Reflection paper for EUCRA-2

Authors:

Marc Zebisch (Eurac Research), Veronica Casartelli (CMCC), Robert Biesbroek (Wageningen University), Silvia Cocuccioni (Eurac Research), Frederique Kirkels (PBL), Richard Klein (SEI), Mikael Mikaelsson (SEI), Johan Munck af Rosenschöld (SYKE), Jaroslav Mysiak (CMCC), Simona Pedde (Wageningen University), Anna Pirani (CMCC), Massimiliano Pittore (Eurac Research)

European Environment Agency
European Topic Centre
Climate change and adaptation
and LULUCF

Cover design: EEA
Cover image © EEA
Layout: Silvia Cocuccioni, Eurac Research

Publication Date: July 2025

EEA activity: climate change mitigation and adaptation

ETC-CA coordinator: Fondazione Centro Euro-Mediterraneo sui Cambiamenti Climatici (CMCC)

ETC-CA partners: Barcelona Supercomputing Centre, Climate-KIC Holding B.V., Climate-Alliance, Environment Agency Austria, European Academy of Bozen-Bolzano, Fresh-Thoughts Consulting GmbH, Istituto Superiore di Sanita, PBL Netherlands Environmental Assessment Agency, Plan Bleu for the environment and the development in the Mediterranea,n Stiftelsen The Stockholm Environment Institute (with its affiliated entity SEI Oxford Office Ltd), Finnish Environment Institute, Thethis S.p.A., Vlaamse Instelling voor Technologisch Onderzoek, Stichting Wageningen Research, Wageningen Environmenal Research.

doi: https://doi.org/10.25424/cmcc-2y5q-z607

European Topic Centre on
Climate change adaptation and LULUCF
https://www.eionet.europa.eu/etcs/etc-ca

Contents

Acknowledgements

This reflection paper has greatly benefited from the contributions and discussions with representatives from the EEA and DG CLIMA, whose valuable insights helped clarify expectations and needs for a second EUCRA.
The authors are also grateful to the representatives of the JRC and ECMWF for their active and thoughtful contributions to the drafting of this paper

Summary

This reflection paper supports the early scoping of the second European Climate Risk Assessment (EUCRA-2). It builds on the direct experience and lessons learned by the authors, who were part of the core team that developed the first EUCRA (EUCRA-1). The paper was informed by a series of expert discussions between January and May 2025, including an in-person workshop at the EEA in Copenhagen. The document incorporates input from the Joint Research Centre (JRC), ECMWF, and insights from informal consultations by DG CLIMA. Aimed primarily at the EUCRA-2 Steering Group, it explores the policy context, scope, methodology, and potential chapter structure of EUCRA-2, while stressing continuity with EUCRA-1 and alignment with relevant international, EU and national initiatives. Although not a substitute for formal scoping by the EEA, DG CLIMA, and EUCRA-2 project partners, it offers preliminary reflections and suggestions to inform the future process.

1 Introduction

This reflection paper was drafted under **ETC-CA Task 2.3.2** and is the result of a series of online meetings held between January and May 2025, and an in-person workshop held at the EEA premises in Copenhagen on 4th-5th March 2025. All authors have been part of the core team that developed the methodology for EUCRA-1. Additionally, representatives from the **JRC** and **ECMWF** were invited to the workshop in Copenhagen and provided valuable input for the drafting of this document. The reflection included in this paper builds upon the experience gained by the authors during the development of EUCRA-1 and on lessons learned that were discussed afterwards. This paper may provide useful input and inspiration for a EUCRA-2 process but cannot replace a proper scoping by EEA, DG CLIMA and the project team of EUCRA-2.

The primary **audience** for this reflection paper is the Steering Group of EUCRA-2, which includes the EEA and selected Directorate-Generals (DGs) of the European Commission.

While drafting this reflection paper, the authors took into consideration insights from a **preliminary informal consultation** conducted by DG CLIMA within the European Commission, to gather views on the expected relevance and use of EUCRA-2 for its target audiences.

This document is structured as follow: Chapter 2 puts EUCRA-2 in the context of current policy developments at the European level, outlining the need for a second EUCRA; Chapter 3 reflects on the scope of EUCRA-2, while also stressing the link with EUCRA-1 and other key related initiatives at the EU/national scale; Chapter 4 describes the key suggested design parameters for EUCRA-2, clarifying the overall approach, the methodology underpinning the assessment, and suggesting the potential workflow and process; Chapter 5 includes a potential chapter structure of EUCRA-2 with key contents for each section. An Annex provides a list of potential knowledge sources that could inform the EUCRA process.

2 EU policy context and priorities: the need for a second EUCRA

In today's rapidly evolving risk landscape and complex political context, having comprehensive risk assessments at the European level is crucial for understanding major current and emerging threats, and for anticipating and preparing for future challenges. Here, we outline several key policies that might be significant to EUCRA-2, acknowledging that this list cannot be exhaustive.

The **Political Guidelines 2024-2029** for the European Commission, published in July 2024, clearly emphasize that *there is no discussion about preparedness (to deal with disasters and disruptions) without talking about climate resilience.* Furthermore, resilience to climate risks is an essential pillar of Europe's overall economic security and the anticipated European Climate Adaptation Plan based on "regular science-based risk assessments".
Following her election as President of the EC, Ursula von der Leyen asked six Commissioners, under the leadership of Wopke Hoekstra, Commissioner for Climate, Net Zero and Clean Growth, to work together on developing the European Climate Adaptation Plan. specifically mentioning EUCRA as an important input.

The **Niinistö report**, published in October 2024, underscores the urgent need for a comprehensive, EU-wide risk assessment to effectively manage risks, anticipate crises, and safeguard European citizens. It emphasizes the importance of moving beyond fragmented, sector-specific approaches by calling for an all-hazards, all-threats risk assessment that spans all sectors of EU activity. In addition, the report advocates for the integration of future scenario- based risk assessments to improve crisis preparedness. By anticipating potential external shocks and crisis, the EU can inform strategic policy development. This proactive, scenario-driven approach would strengthen EU resilience.

The **EU Preparedness Union Strategy (2025)**, built on the **Disaster Resilience Goals** (2023/C 56/01) and launched on March 27th, 2025, aims to enhance Europe's capacity to prevent, prepare for, and respond to current and future challenges. The Strategy includes 30 key actions and a detailed Action Plan to advance

the Preparedness Union's objectives. Among key objectives and actions, the Strategy outlines the need for improving foresight and anticipation capabilities, calling for an integrated assessment of risks, threats and of their cascading effects, including from outside the Union. A cross-sector and all-hazard EU-level comprehensive risk assessment, based on evidence and informed by scientific advice, is needed to provide actionable insights for decision-making. Lately, JRC presented its report "Analysis of Risks Europe is facing"[1] that is responding to this request.

