</p> <p>The cost will be adjusted from 2023 to 2024 price levels. It covers a multi-year project (2023-2027) aimed at developing and harmonizing environmental labelling at the European level. This is a one-off cost solely for ecolabelling, which can be scaled to each country based on GDP<sup>77</sup>. The cost of applying such a label is considered negligible, as it does not entail substantial national expenses (being a private obligation). To account for energy labelling, the cost</p>

<sup>74</sup> European Commission. (2021, July). EMFAF FAQ (p. 7). European Commission. Retrieved March 18, 2025, from [https://oceans-and-fisheries.ec.europa.eu/system/files/2021-07/emfaf-faq\\_en.pdf](https://oceans-and-fisheries.ec.europa.eu/system/files/2021-07/emfaf-faq_en.pdf)

<sup>75</sup> Eurostat. Fisheries database. European Commission. Retrieved from <https://ec.europa.eu/eurostat/web/fisheries/database>

<sup>76</sup> Eurostat. National accounts and GDP. European Commission. Retrieved from [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=National\\_accounts\\_and\\_GDP](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=National_accounts_and_GDP)

<sup>77</sup> Eurostat. National accounts and GDP. European Commission. Retrieved from [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=National\\_accounts\\_and\\_GDP](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=National_accounts_and_GDP)

				implementation of ecolabelling schemes.	will be doubled, assuming the same development costs as for ecolabelling.
Incentives and subsidies for sustainable food production	Cost of actions for promotion and incentives for sustainable food production (€45 million over 2023-2027)	6.4 Million EUR/year	PPP	<p>Cost data confidence: MED</p> <p>The nationwide cost comes from Romania's most recent official climate adaptation plan, offering a high degree of representativeness as it directly focuses on the adaptation element of the sustainable food production.</p>	<p>Scaling approach confidence: HIGH</p> <p>Cost will be adjusted from 2022 to 2024 price value. The cost is already at national level, it will be scaled to other countries using "Output of the agricultural industry - basic and producer prices" ratios for each country from Eurostat<sup>78</sup>.</p>
Climate-proofing barns (shades, cooling, water supply) - livestock infrastructure	Bulgaria national cost for development of climate-proofing farms and facilities	128.26 Million EUR	PPP	<p>Cost data confidence: HIGH</p> <p>Nationwide cost, from the most recent official climate adaptation plan of Bulgaria, high representativeness as it specifically matches the measure defined.</p>	<p>Scaling approach confidence: HIGH</p> <p>The cost will be adjusted from 2023 to 2024 price levels. It is a nationwide cost focus on climate adaptation, it will be scaled to other European countries calculating the ratio between number of livestock in each country and number of livestock in Bulgaria<sup>79</sup>. The cost estimate will be economically adapted using Construction Cost Index to adapt it to specific national economy.</p>
Development of heat-tolerant livestock breeds and encouraging the diversification of livestock breeds and farming practice	Annual costs at European level for improving animal rearing conditions	760 million EUR/ year	PPP	<p>Cost data confidence: HIGH</p> <p>Chosen as it includes information that can be converted across the Member States. Source is reliable and part of a wider climate adaptation costs study.</p>	<p>Scaling approach confidence: HIGH</p> <p>The cost will be adjusted from 2012 to 2024 price levels. It covers all of Europe and will be scaled to specific European countries using the ratio of livestock data from each Member State, based on Eurostat data<sup>80</sup>. The scaling will be calculated by summing the number of bovines, sheep, and pigs in each country and dividing it by the total number of these animals in the EU.</p>

<sup>78</sup> European Commission. Eurostat - Agriculture database. Eurostat. Retrieved March 18, 2025, from <https://ec.europa.eu/eurostat/web/agriculture/database>

<sup>79</sup> Eurostat. Agriculture - database. European Commission. Retrieved from <https://ec.europa.eu/eurostat/web/agriculture/database>.