Building on EUCRA-1, a European Climate Adaptation Plan will be presented to strengthen the resilience of the Union and support Member States in preparing for climate risks. The Plan will embed 'preparedness by design' across relevant EU sector policies and investments and support people, business and policymakers using common climate reference scenarios.

Considering these developments, there is a clear **need to develop a second European Climate Risk Assessment (EUCRA-2)**. This new assessment will complement ongoing risk and resilience activities, including the Comprehensive risk assessment announced in the PUS, by focusing on climate-related risks with a comprehensive all-system approach and by extending the time horizon until the end of the century and beyond to understand and address systemic climate risks and response that require a long time frame (e.g. spatial development, infrastructure design, forestry).

By aligning with the objectives set out in the Political Guidelines 2024–2029, and the EU Preparedness Union Strategy, EUCRA-2 can serve as a cornerstone for embedding climate resilience at the core of EU decision-making—providing a comprehensive assessment and actionable insights directly linked to the Union's strategic priorities to effectively inform policies. Furthermore, EUCRA-2 could support future updates of the upcoming **Climate Adaptation Plan**, ensuring it addresses all major risks and effectively prioritises urgent actions.

3 EUCRA-2: reflections on scope and link to other ongoing initiatives

This chapter summarizes and reflects on the character and potential objectives of an EUCRA-2 as an output of the discussion between the EEA, the ETC-CA team and preliminary discussions with DG CLIMA (see Chapter 1). How this overall character could be translated into key design parameters of an EUCRA-2 is described later in Chapter 4.

Scope of a second EUCRA and link with EUCRA-1

EUCRA-2 should remain both a **scientific and independent assessment report** (as for EUCRA-1) and, at the same time, be designed to inform integrated EU policy making, given the complexity and interconnectivity of many of the risks and related responses. It should be finalised and published in the second half of 2028 with the aim of informing the next EU policy cycle. The **main objective** of EUCRA-2 should remain focusing on assessing and evaluating climate-related risks, along with risk governance and policy gaps that require action at the European or transnational level. As such, EUCRA-2 should provide actionable yet non-prescriptive recommendations to support evidence informed decision-making, the EU Preparedness Union strategy implementation and future updates of the upcoming European Climate Adaptation Plan.

EUCRA-1 was the first fast-track attempt ever to develop a climate risk assessment at the European level and was widely recognised as a success. The report had a significant impact, generating strong interest across the European Commission's services and the EU countries for the development of EUCRA-2.

While EUCRA-1 introduced novel approaches and methodologies delivering valuable insights to inform policies across various sectors, it also had some limitations both in its methodological approach and analytical depth, mainly due to time constraints. Furthermore, the fast-evolving EU political landscape now demands an assessment that addresses a broader spectrum of risks and policy areas (see Chapter 2). In this document, we refer to a "policy area" as a distinct subsystem governed by relevant policies.

[1] https://publications.jrc.ec.europa.eu/repository/handle/JRC141673

Examples of policy areas include agriculture and food security, health and health infrastructure, and social aspects.

EUCRA-2 therefore offers an excellent opportunity to refine and enhance the EUCRA-1 framework, delivering more targeted policy-relevant suggestions to guide the EU towards a more-resilient future. Rather than starting from scratch or replicating EUCRA-1, EUCRA-2 should introduce key improvements, such as:

- Adopt a more **effective structure to enhance the usability** of results for policymakers and provide clear, actionable recommendations;
- **Expand risk and policy coverage** to address EU current needs and emerging challenges, including risks from outside Europe, tail risks and high impact-low probability (HILP) events or outcomes;
- **Revisit the approach** for conducting risk assessment and policy analysis, while ensuring that the overall methodological approach remain consistent;
- **Strengthen the policy analysis** component, with a focus on translating findings into practical guidance for decision-makers.

Link to other relevant climate and disaster risk assessments

In the current poly-crisis landscape, EUCRA-2 represents an opportunity to take stock and integrate key insights from other relevant climate and disaster risk assessment initiatives conducted at the global, transnational, pan-European and national scales. There is a scope for a cross-fertilisation of approaches and results, while also promoting consistency and coherence, thus facilitating uptake across sectors and scales. Below some of the key initiatives at the EU and national levels.

Scenario building initiative (Dec.1313/2013, art.10): led by the Directorate-General for European Civil Protection and Humanitarian Aid Operations (DG ECHO) under the Union Civil Protection Mechanism (UCPM) framework, is a strategic effort aimed at strengthening the EU preparedness through the development of complex, cross-border risk scenarios designed to challenge and further improve the UCPM itself. The scenarios already developed, not publicly available, are exploratory in nature, and focus on cross-sectoral, multi-country and reasonably- worst-case disasters. This initiative support DRM planning, cross-sectoral cooperation, and crisis anticipation across the EU. Despite differences in scope and methodology, EUCRA-2 could take these scenarios into account as an additional source of information. Conversely, future updates of these scenarios could also reflect the findings of EUCRA-2 to ensure consistency and coherence.

Overview of natural and man-made disaster risks in the EU (series): commission staff working papers that serve as an overview assessing natural and human-induced disaster risks that the European Union may encounter. Prepared within the framework of the UCPM legislation, these documents explore ongoing trends in the evolving disaster risk landscape, examine the key factors influencing these developments, and provide a detailed analysis of specific disaster risks that are particularly significant for Europe. Additionally, they evaluate the implications of these risks for risk management practices. The overview draws heavily from the national disaster risk assessments submitted by EU Member States and Participating States in the UCPM. It also incorporates the most recent evidence from the European Commission's own cross-sectoral policy, scientific, and operational activities related to disaster risk. The goal of these documents is to build a solid understanding of the disaster risks facing Europe's population and to support informed decision-making in risk management, with the intention of reducing potential loss of life and minimizing damage. EUCRA-2 could take into account future updates of this summary document to ensure that relevant elements emerging from National Risk Assessments inform the overall analysis.

Strategic foresight reports and risks on the horizon foresight study (JRC): developed by the European Joint Research Council (JRC), these reports analyse emerging trends and risks, offering valuable insights to help shape the EU's strategic priorities[2]. Harnessing collective intelligence to explore and anticipate

[2] https://knowledge4policy.ec.europa.eu/foresight_en

potential future developments is essential for recognizing upcoming shocks and opportunities, and for informing effective policymaking. EUCRA-2 could consider results of strategic foresight reports as a key source to inform the assessment and, in turn, EUCRA-2 should inform future strategic foresight reports. EUCRA-2 could improve linkages between foresight reports and the IPCC approach with SSPs (Shared Socioeconomic Pathway).

JRC PESETA/TRACE Program: carried out by the European Commssion's Joint Research Centre (JRC), the PESETA research project has been running since 2006 and aims at better understanding the scale and distribution of climate risks in Europe, providing a science-based, quantitative multi-risk assessment for a set of specific risks. The latest and ongoing PESETA V project is also known as TRACE[3] (Territorial Risk Assessment of Climate in Regions of Europe). TRACE's preliminary results are already available and provide additional information on temperature-related mortality, impacts on tourism and labour productivity, as well as transport infrastructure. Project results will be progressively published in the JRC Risk Data Hub and the Urban Data Platform. These products could efficiently support the policy-oriented analysis.

National Climate Risk Assessments (CRAs): most European countries have conducted their own CRAs as part of their national adaptation planning. In an ongoing exchange with national agencies organized by EEA and EIONET, many countries expressed their interest to integrate EUCRA risk assessments methods in national CRAs where appropriate and to inspire EUCRA-2. This process may include an exchange on key risks identified. EUCRA-2 can benefit from this exchange and contribute to a potential harmonisation of CRA approaches within Europe.

Sectoral risk assessments: risk assessment conducted by countries under sectoral policies implementation (e.g. the Floods Directive, the WFD, and the CER) could be considered while developing EUCRA-2 to the extent possible.

EU comprehensive risk assessment (upcoming): a comprehensive EU-level risk and threat assessment is identified as a key action under *Area 1 – Foresight and anticipation* of the EU Preparedness Union Strategy and is expected to be published by 2026 (see Annex). EUCRA-2 could take into account the results of this upcoming assessment to ensure that all major risks are considered and to promote consistency and coherence. In preparation, the JRC has published in June 2025 its report *Analysis of Risks Europe is facing*.

EU projects on climate risk and adaptation: several research and innovation projects funded under the EU's Horizon Programme, including projects directly supporting the EU Mission on Adaptation to Climate Change, have developed innovative risk assessment methodological frameworks, tools and data that could inspire the EUCRA-2 scoping process. Relevant projects include for instance CLIMAAX [4] Pathway2Reslience[5], Myriad-EU[6], CASCADE[7].

Links to international assessments: the IPCC AR7 and MedECC MAR2

The timeline for the development of EUCRA-2 is aligned with that of the IPCC Seventh Assessment Report (AR7). Furthermore, EUCRA-2 could be aligned with other upcoming regional assessments such as the MedECC Second Mediterranean Assessment Report (MAR2).

IPCC AR7

In April 2025, the IPCC launched its call for authors for the Working Group reports, with first lead authors' meeting expected for December 2025. The publication of AR7 is expected in 2028, though the dates are still to be confirmed by the IPCC Plenary. The published outline for AR7 (a result of the AR7 scoping

[3] https://joint-research-centre.ec.europa.eu/projects-and-activities/peseta-climate-change-projects-0
[4] https://www.climaax.eu/
[5] https://www.pathways2resilience.eu/
[6] https://www.myriadproject.eu/
[7] https://www.cascades.eu/

process) was already used for this reflection paper as a reference to align EUCRA-2 as far as possible with IPCC AR7[8] **EUCRA-2 can be designed to provide complementary insights** to the IPCC Europe chapter, avoiding overlap and redundancy, **while** enhancing synergy in terms of the respective report scopes. **A close** coordination between IPCC AR7 (especially the WGII Europe chapter authors) and EUCRA-2 team is hence recommended. Harmonizing their content could enhance scientific consistency, policy relevance, and efficiency, while enabling shared use of evidence and methodologies. However, important differences in mandate, scope, timing, and target audiences should be respected. EUCRA-2's policy-oriented, EU-specific focus allows for greater granularity and flexibility, whereas IPCC assessments follow a more formalized, globally negotiated processes. The IPCC provides a robust formalisation of key concepts, such as the framework to assess climate risk, as defined in the IPCC Glossary, and the use of calibrated terms to quantify the robustness and confidence in the assessment. EUCRA-2 should continue to build on these concepts, definitions and harmonised approaches. Messaging of key assessment findings between EUCRA-2 and IPCC AR7 should also be consistent to avoid confusion and ensure clear information is communicated across policy and scientific audiences.

Efforts should be made to foster regular informal exchanges between the author teams, including individuals contributing to both reports. In addition, involving the IPCC WGII leadership in an advisory capacity for EUCRA-2 would be highly beneficial. Similarly, EUCRA-2 authors should be invited to participate at all relevant stages in the preparation of the IPCC AR7 Working Group II Europe chapter, including in early informal draft review of the chapter. They could also participate the formal First Order Draft (FOD) and Second Order Draft (SOD) reviews of the chapter. This is to ensure a consistent assessment, particularly the characterisation of the drivers of risk, key risks, compound, cascading, transboundary and residual risks in future climate change scenarios and different levels of global warming.

MedECC MAR2

The preparatory work for the MAR2 was launched early this year. The scoping phase took place in April 2025, with 2 online meetings with around 60 experts aiming at laying the foundation of the development of MAR2. The draft outline of the report is currently being finalised, and the authors' appointment process is underway, with drafting expected to begin in Fall 2025 The final report is scheduled for publication at the end of 2027, with the overall development timeline aligned with EUCRA-2. The report will assess the drivers of climatic and environmental change in the Mediterranean, the impacts and risks to natural and human systems, adaptation and mitigation, including enablers, policies, governance, economic instruments and finance, and will synthesise the findings to inform transformative and sustainable future pathways.

Similarly to IPCC AR7, coordination is recommended with the MAR2 process to ensure that key messages are consistent. Also, regular mutual exchanges between authors involved in the two processes, including via informal meetings and soliciting participation in the review processes will be important, as insights from one can inform the other.

4 EUCRA-2: key design parameters and methodological approach

The **key design parameters** proposed for EUCRA-2 are outlined below. This chapter provides reflections and recommendations regarding the overall design and process, geographical scope, and coverage of risks and policy areas.

EUCRA-2 should present an effective **structure** to deliver results more directly usable for policy makers in the European Commission, in line with the need for greater "plug and play" applicability, without losing its cross-cutting risk assessment approach. Chapter 5 outlines a potential chapter structure, including

[8] https://www.ipcc.ch/site/assets/uploads/2025/03/Decision-8-Working-Group-Outlines.pdf

main contents for each section.

Overall risk framework

The overall risk framework should be based on the well-established IPCC and UNDRR concepts of risk. According to the IPCC, risk is defined as *the potential for adverse consequences for human or ecological systems* (…). *In the context of climate change impacts, risks result from dynamic interactions between climate-related hazards with the exposure and vulnerability of the affected human or ecological system to the hazards*[9]. The IPCC definition of risk also includes the potential for risk that can result from human responses to climate change. The more general definition of UNDRR of Disaster risk includes as a fourth component "capacity"[10], which is integrated into vulnerability ("lack of capacity", see Figure 1 and discussion below) in the IPCC concept.