<sup>80</sup> Eurostat. Agriculture - database. European Commission. Retrieved from <https://ec.europa.eu/eurostat/web/agriculture/database>

Table 22 Overview of health selected costs and scaling approach

Adaptation measure(s)	Cost description	Cost	Price adjustment approach	Rationale for selection	Scaling approach
Urban Cooling and Infrastructure Resilience - Green & Hybrid	Nationwide cost for implementing green measures in France cities	500 million EUR/year	PPP	<p>Cost data confidence: HIGH</p> <p>A well-recognised paper on climate adaptation costs, recently published, covering nationwide expenses and providing a specific cost estimate for the measures underpinning the cluster.</p>	<p>Scaling approach confidence: LOW</p> <p>Cost already adjusted to 2024 value. It will be scaled to other countries using the number of people living in cities according to Eurostat definition. Data will be taken from Eurostat<sup>81</sup> or from National Statistical Offices.</p>
Improving cooling in public transport systems	Nationwide cost to upgrade cooling systems in public transportation in Austria	3.5 million EUR/year	PPP	<p>Cost data confidence: HIGH</p> <p>Nationwide cost, well-recognised paper specifically on climate adaptation costs, specific cost fitting the measures underpinning the cluster, recent publication.</p>	<p>Scaling approach confidence: HIGH</p> <p>Cost will be adjusted from 2017 to 2024 price levels. Cost is already at national level, it will be scaled to other countries using the modal split of inland passenger transport defined by Eurostat<sup>82</sup>, specifically the sum of trains, motor coaches, buses and trolley buses.</p>
Prevention of infectious diseases	Nationwide budget to develop a monitoring system for vectors and pathogens in Austria.	4 million EUR/year	PPP	<p>Cost data confidence: MEDIUM</p> <p>Nationwide cost, taken directly from EU4Health Work Programme direct grants. Specific cost fits the measure underpinning the cluster, publication is recent.</p>	<p>Scaling approach confidence: HIGH</p> <p>Cost to be adjusted from 2022 to 2024 price levels. As no breakdown was available, a 40% fixed and 60% variable split was assumed based on expert judgement to reflect the balance between fixed component (baseline infrastructure needs) and variable component (operational scaling). Variable component cost will be adjusted to other EU member states using population and PPP index.</p>
Wildfire early warning system	Budget to implement a nationwide early warning system against wildfires in Romania	7 million EUR/year	PPP	<p>Cost data confidence: HIGH</p> <p>Nationwide cost, obtained from the most recent official climate</p>	<p>Scaling approach confidence: HIGH</p> <p>Cost to be adjusted to 2024 price levels. As no breakdown was available, a 40% fixed and 60%</p>

<sup>81</sup> Eurostat. Cities and greater cities database. Retrieved from: [https://ec.europa.eu/eurostat/databrowser/view/urb\\_cpop1/default/table?lang=en&category=urb.urb\\_cg](https://ec.europa.eu/eurostat/databrowser/view/urb_cpop1/default/table?lang=en&category=urb.urb_cg)

<sup>82</sup> Eurostat. Percentage share of each mode of transport in total inland transport percentage share of each mode of transport in total inland transport. Retrieved at: [https://ec.europa.eu/eurostat/databrowser/view/tran\\_hv\\_psmod/default/table?lang=en&category=tran.tran\\_hv\\_ms](https://ec.europa.eu/eurostat/databrowser/view/tran_hv_psmod/default/table?lang=en&category=tran.tran_hv_ms)

				adaptation plan of Romania, it is specific for climate adaptation costs.	variable split was assumed based on expert judgement to reflect the balance between fixed component (baseline infrastructure needs) and variable component (operational scaling). Variable component cost per km <sup>2</sup> in Romania will be calculated using land cover data from Eurostat "woodlands" <sup>83</sup> . This cost per km <sup>2</sup> will be adjusted to other European countries using land covered by forest for each Member State from the same source.
Wildfire disaster response	Budget for updating emergency plans and strengthening fire and emergency response infrastructure in France	115 million EUR/year	PPP	Cost data confidence: HIGH  Nationwide cost, well-recognised paper specifically on climate adaptation costs due to increase in wildfires, specific cost fitting the measures underpinning the cluster, fairly recent publication.	Scaling approach confidence: MEDIUM  Costs to be adjusted from 2017 to 2024 euros. Cost already nationwide. The cost per km <sup>2</sup> in France will be calculated using land cover data from Eurostat "woodlands". This cost per km <sup>2</sup> will be adjusted to other European countries using land covered by forest for each Member State from the same source.
Organisational measures for OHS	Cost of complying with the rule on heat injury and illness prevention in outdoor and indoor work setting in the United States.	7200 million EUR/year	PPP	Cost data confidence: LOW  Nationwide cost, only cost estimate available at cluster level, the measures financed under the programme align with the measures underpinning the cluster, the source is a national authority, publication is recent.	Scaling approach confidence: MED  Cost to be adjusted from 2023 to 2024. Cost per worker will be obtained by dividing the investment amount by the US workforce in 2023. This will be scaled to other EU MS using the Labour Force Survey (LFS) from Eurostat <sup>84</sup> looking at NACE sectors highly exposed to heat stress: agriculture, forestry, and fishing, construction, mining and quarrying, utilities (e.g., energy, water supply, waste management), transport and logistics.
Nutrient reduction initiatives	The cost data reflects measures to promote sustainable farming practices for improved nutrient and pesticide management. The data is retrieved from Italian public authority and the publication is recent.	120 Million EUR	PPP	Cost data confidence: MED  Nationwide cost derived from an Italian public authority (ISPRA), recent publication, and closely aligned with nutrient and pesticide management. Original data was regional and required scaling,	Scaling approach confidence: LOW  Costs adjusted from 2022 to 2024. Original cost was regional for a 2021–2027 programme; only 2026–2027 costs were retained and extended to all Italian regions. Cyclicity assumed once before 2050. Scaling to other MS uses surface area of river basins (ISPRA, EEA), a simplified approach.