Already for EUCRA-1 the IPCC framework was expanded by introducing the concept of non- climatic (underlying) risk drivers (NCRDs). The concept of underlying risk drivers is adopted from the DRR world and is expressing *processes or conditions (…), that influence the level of risk by increasing levels of exposure and vulnerability or reducing capacity*[11]. EUCRA-1 identified as relevant underlying risk drivers processes such as degradation of ecosystems due to intensive land-use, environmental pollution, wild/unplanned urbanisation or (increasing) economic and social disparity. Underlying risk drivers can often be influenced and mitigated by European policies and are therefore an important entry point to reduce climate risks.

Both, capacities and underlying non-climatic risk drivers are an important link to the policy analysis, that could help to focus on how policies can reduce non-climatic risk drivers, enhance capacity and increase resilience of European ecological and human systems.

There are some open discussions on this framework and its terminology that have to be solved in the scoping phase.

- There is incoherence in the terminology of climatic risk drivers. In the risk logic, the direct trigger of an adverse consequence is called a "hazard". IPCC AR6 WG1 introduced the new term climatic-impact driver (CID) for any physical climate condition that directly affects society or ecosystems. The intention was to express that any impact can be beneficial, neutral or harmful. The IPCC suggest that a CID which is mainly detrimental to a specific system can be called a "hazard"[12]. From a risk logic, the term "climate- related hazard" would be therefore more suitable. For the sake of simplicity, in this reflection paper we refer to "CIDs" when referring to climatic impact drivers / climatic risk drivers / climate-related hazards.
- The question, if "capacity" is treated as separate from vulnerability (ref. UNDRR), or if capacity is integrated as "lack of capacity" into the vulnerability concept. This decision is more a strategic than a scientific one. The national risk assessment for Germany[13] explicitly addresses adaptive capacity as separate from vulnerability (here called sensitivity) to stress the importance for policy making of this aspect.
- The IPCC AR6 (although inconsistent throughout the reports) proposed a new element of climate risk related to responses as a fourth "propeller leaf". While we agree on the relevance of considering the risks related to responses and recommend treating these risks explicitly in EUCRA (e.g. economic impacts of building insulation on tenants), we recommend treating risk due to "responses" separately from climate risk itself.
- The IPCC (for instance in its burning ember representation) is differentiating future risks based on adaptation levels (e.g., low, medium, high) with an approach that is not yet fully consistent. To apply such an approach in the context of EUCRA would need more development effort, including

[9] https://apps.ipcc.ch/glossary/
[10] https://www.undrr.org/drr-glossary/terminology
[11] https://www.undrr.org/terminology/underlying-disaster-risk-drivers
[12] https://www.ipcc.ch/report/ar6/wg1/downloads/faqs/IPCC_AR6_WGI_FAQ_Chapter_12.pdf
[13] https://www.umweltbundesamt.de/publikationen/KWRA-English-Summary

methodological enhancement and analysis of different adaptation options and their effectiveness. For the sake of simplicity, in the fast-track approach of EUCRA-1, risk severity was implicitly understood as "low level adaptation". Furthermore, the current state of policy readiness was taken explicitly into account. For EUCRA-2, it would be necessary to discuss if and how the effect of adaptation levels on risk severity would need to be considered, which would require additional planning and effort. This discussion ties into the "limits of adaptation" topic, addressing the scope for adaptation and critical thresholds beyond which adaptation is not possible. This discussion is not covered in this reflection paper but should be addressed with EEA, DG CLIMA, and the author team during the EUCRA-2 scoping phase.

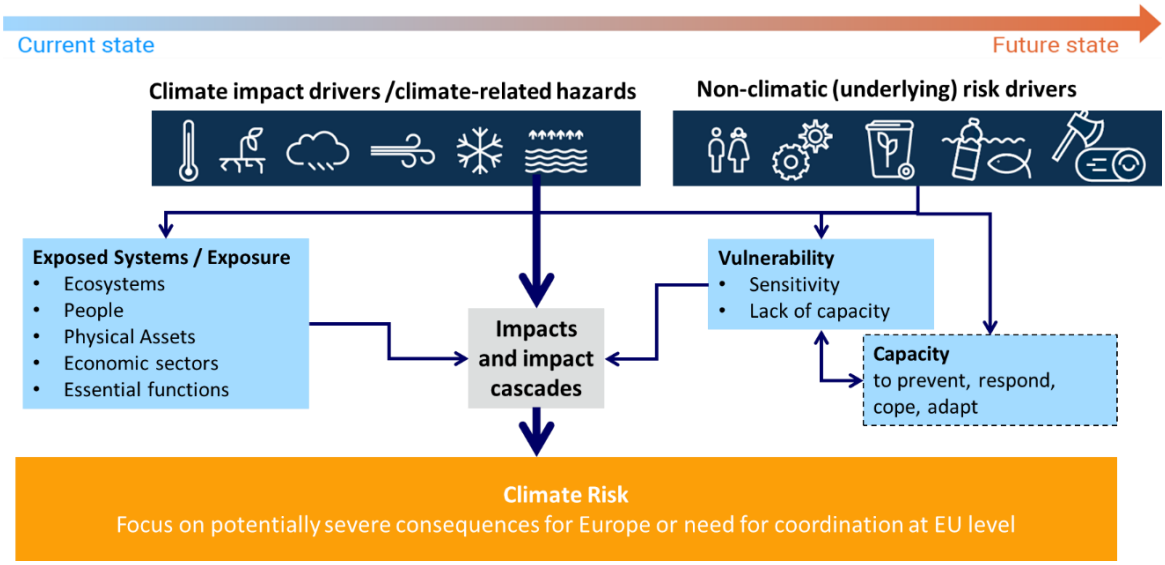

Figure 1 Risk framework proposed for EUCRA-2, based on the risk framework in EUCRA-1

Potential workflow

We recommend keeping the overall approach of EUCRA-1 that is in line with the respective ISO- Norms[14], the IPCC risk concept and international guidelines[15]. This was perceived as useful by DG CLIMA and other EC and national policy makers. The ISO approach implies the established sequence of a) risk identification b) risk analysis and c) risk evaluation as the three major steps of risk assessment. In EUCRA-1, the quantitative and qualitative description of climatic and non-climatic risk drivers was organised as separate step to inform the risk analysis across themes and storylines.

Keeping the general workflow would ensure a consistent and sustainable scheme that can be repeated over time. Figure 2 shows the original workflow of EUCRA-1 for a structured risk assessment with some remarks (yellow notes) on what might be improved.