<sup>83</sup> Eurostat. Land cover and land use, landscape. Retrieved from: [https://ec.europa.eu/eurostat/databrowser/view/lan\\_lcv\\_ovw\\_\\_custom\\_16069571/default/table?lang=en](https://ec.europa.eu/eurostat/databrowser/view/lan_lcv_ovw__custom_16069571/default/table?lang=en)

<sup>84</sup> Eurostat. EU labour force survey – Microdata. Retrieved from: <https://ec.europa.eu/eurostat/web/microdata/european-union-labour-force-survey>

				which introduces some uncertainty.	
Upgrade wastewater treatment facilities	The cost data is in line with the adaptation measure identified (upgrade of wastewater treatment facilities). The data is retrieved from the Government of Ireland and has been recently published (2024).	215.8 Million EUR/Year	PPP	Cost data confidence: HIGH  Nationwide, recent (2024), authoritative government source; cost is directly aligned with the identified adaptation measure (upgrade of 108 WWT plants).	Scaling approach confidence: MED  Costs adjusted to 2024. Scaling uses untreated population equivalent (p.e.) based on UWWTD compliance, applying Ireland's cost per untreated p.e. to each MS. PPP adjustments applied; method is robust but cost transferability across MS may vary.
Public Health and Safety	The cost is closely aligned with the measures, retrieved from a EEA case study published on Climate-ADAPT. The cost data is recent and includes installation, maintenance, and repair services.	4,200 EUR per monitoring point	PPP	Cost data confidence: MED  Recent data from an EEA Climate-ADAPT case study; aligned with the measure but based on a single lake (Lake Pien-Saimaa), limiting representativeness.	Scaling approach confidence: LOW  Costs adjusted from 2023 to 2024. Scaling based on monitoring point density in Lake Pien-Saimaa and applied to water bodies not in good ecological status in each MS. Simplified and assumption-heavy approach.
Training of health professionals in disaster management	Investment needed to train health professional in Austria to manage health related outbreaks.	0.5 Million EUR/Year	PPP	Cost data confidence: MEDIUM  Nationwide cost, well-recognised paper specifically on climate adaptation costs, specific cost fitting the measures underpinning the cluster, recent publication.	Scaling approach confidence: HIGH  Costs to be adjusted from 2017 to 2024 euros. It will be scaled to other EU MS using population data. This will be calculated by using the ratios between other MS population and Austria population. The ratio will be multiplied by the investment need to get an estimate for each Member State.
Early warning systems for health risks	Investment needed to develop an early warning system against emerging diseases in North Macedonia	0.2 million EUR/Year	PPP	Cost data confidence: MEDIUM  Nationwide cost, retrieved from a well-recognised organisation. Only data identified for the measure, and it is relatively recent publication..	Scaling approach confidence: HIGH  Costs to be adjusted from 2018 to 2024 euros. As no breakdown was available, a 40% fixed and 60% variable split was assumed based on expert judgement to reflect the balance between fixed component (baseline infrastructure needs) and variable component (operational scaling). Variable component cost will be scaled to other EU MS using population data. It will be calculated by using the ratios between other MS population and North Macedonia population. The ratio will be multiplied by

					the investment need to get an estimate for each Member State.
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Table 23 Overview of infrastructure selected costs and scaling approach

Adaptation measure(s)	Cost description	Cost	Price adjustment approach	Rationale for selection	Scaling approach
Improved energy assets and diversification of energy systems	Annual costs for adaptation options for electricity transmission and distribution networks and infrastructure for all EU	640-650 million EUR/year	PPP	Cost data confidence: HIGH Europe-wide cost chosen as it includes information that can be allocated across the Member States. Source is reliable and part of a wider climate adaptation costs study.	Scaling approach confidence: HIGH The proportion of the 640 million will be assigned to each Member State proportionately based on their share of total electricity generation using EUROSTAT data. Data will be also adjusted per energy consumption growth rate from 2012 (date of the data retrieved) to 2024 to adjust the cost to today's energy need.
Energy demand management	Annual costs for additional cooling of power plants for all EU	650 million EUR/year	PPP	Cost data confidence: HIGH Europe-wide cost chosen as it includes information that can be allocated across the Member States. Source is reliable and part of a wider climate adaptation costs study.	Scaling approach confidence: HIGH Costs to be adjusted from 2012 to 2024 euros. The proportion of the 640 million will be assigned to each Member State based on their share of total electricity generation using Eurostat data. <sup>85</sup> Data will be also adjusted per fossil generated energy consumption growth rate from 2012 (date of the data retrieved) to 2024 to adjust the cost to today's energy need from sources that will need cooling.
Resilient Maritime and Transport Systems	Total cost to 2050 at EU level (data available also at EU member state level) for Resilient Maritime and Transport Systems	922 Million EUR	PPP	Cost data confidence: HIGH Robust, recent data source (DG MOVE - TEN T) that covers all MS and compliments Resilient Maritime and Transport Systems	Scaling approach confidence: HIGH Numbers are provided for each MS so does not require scaling. Costs already in 2024 euros.

<sup>85</sup> See [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Electricity\\_production,\\_consumption\\_and\\_market\\_overview](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Electricity_production,_consumption_and_market_overview)

Strengthen road and rail network	Total cost to 2050 at EU level (data available also at EU member state level) for strengthening road and rail networks to safeguard transportation functionality	1,751 Million EUR	PPP	Cost data confidence: HIGH Robust, recent data source (DG MOVE - TEN T) that covers all MS and compliments Strengthen road and rail network measure	Scaling approach confidence: HIGH Numbers are provided for each MS so does not require scaling. Costs already in 2024 euros
Reduced criticality	Additional annual budget to address critical vulnerability points in transport networks in France	325 million EUR/year	PPP	Cost data confidence: HIGH Cost is nationwide, retrieved from a reliable and recent source. Only cost estimate identified that reflects the measures to be implemented.	Scaling approach confidence: LOW Costs will be updated from 2022 to 2024 euros. The cost will be adjusted to other EU countries using GDP values <sup>86</sup> .
Flood protection - Grey infrastructure	Cost of strengthening dyke systems and damage reduction measures across whole EU (also UK considered)	3,040 million EUR/year	PPP	Cost data confidence: HIGH Robust, recent data source (JRC) that covers all MS and compliments 'flood protection - green and hybrid infrastructure' and relocation of exposed populations/assets.	Scaling approach confidence: HIGH Costs will be updated from 2020 to 2024 euros. Numbers are provided for each MS so does not require scaling.
Flood protection - Green & Hybrid infrastructure	Cost of creating retention areas for whole EU (also UK considered)	2,458 million EUR/year	PPP	Cost data confidence: HIGH Robust, recent data source (JRC) that covers all MS and compliments 'flood protection - green and hybrid infrastructure' and relocation of exposed populations/assets.	Scaling approach confidence: HIGH Costs will be updated from 2020 to 2024 euros. Numbers are provided for each MS so does not require scaling.
Relocation of exposed population/assets	Costs based of relocation to avoid flooding for whole of EU (also UK considered)	1,282 million EUR/year	PPP	Cost data confidence: HIGH Robust, recent data source (JRC) that covers all MS and compliments 'flood protection - green and hybrid infrastructure'	Scaling approach confidence: LOW Costs will be updated from 2020 to 2024 euros. Numbers are provided for each MS so does not require scaling.