[14] https://www.iso.org/standard/65694.html; https://www.iso.org/standard/68508.html
[15] https://www.undrr.org/media/79566/download; https://www.adaptationcommunity.net/climate-risk-assessment-management/climate-risk-sourcebook/

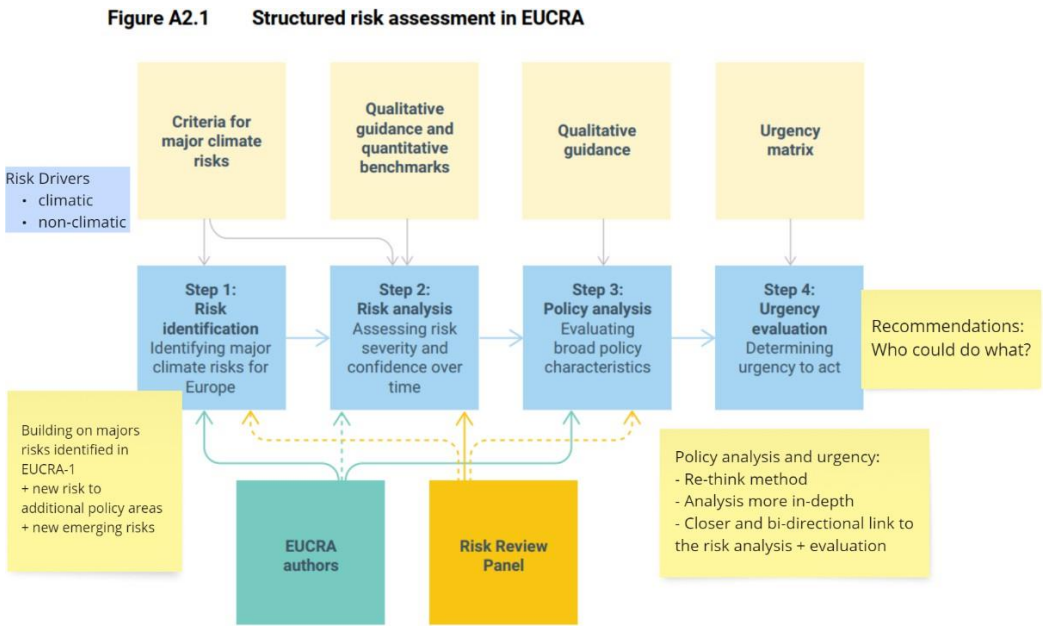

Figure 2: Risk assessment scheme from EUCRA-1 with major remarks on what should be improved.

Considering the proposed innovations and key design parameters for EUCRA-2 as well as the potential chapter structure (Chapter 5), a workflow for EUCRA-2 might improve the integration of risk drivers as well as the policy analysis into the workflow for the risk assessment.
Furthermore, before or parallel to the risk assessment per policy area, we recommend working on a risk analysis across systems including outside-in risks in the background. As "outside-in risks" we understand cross-border climate risks emanating from outside the EU's borders. This background analysis could be supported by impact chains as conceptual models to capture interlinkages between risk drivers across systems and ontological databases to store these conceptual models. This consistent background analysis would serve as a basis for the detailed risk analysis per policy area and could be updated by the results of the latter in defined feedback loops and inform the chapter on risks across policy areas. The background analysis would be the basis for a chapter on "key risks across systems and policy areas".

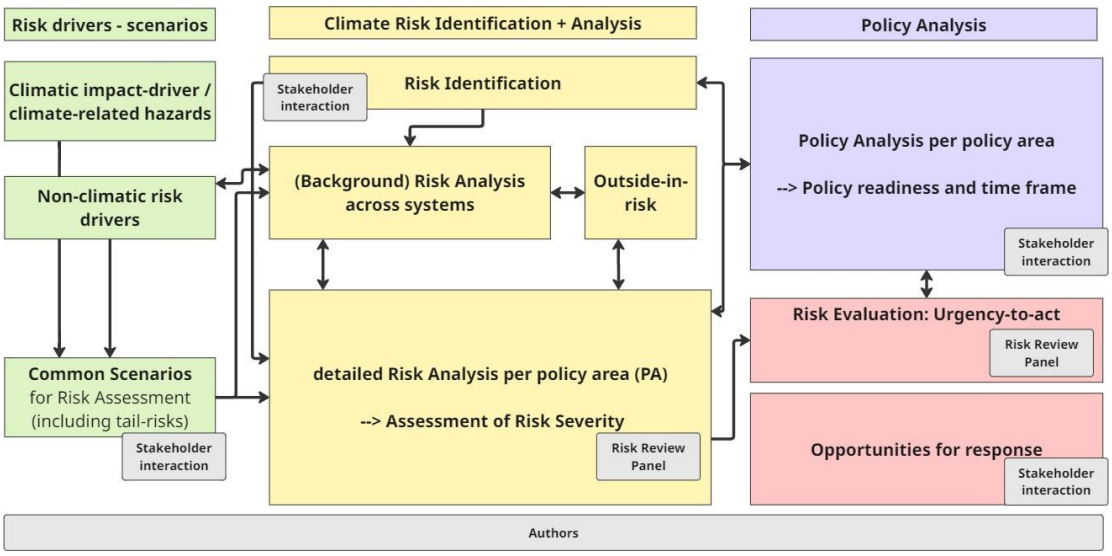

Figure 3: Potential workflow for EUCRA-2 and role of EUCRA actors

Further consequences of this integrated workflow are as follows:

- a timelier provision of the risk drivers chapter (which was provided in EUCRA-1 only in the second half of the project).

- a feedback loop from the risk analysis process to the risk driver analysis, including a co-development of appropriate information (including climate indicators) with the risk assessment team. Here, an analysis of risk drivers identified in the EUCRA-1 risk analysis could be a useful starting point.
- a deeper and timely integration of the policy analysis into the risk assessment (see two options in the "Policy Analysis" sub-chapter below).
- a deeper and explicit integration of actors.

Key information sources

EUCRA-2 should build largely on the available scientific knowledge base, integrating quantitative and qualitative knowledge sources and involving expert judgement and stakeholder processes. Similar to the IPCC, the risk assessment should be based on an assessment of existing scientific literature, reports from European projects and other initiatives (see also chapter 3 and in particular the "Link to other relevant climate and disaster risk assessments" sub-chapter).

Compared to EUCRA-1, we propose to increase the level of consistent, data-based evidence in EUCRA-2 as far as possible and link this more closely to the risk assessment chapter by extending data-based approaches for risk drivers (climatic and non-climatic) as well as for climate impacts (e.g. by providing data on observed impacts and models of potential future impacts). However, a good balance with more qualitative evidence and approaches for the many aspects of climate- related risks that are not sufficiently covered with quantitative information should be kept.

Impact chains, as developed in EUCRA-1, could serve as consistent architecture for knowledge representation of the risk component, be implemented in an ontological database and serve as blueprints for model architecture. A consistent integration of quantitative and qualitative evidence through authors and experts (risk review panel) remains the preferred method for the risk analysis and the risk evaluation.