<sup>86</sup> Eurostat. National accounts and GDP. European Commission. Retrieved from [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=National\\_accounts\\_and\\_GDP](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=National_accounts_and_GDP)

				and relocation of exposed populations/assets.	
Flood early warning systems	Approximate annual EU-wide cost of developing and operating the European Flood Awareness System (EFAS):	63.5 million EUR/year	PPP	Cost data confidence MED  JRC report is recent and represents a robust resource, however the EFAS is at a European level and not Member State.	Scaling approach confidence: LOW  Costs will be updated from 2015 to 2024 euros. Scaling will involve allocating the EFAS total to Member States by applying a proportion based on GDP. To account for climate change impacts, the baseline cost is scaled up based on projected increases in flood damages under a 2°C warming scenario using the calculation from the Nature Climate Change paper, 'Cost-effective adaptation strategies to rising river flood risk in Europe' <sup>87</sup> . According to this source, flood damages in Europe are expected to rise from €7.6 billion to €24 billion, representing a 3.16x increase.
Buildings and infrastructure retrofitting	Internal data from Ricardo developed under an European Commission project. Adaptation scope and recent (2024).	6.845 billion EUR/year	PPP	Cost data confidence MED  The sources used for this cost data are consider sufficiently robust to use for modelling.	Scaling approach confidence: MED  Data are available per most of the member states, where data were unavailable we filled the gap by calculating the average cost per building ratio (using EU building stock data per country) and multiplied by the building stock of countries with missing data.
Protection of cultural heritage and historic buildings	The cost covers studies, infrastructure upgrades, climate monitoring systems, policy development, and awareness campaigns to adapt Romania's cultural heritage to climate change.	41.3 million EUR / Year	PPP	Cost data confidence MED  This source was selected as it is the only available national strategy in the EU providing a detailed, costed breakdown of climate adaptation measures specifically targeting cultural heritage.	Scaling approach confidence: LOW  Costs will be converted from 2023 to 2024 euros. This cost will be scaled across EU Member States using GDP ratios.
Legislative and Regulatory Measures	Cost of studies and plans for adapting the built environment to climate change across urban, rural, and economic	0.71 million / year	PPP	Cost data confidence MED  This was the only source available. It is suitable for	Scaling approach confidence: LOW

<sup>87</sup> Dottori, F., Bisselink, B., Naumann, G., Marin Herrera, M.A., de Roo, A., Wyser, K., Betts, R.A., Alfieri, L., & Feyen, L. (2023). Cost-effective adaptation strategies to rising river flood risk in Europe. *Nature Climate Change*, 12, 668–675.

	areas, including public assets, with scenario-based vulnerability and risk assessments.			modelling as the Navarra regional adaptation plan provides a documented, region-specific cost covering staff salaries, monitoring, and legal adjustments, which is related to legislative and regulatory measures.	Costs will be converted from 2017 to 2024 euros. Scaling will be done using population data of the Navarra region and scaling up to national level.
Coastal protection - Grey infrastructure	Annual additional costs required to raise coastal flood defences in Europe to ensure resilience against rising extreme sea levels.	1.75 billion EUR / Year	PPP	Cost data confidence HIGH  Very robust source – a recent academic journal article that covers coastal defence and provides values for all Member States.	Scaling approach confidence: HIGH  Costs will be updated from 2021 to 2024 euros. Numbers are provided for each Member State so does not require scaling.

*Table 24 Overview of economy & finance selected costs and scaling approach*

Adaptation measure(s)	Cost description	Cost	Price adjustment approach	Rationale for selection	Scaling approach
Water demand management, water supply management, water distribution network	Future investment needs to comply with the Drinking Water Directive (DWD) and the Urban Wastewater Treatment Directive (UWWTD) and to enhance the efficiency of their water supply systems (10% reduction of leakages). Most of the expenses are for the sanitation sector.	30,400 million EUR	PPP	Cost data confidence: MED  Cost available for the whole European Union, divided by Member State. Developed by OECD to calculate future investment needs to comply with DWD and UWWTD, publication is recent.	Scaling approach confidence: HIGH  Cost is from 2020 and needs to be adjusted to 2024 euros, 255 euros billion to be spent by 2030. Cost is already available for each EU Member State. No extrapolation needed. To isolate climate adaptation-related costs, the total investment is disaggregated across three clusters and multiplied by a percentage based on OECD and EEA justifications.
Adapting the winter tourism sector to climate change	The cost relates to investments in France to support alpine regions through capacity building and engineering support to develop new service offers.	16.7 million EUR/Year	PPP	Cost data confidence: MED  Cost is nationwide, retrieved from a reliable and recent source. Only cost identified that reflects the measures to be implemented.	Scaling approach confidence: MED  Cost is an annual cost from 2022 and needs to be adjusted to 2024 euros. This cost will be extrapolated to other European countries using the number of ski

					areas in selected countries in Europe in 2020/21 developed by Statista <sup>88</sup> .
Adapting European property and insurance markets to climate change	National budget aims to revise existing financial instruments and design new ones for Climate Change Adaptation and Disaster Risk Management, including for energy efficiency and renovation of buildings in Bulgaria	0.75 million EUR/Year	PPP	Cost data confidence: HIGH  Nationwide cost retrieved from National Adaptation Plan. The source is reliable and recent and closely aligned with the adaptation measures identified to mitigate the risk.	Scaling approach confidence: LOW  Cost is from 2021 and needs to be adjusted to 2024 euros. Already at national level, the cost will be extrapolated to other EU countries using the number of buildings developed before 1989 as a proxy for buildings more exposed to climate risks from the EU Building Stock Observatory <sup>89</sup> .