Data-driven key information sources which could support the development of EUCRA-2 include a range of existing European and global platforms which provide access to both data as well as to knowledge and information. Furthermore, the European Climate Data Explorer[16] (ECDE), the Climate Data Store[17] (CDS), the C3S Atla[18]s, and the ERA Explorer[19], all provided by ECMWF under the Copernicus Climate Change Service, offer interactive access to high-quality climate data, indices, and projections. More recently, ECMWF has also been implementing key components of the European Commission's Destination Earth (DestinE) initiative, notably the Digital Twins on Climate Change Adaptation and on weather-induced Extremes[20]. Additionally, CEMS[21] delivers operational hazard data for real-time risk assessment.

Furthermore, internationally coordinated activities and data sets should be taken into account. This includes the Climate Model Intercomparison Project, with the latest, 7th phase[22] (CMIP7) underway with a 'Fast Track' being coordinated and implemented for delivery in time for the AR7, with climate change projections available by 2027. The CORDEX[23] community will be implementing a flagship activity to downscale CMIP7 simulations, including dynamical and ML emulated downscaling. The Inter-Sectoral Model Intercomparison Project[24] (ISIMIP) is preparing CMIP7-driven simulations with and without adaptation and taking into consideration climate change and 'direct human forcings' in high resolution (10km).

---

[16] https://climate-adapt.eea.europa.eu/en/knowledge/european-climate-data-explorer/
[17] https://cds.climate.copernicus.eu/
[18] https://atlas.climate.copernicus.eu/atlas
[19] https://era-explorer.climate.copernicus.eu
[20] https://destine.ecmwf.int
[21] https://emergency.copernicus.eu/
[22] https://cordex.org/strategic-activities/taskforces/task-force-on-preparation-of-cordex-cmip7/
[23] https://www.isimip.org/
[24] https://cordex.org/strategic-activities/taskforces/task-force-on-preparation-of-cordex-cmip7

Other sources can contribute to the other chapters of EUCRA-2. For example, the DRKMC-Risk Data Hub[25] offers detailed geospatial data on exposure and historical impacts across Europe and INFORM Climate Change[26] provides a future-oriented risk index combining climate and socio- economic factors. ECMWF has been collaborating with stakeholders like the European Investment Bank (EIB) for climate hazard assessments, and the European Central Bank to utilize climate projections for risk quantification. Additionally, they are working with the European Network of Transmission System Operators Electricity (ENTSO-E) for planning purposes. These activities could inform quantitative risk assessments under EUCRA-2.

Together, these tools cover multiple EUCRA-2 chapters, supporting a comprehensive and integrated assessment of climate risk as well as contributing to policy analysis and risk evaluation.

In order to most efficiently tap the available information sources, a few considerations are in order:

a) considering that EUCRA-2 is not aiming at carrying out novel quantitative assessments of risk, higher level indicators providing actionable information might be prioritized over raw data sources;

b) key information sources should cover as much as possible all determinants of risk, including, e.g., exposure and vulnerabilities, as well as non-climatic impact drivers, besides the climatic ones;

c) given the geographical scope of EUCRA-2, global, European and regional data and information products should be privileged, although consistency should be verified with respect to national and subnational data, to minimize uncertainty and loss of trust; timeliness and update frequency of data products should be carefully considered, in order to ensure long-term sustainability to the EUCRA program, particularly considering that subsequent assessments could follow in the next years, and that monitoring of risk indicators would be increasingly relevant.

The full list of sources, including details on coverage, readiness, and relevance to the EUCRA-2 chapters, is available in the Annex.

Geographical and temporal scope, the use of scenarios

Geographical scope

The EU and its Member States should be the **primary geographical focus** of EUCRA-2. However, extending the analysis to the EU neighbourhood area would be beneficial, as the risks materialised in these regions can easily spill over into the EU. In deciding on a possible geographical extension (e.g. to other EEA countries, South-Mediterranean countries), data availability needs to be carefully considered.

Furthermore, risks for Europe that result from climate risk in other regions of the world or climate risks in Europe that are amplified by non-climatic risk drivers from outside Europe should be considered (Outside-in risks).

In terms of **scale of analysis**, a regional disaggregation of risks could be provided in EUCRA-2, also in view of the strong links to policy. According to available data, specific focus could be devoted to macro-regions at risk (e.g. the Mediterranean), coasts and other vulnerable territories, such as mountainous areas and islands. Building on EUCRA-1, the outermost regions might be covered. However, developing a sound methodology for conducting the analysis in these territories would be beneficial to ensure a more robust assessment. EUCRA-2 could also include specific analysis for territories recognised as hot spots for major compounding risks.

Temporal scope

As in EUCRA-1, the **temporal focus** should remain on near-term and mid-term as the main timeframe of policy making with an outlook to the long-term (2080 – 2100). In EUCRA-1, following IPCC AR6, 2020-

[25] https://drmkc.jrc.ec.europa.eu/risk-data-hub/#/

[26] https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Climate-Change/INFORM-Climate-Change-Tool

2040 represents near-term and 2040-2060 represents mid-term. These periods may need adjustment for IPCC AR7. It can further be discussed if a longer perspective – beyond 2100 – should also be considered in relation to specific risks and policy needs (e.g. ecosystems, sea level rise, infrastructural planning and investments).

The use of scenarios

A proper **design, development and selection of scenarios** should be an important step of the scoping phase together with DG CLIMA and other stakeholders. Here, we can present some preliminary ideas from our standpoint.

Regarding **climate scenarios**, we recommend a similar approach as in EUCRA-1.

High risk outcomes can be explored with high-end emissions scenarios (similar trajectory as the Paris non-compliant emission scenario as in EUCRA-1) or higher Global Warming Level (GWL). Comparison with more moderate risk outcomes (such as the Paris-compliant one in EUCRA-1), expected from low-end emissions scenarios can also be relevant.

Given current policies, very high-end emissions scenarios have become less likely. However, given the global nature of mitigation policies and our focus on European risk only, these very high-end emission scenarios cannot be ruled out. Warming levels >4°C may result from very high emissions scenarios but can also occur from lower emission scenarios if climate sensitivity or carbon cycle feedback are higher than the best estimate. If deemed relevant in first consultation, comparison of projected changes (anomalies) to pre-industrial, historical conditions, or a low

end emission scenario can serve as a baseline to assess current and future conditions, as well as the added value of adaptation and mitigation actions.

Climate events, trends or compound events that lead to tail risks should explicitly be considered. Particular attention should also be drawn on considering **discrepancies between observations and expectations** based on climate models. These discrepancies are piling up, especially at regional scales[27] ("blind spots"). In last years, we observe extremes and trends that are outside

the standard range of climate scenarios for the same period. A sound analysis of these discrepancies would be recommended. Climate risk storylines for tail risks, compound events and blind-spots could be appropriate approaches.

Scenario-based information can be analysed relative to different time horizons, or time slices, in addition to considering a continuous (transient) time series over the course of this century or even following centuries. Decadal predictions may complement climate projections to assess hazard-driven risks in the near- to mid-term.

EUCRA-2 might build further on the EUCRA-1 **'cornerstone' scenarios** to compare future divergent trends in climatic and socio-economic outcomes across all dimensions of risk. One scenario could describe a middle of the road trajectory combined with modest to high challenges and more leverage for adaptation and the other, a high-end emission trajectory combined with high and very high challenges and barriers to adaptation. EUCRA-2 could expand this method for all sectors.

For the **non-climatic risk driver** side, we could imagine including influence of two (geo)political scenarios on the risk assessment or the policy recommendations: one characterised by a democratic and unified EU, prevalence of global cooperation, relatively open trade, etc. A challenging one characterised by an EU plagued with major democracy deficits and inner conflicts, limited global cooperation, weaponisation of trade, large military spending, etc.

Also here, storylines might be appropriate approaches to combine complex combinations of climatic and non-climatic risk drivers.

The selection and development of a **set of common scenarios**, that links projections for all risk dimensions (hazard, exposure, vulnerability) needs to enable both a scenario-robust assessment of future

[27] https://www.nature.com/articles/s41586-025-08680-1

uncertainties and a clear communication and policy embedding of the scientific findings.

Climatic and non-climatic risk drivers

CIDs / climate-related hazards

CIDs have been explicitly addressed in EUCRA-1 following the IPCC classification of CIDs (heat and cold, wet and dry, wind, snow and ice, marine and coastal) plus an extra section on compound events. Boxes with reports on recent events (e.g. recent drought events) were complementing this chapter. Given the "blind spots" of climate models applying the standard scenario approach (see above) on some climate extremes and some observed climate trends, complementary climate storylines could be an appropriate approach.

The EUCRA-2 chapter on climate impact drivers (climate-related hazards) could draw on the C3S products as well as data from other international and European data sources (see sub-chapter on key information sources). Furthermore, it could cover not only climate trends but related hazards, exemplified by selected extremes. This approach would also be in line with the definition of CIDs by the IPCC, that also include, besides purely weather-related impact drivers, a series of hazard triggered by extreme weather (e.g. landslides, coastal erosion, river flooding)[28].

Return periods derived from re-analyses and projections could help quantify this. Specific hazard or risk indices to quantify selected risks could be computed based on C3S and/or DestinE data. This could include measures of intensity or occurrence statistics for selected events (including compound events) from climate time series (reanalysis, projections). Climate risk storylines could be elicited from the recent past to inform EUCRA-2's risk scenarios.

A potential list with indicators could be classified in-line with IPCC CIDs and ETC CA report[29]:

- mean temperature + seasonal temperature, temperature extremes (heat, cold)
- mean precipitation + seasonal distribution, aridity, precipitation extremes (meteorological droughts, heavy precipitation, …)
- other extremes (storm, hail, ….)
- hydrosphere (impacts on water balance, hydrological droughts, pluvial flooding, river flooding, …)
- cryosphere (glacier retreat, snow cover, …)
- other climate-related terrestrial hazards (mass movements, fire-weather, …)
- marine (marine temperature, marine heatwaves, marine biochemical, …)
- coastal (sea level rise, coastal flooding, coastal erosion, …)

Further options have to be discussed in the scoping process to align classification with other European initiatives such as UCPM. It has to be discussed to which extent such data will be presented through a consistent **web- atlas**, either an existing one or a specific one for EUCRA.

Non-climatic risk drivers

Non-climatic (underlying) risk drivers are an essential component to understand socio-economic processes that are affecting exposure and vulnerability of systems and to identify important entry points for policies that increase resilience. In EUCRA-1, underlying non-climatic risk drivers (NCRD) have been reported based on very broad SSP-categories, but not fully applied as risk- specific scenarios.

Examples of additional and more specific risk-oriented NCRDs for EUCRA-2 could include ecosystem degradation, aging, loss of social cohesion, migration, loss of trust, missing capacities of institutions, international cooperation; Geopolitical changes; Supply-chain disruptions; Economic instability; Trade conflicts; Erosion of democratic institutions etc.

---

[28] https://www.ipcc.ch/report/ar6/wg1/figures/technical-summary/figure-ts-22

[29] https://doi.org/10.25424/cmcc/climate_related_hazard_indices_europe_2020

To develop NCRD indicators and scenarios, EUCRA-2 socioeconomic scenarios may build on a methodology that combines European datasets (e.g. EUROSTAT), foresight-based narratives (e.g. JRC and other European project foresights), and future projections based on the updated SSP 3.0 release. These projections will be closely aligned with any forthcoming updates, especially in light of IPCC AR7. Mapping of these sources will help understanding match and mismatching between evidence and EU priorities built on foresight. The methodology thus needs synthesis of quantitative analyses and participatory methods compatible with foresight.

Compared to EUCRA-1, the **interaction between CIDs and NCRD** could be further analysed. The influence of the drivers could be assessed per key risk by focusing on CIDs and identifying relevant NCRDs. Highlighting the interconnections among risks and their compound and cascading effects within/across sectors would be essential to capture the multi-risk and systemic nature of these challenges. Major common NCRD for key risks could be analysed and inform the policy analysis to understand the linkages to relevant NCRD.

For NCRD it is even more important than for CRD to consider the limitations of underlying integrated assessment models, which do not include disruptive changes by design (e.g. 5 year time steps or longer).

Risk identification

EUCRA-2 could comprehensively cover climate-related hazards as major risk drivers. EUCRA-2 could offer a **comprehensive coverage** of **major climate-related risks** caused by the interaction of both climatic and non-climatic drivers from inside and outside the EU, and their impacts across sectors, systems and policy areas. Building on the **36 major risks** identified in EUCRA-1, EUCRA-2 could revisit, refine, extend and update this list to reflect new evidence, emerging challenges, and evolving policy priorities. An assessment of the impact of risks outside EU borders and spillover effects of climate risks on the EU could be included. Key risks identified in national CRAs could be taken as a further inspiration for additional major risks or fine-tuning of existing ones.

The identification phase could leverage other initiatives at European scale, including outcomes from European research projects and large-scale scenario-building activities (e.g., DG ECHO initiative), and could also be carefully aligned with the EUCRA-2 perspective on policy areas. Relevant stakeholders could be involved already in the identification phase to ensure comprehensive coverage across different policy areas.

Risk should be reported as “Risk to” exposed social or ecological system “from” hazards or “due to” impacts (in-line with the IPCC Guidance for IPCC authors on the risk concept)[30].

A specific task in the risk identification phase could be devoted to the identification of **tail risks**, i.e., risks related to rare events (high-impact, low-probability - **HILP**), and blind spots in climate models, or to unforeseeable consequences following the exceedance of tipping points in the earth system or in the socio-economical systems. Such risks will have to be dealt with consistently with their particular level of uncertainty.

Risk Analysis

Overall logic and orientation

In the analysis phase risks should be analysed for the current and potential future. A focus is on **understanding risks** and their elements and drivers (hazard, exposure, vulnerability and capacity, underlying non-climatic risk drivers) with the aim to identify severe risks, critical constellations as well as entry points for adaptation.