## Investment need overview per country

The following tables presents the detailed country-by-country tables of estimated annual and net present value (NPV) adaptation investment needs, disaggregated by sector.

*Table 25 Annual investment need per country*

Country	Total (Million €)	Ecosystems (Million €)	Infrastructure (Million €)	Health (Million €)	Food (Million €)	Economy and Finance (Million €)
<b>EU total</b>	<b>68,894 €</b>	20,999 €	28,883 €	6,809 €	11,479 €	724 €
<b>Belgium</b>	<b>1,634 €</b>	221 €	958 €	115 €	311 €	29 €
<b>Bulgaria</b>	<b>591 €</b>	320 €	121 €	95 €	51 €	4 €
<b>Czechia</b>	<b>1,244 €</b>	411 €	583 €	118 €	131 €	1 €
<b>Denmark</b>	<b>1,887 €</b>	907 €	512 €	110 €	351 €	8 €
<b>Germany</b>	<b>9,592 €</b>	2,486 €	4,836 €	763 €	1,408 €	98 €

<sup>88</sup> Statista. Number of ski areas in selected countries in Europe in 2020/21. Retrieved from: <https://www.statista.com/statistics/660925/europe-number-of-ski-areas-by-country/>

<sup>89</sup> EU Building stock observatory. Retrieved from: <https://building-stock-observatory.energy.ec.europa.eu/database/>

<b>Estonia</b>	<b>652 €</b>	315 €	258 €	52 €	25 €	2 €
<b>Ireland</b>	<b>1,680 €</b>	562 €	545 €	140 €	420 €	14 €
<b>Greece</b>	<b>1,940 €</b>	966 €	501 €	170 €	302 €	1 €
<b>Spain</b>	<b>6,970 €</b>	2,929 €	1,706 €	710 €	1,565 €	61 €
<b>France</b>	<b>10,637 €</b>	1,747 €	5,749 €	853 €	2,157 €	131 €
<b>Croatia</b>	<b>885 €</b>	225 €	489 €	107 €	56 €	8 €
<b>Italy</b>	<b>10,083 €</b>	2,128 €	4,533 €	1,430 €	1,846 €	146 €
<b>Cyprus</b>	<b>117 €</b>	36 €	49 €	13 €	18 €	1 €
<b>Latvia</b>	<b>664 €</b>	234 €	361 €	40 €	26 €	2 €
<b>Lithuania</b>	<b>481 €</b>	277 €	97 €	34 €	71 €	2 €
<b>Luxembourg</b>	<b>133 €</b>	21 €	87 €	7 €	16 €	3 €
<b>Hungary</b>	<b>1,399 €</b>	460 €	655 €	129 €	155 €	1 €
<b>Malta</b>	<b>56 €</b>	2 €	35 €	15 €	4 €	1 €
<b>Netherlands</b>	<b>2,517 €</b>	308 €	1,266 €	209 €	729 €	4 €
<b>Austria</b>	<b>1,622 €</b>	465 €	787 €	115 €	230 €	26 €
<b>Poland</b>	<b>3,550 €</b>	1,300 €	1,292 €	373 €	541 €	45 €
<b>Portugal</b>	<b>1,667 €</b>	551 €	497 €	170 €	440 €	10 €
<b>Romania</b>	<b>2,154 €</b>	882 €	631 €	289 €	262 €	90 €
<b>Slovenia</b>	<b>297 €</b>	48 €	172 €	34 €	37 €	6 €
<b>Slovakia</b>	<b>788 €</b>	233 €	453 €	54 €	47 €	0.5 €
<b>Finland</b>	<b>2,096 €</b>	1,281 €	447 €	247 €	112 €	9 €
<b>Sweden</b>	<b>3,556 €</b>	1,684 €	1,263 €	417 €	169 €	24 €

Table 26 Net present value of investment need to 2050 per country<sup>90</sup>

Country	Total (Million €)	Ecosystems (Million €)	Infrastructure (Million €)	Health (Million €)	Food (Million €)	Economy and Finance (Million €)
<b>EU total</b>	<b>1,217,272 €</b>	365,656 €	520,568 €	118,561 €	199,878 €	12,609 €
<b>Belgium</b>	<b>29,244 €</b>	3,844 €	17,473 €	2,008 €	5,414 €	505 €
<b>Bulgaria</b>	<b>10,362 €</b>	5,570 €	2,178 €	1,655 €	892 €	67 €
<b>Czechia</b>	<b>22,265 €</b>	7,153 €	10,751 €	2,060 €	2,286 €	15 €
<b>Denmark</b>	<b>32,888 €</b>	15,798 €	8,943 €	1,910 €	6,104 €	133 €
<b>Germany</b>	<b>170,269 €</b>	43,294 €	87,459 €	13,290 €	24,512 €	1,715 €
<b>Estonia</b>	<b>11,541 €</b>	5,492 €	4,684 €	910 €	429 €	27 €
<b>Ireland</b>	<b>29,371 €</b>	9,784 €	9,604 €	2,441 €	7,306 €	235 €
<b>Greece</b>	<b>33,834 €</b>	16,818 €	8,781 €	2,954 €	5,258 €	23 €
<b>Spain</b>	<b>121,536 €</b>	51,001 €	29,864 €	12,358 €	27,254 €	1,059 €
<b>France</b>	<b>189,564 €</b>	30,420 €	104,456 €	14,850 €	37,561 €	2,276 €
<b>Croatia</b>	<b>15,968 €</b>	3,925 €	9,064 €	1,862 €	979 €	138 €
<b>Italy</b>	<b>177,509 €</b>	37,053 €	80,861 €	24,906 €	32,144 €	2,545 €
<b>Cyprus</b>	<b>2,047 €</b>	631 €	868 €	228 €	309 €	11 €
<b>Latvia</b>	<b>12,063 €</b>	4,083 €	6,785 €	696 €	459 €	40 €
<b>Lithuania</b>	<b>8,474 €</b>	4,818 €	1,796 €	598 €	1,229 €	33 €
<b>Luxembourg</b>	<b>2,356 €</b>	368 €	1,547 €	119 €	279 €	44 €
<b>Hungary</b>	<b>24,700 €</b>	8,004 €	11,739 €	2,239 €	2,695 €	23 €
<b>Malta</b>	<b>970 €</b>	34 €	606 €	258 €	62 €	9 €

<sup>90</sup> Net Present Value is calculated with a 3% discount rate.

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<b>Netherlands</b>	<b>44,029 €</b>	5,366 €	22,251 €	3,633 €	12,702 €	77 €
<b>Austria</b>	<b>28,851 €</b>	8,097 €	14,297 €	2,004 €	3,997 €	456 €
<b>Poland</b>	<b>62,377 €</b>	22,635 €	23,050 €	6,496 €	9,420 €	777 €
<b>Portugal</b>	<b>29,395 €</b>	9,587 €	9,023 €	2,956 €	7,661 €	168 €
<b>Romania</b>	<b>37,907 €</b>	15,352 €	11,390 €	5,036 €	4,569 €	1,559 €
<b>Slovenia</b>	<b>5,336 €</b>	828 €	3,156 €	598 €	651 €	104 €
<b>Slovakia</b>	<b>13,957 €</b>	4,061 €	8,129 €	947 €	812 €	8 €
<b>Finland</b>	<b>36,930 €</b>	22,313 €	8,217 €	4,295 €	1,956 €	148 €
<b>Sweden</b>	<b>63,531 €</b>	29,328 €	23,598 €	7,255 €	2,937 €	413 €

## Investment need overview per measure

The table below presents a breakdown of adaptation investment needs by individual measure, including annual cost estimates, cumulative net present value to 2050, and the share of each measure relative to total EU needs.

Table 27 Net present value of investment need to 2050 per country

Sector	Cluster / measure	Annual cost (million €)	Cost Net Present Value to 2050 <sup>91</sup> (million €)	% over total as
Ecosystems	Adaptive forest management	995 €	17,329 €	1.4%
Ecosystems	Early Monitoring System for Pest and Disease Outbreaks in Forests	186 €	3,237 €	0.3%
Ecosystems	Invasive species (non native-plants and insects) management	184 €	3,206 €	0.3%
Ecosystems	Soil Restoration and Management	7,952 €	138,472 €	11.5%
Ecosystems	Soil Pollution prevention and control	2,079 €	36,207 €	3.0%
Ecosystems	Dune restoration	51 €	890 €	0.1%
Ecosystems	Saltmarsh restoration	1,201 €	20,910 €	1.7%
Ecosystems	Coastal management - green & hybrid	2,614 €	45,516 €	3.8%
Ecosystems	Grassland maintenance and restoration	935 €	16,281 €	1.4%
Ecosystems	Heath, steppe & scrub restoration	14 €	240 €	0.02%
Ecosystems	Peatlands & marshlands restoration	172 €	2,992 €	0.2%
Ecosystems	Freshwater system restoration	6 €	101 €	0.01%
Ecosystems	Enhanced habitat connectivity, including creation of buffer zones, ecological corridors and refuges	1,287 €	22,410 €	1.9%

<sup>91</sup> Net Present Value is calculated with a 3% discount rate.

Ecosystems	Pollinators	1,241 €	21,602 €	1.8%
Ecosystems	Wildfire prevention	2,058 €	35,830 €	3.0%
Ecosystems	Management of invasive alien species	28 €	488 €	0.04%
Infrastructure	Improved energy assets and Diversification of energy systems	820 €	14,282 €	1.2%
Infrastructure	Improved cooling efficiency for energy systems (cooling towers or air coolers in power plants to maintain efficiency during heatwaves)	519 €	9,039 €	0.8%
Infrastructure	Resilient Maritime and Transport Systems	1,257 €	21,881 €	1.8%
Infrastructure	Strengthen road and rail network	2,514 €	43,774 €	3.6%
Infrastructure	Reduced criticality	2,026 €	35,278 €	2.9%
Infrastructure	Flood protection - Grey infrastructure	3,387 €	58,971 €	4.9%
Infrastructure	Restoration of natural floodplains	2,886 €	49,913 €	4.2%
Infrastructure	Relocation of exposed population/assets	1,300 €	22,642 €	1.9%
Infrastructure	Flood disaster response	7 €	123 €	0.01%
Infrastructure	Retrofitting of existing building and infrastructure	6,845 €	119,198 €	9.9%
Infrastructure	Protection of cultural heritage and historic buildings	3,797 €	66,126 €	5.5%
Infrastructure	Land use planning (including construction laws and permits)	553 €	9,623 €	0.8%
Infrastructure	Coastal protection - Grey infrastructure and coastal zone management	2,922 €	69,717 €	4.2%
Health	Urban Cooling and Infrastructure Resilience - Green & Hybrid	429 €	7,470 €	0.6%

Health	Improving cooling in public transport systems	136 €	2,362 €	0.2%
Health	Prevention of infectious diseases	160 €	2,789 €	0.2%
Health	Wildfire early warning systems	164 €	2,858 €	0.2%
Health	Wildfire disaster response	1,247 €	21,715 €	1.8%
Health	Organisational measures for occupational health and safety	2,391 €	41,633 €	3.5%
Health	Upgrade wastewater treatment facilities	1,635 €	28,472 €	2.4%
Health	Nutrient reduction initiatives (agricultural best practices)	470 €	8,188 €	0.7%
Health	Real-time water quality monitoring systems (freshwater and marine ecosystems)	6 €	108 €	0.01%
Health	Training of health professionals in disaster management	19 €	323 €	0.03%
Health	Early warning systems for health risks	101 €	1,759 €	0.1%
Food	Climate smart agriculture and financial support	7,749 €	134,926 €	11.2%
Food	Adaptive fisheries management	1,130 €	19,678 €	1.6%
Food	Fisheries innovation	130 €	2,266 €	0.2%
Food	Incentives and subsidies for sustainable food consumption	21 €	360 €	0.03%
Food	Incentives and subsidies for sustainable food production	148 €	2,578 €	0.2%
Food	Climate-proofing barns (shades, cooling, water supply) - livestock infrastructure	1,218 €	21,202 €	1.8%
Food	Development of heat-tolerant livestock breeds	1,084 €	18,868 €	1.6%
Economy and Finance	Development of year-round tourism offerings	80 €	1,391 €	0.1%

Economy and Finance	Insurance programs and risk management strategies (tailored for different sectors agri, industry ...)	46 €	803 €	0.1%
Economy and Finance	Water demand management	187 €	3,248 €	0.3%
Economy and Finance	Water supply management	133 €	2,320 €	0.2%
Economy and Finance	Water distribution network	278 €	4,848 €	0.4%
Cross cutting measures		195 €	3,387 €	0.3%
Cross cutting measures		63 €	1,091 €	0.1%

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