Risk severity should be assessed based on the potential magnitude of consequences and likelihood (where applicable) as well as the other criteria for risk severity introduced within EUCRA-1 (irreversibility of

[30] https://www.ipcc.ch/site/assets/uploads/2021/02/Risk-guidance-FINAL_15Feb2021.pdf

consequences, potential for cascading effects). The granularity of the assessment of risk severity has to be defined. We recommend to at least assess risk severity for the three time horizons and two different scenarios (ideally combined climate – non-climatic). A finer regional resolution is only recommended where risk severity would differ significantly between regions.

In the analysis of risks, a more explicit stance could be taken with respect to **exposed** systems and functions and their **vulnerabilities**, as well as other **underlying non-climatic risk drivers** depending on, e.g., large scale demographic and socioeconomic trends. A wider and intersectoral perspective could be used to highlight cross-cutting risks across different policy areas.

Complexities could be addressed more thoroughly than in EUCRA-1, using a systemic perspective in the background analysis (see Figure 3), highlighting compound and cascading effects that can amplify adverse consequences, at least qualitatively and conceptually.

Conceptual models of risk such as **impact chains** should be used to integrate and expose available knowledge about the observed and potential impacts and their causal relationships and cascading across different sectors and systems. Impact chains could also provide an actionable and intuitive way to navigate the complexity of the available analysis data in a risk- oriented manner and identify entry points for adaptation and response options.

The analysis of **tail risks** and those related to blind spots and tipping point can hardly be carried out using quantitative approaches, due to the significant uncertainties and partly very low probability of occurrence. To carry out a useful analysis, alternative approaches, such as **risk storylines,** might be employed to provide a consistent and plausible narrative of what could happen (or has happened) this information could be included in form of boxes to complement and integrate the analysis of other risks. Storylines can partly build around past events, but downward counterfactuals could be inserted to account for alternative (worst case) scenarios which can provide a useful support for risk management.

The basic output of the analysis phase is an assessment of severity for each selected risk complemented by a confidence assessment.

Policy areas as main reference units in EUCRA-2

The risk assessment in EUCRA-1 was structured around sector- and system-specific themes, complemented by cross-sectoral storylines, and presented by policy cluster. For EUCRA-2, a more consistent and policy-oriented structure by focusing on specific **policy areas** is recommended. We refer here to a "policy area" as a distinct subsystem governed by relevant policies. Examples of policy areas include agriculture and food security, health and health infrastructure, and social aspects. By using “policy areas” as main subsystem, the analysis of impacts, vulnerabilities and risks can be more closely related to the analysis of policy gaps and the identification of opportunities for response. However, while policy-based structuring is useful, risks are multifaceted and do not fit neatly into policy categories. Therefore, it would be crucial to further highlight **interlinkages** between policy areas and cascading risks across sectors. Co-benefits, synergies, trade-offs, and the broader context could be clearly presented.

Given the complex and fast-changing geopolitical context, to effectively inform the next EU policy cycle, EUCRA-2 needs to significantly **broaden the range of policy areas** to be covered. For instance, human mobility, civil and military defence and security could be addressed more explicitly in EUCRA-2. A potential structure of policy areas is proposed in Chapter 5.

Policy analysis

In relation to the overall methodology for policy analysis, EUCRA-2 should **not only build upon the established methodology of EUCRA-1 but also overcome its limitations** by performing a more in-depth and expanded analysis. The assessment of policy readiness in EUCRA-1 was indicative due to resource and time constraints, as well as the fragmented nature of available evidence. Similarly, the initial identification of risk ownership offered a preliminary view of vertical responsibilities across EU and Member State governance levels. Given that the risk evaluation process should still be informed by assessments of **risk**

ownership, **policy readiness**, and **policy horizon**, the policy analysis in EUCRA-2 could expand its breadth and depth to effectively cover the following components:

- **Policy Gaps:** A standardized methodology, supported by stakeholder consultation and document analysis, should be developed to identify the existence and severity of policy gaps related to climate risks. While not evaluating individual Member State policies, collaboration with EIONET for a preliminary Member State-level gap analysis would be beneficial.
- **Policy Interlinkages:** The analysis could map how policies connect to inform EU policy reconfiguration for a more systemic response and to minimize incoherence and inconsistency. This ideally involves consulting experts to identify how policies in one area affect climate risks in others, either positively (managing risks) or negatively (creating/exacerbating risks).
- **Risk Ownership:** EUCRA-2 should adopt a structured approach to clarify risk ownership. This includes assessing vertical ownership (EU, shared, or Member State) based on legal analysis and consultation with EU and national policymakers to identify any ambiguities. Horizontal ownership—across EU Directorates-General and policy areas—should be assessed through joint analysis of EU policy frameworks and stakeholder consultations. The legal analysis could be complemented by an assessment of private-sector risk ownership, particularly for transferred risks. This involves identifying financial ownership (i.e., who currently pays and how much across different policy areas) and conducting a survey to capture the informal influence of various policy actors. Where relevant, the concept of "policy ownership" could be introduced to reflect cases where those responsible for risk and policy are not the same.
- **Policy Readiness:** The analysis should evaluate whether current policy goals, targets, instruments, and governance structures are adequate to address Europe's systemic climate risks. This includes reviewing relevant literature and consulting stakeholders to assess the effectiveness and limitations of adaptation and risk management policies— particularly in addressing complex challenges such as compounding and cascading events, tail risks, blind-spots and tipping points. The assessment could examine both *policy readiness*—alignment with the EU's legal and institutional frameworks, goals, and targets—and *implementation readiness*, including institutional capacity, role assignment, and mechanisms for evaluation, monitoring, and enforcement. The ultimate aim is to identify pathways toward more anticipatory and transformative adaptation, strengthening Europe's resilience across a range of climate scenarios

To better link opportunities for responses and risk identification and analysis in addition to quantifying severity and likelihood, the policy analysis in EUCRA-2 may consider the strategic salience of climate risks in the European policy and governance landscape. This involves assessing where there may be mismatches between risk severity and policy attention— highlighting both under-recognised systemic risks ("silent risks") and those receiving disproportionate focus relative to their assessed severity.

To ensure ease of use by EC DGs and national authorities **two options on how to structure the policy analysis** are suggested and briefly analysed below:

(A) **integration of policy analysis into risk analysis**, with the policy analysis structured along the same policy areas as for the risk analysis. Results could be reported for each policy area as part of the risk analysis chapter.

- Advantage: policy areas serve as the main chapter structure integrating risk analysis and policy analysis, resulting in a high policy orientation of the whole report.
- Disadvantage: Cross-cutting policy aspects might be underrepresented, higher effort for coordination between different analysis teams (risk and policy) is required, the shape of policy areas that might change over time is dominating the structure.

(B) **separate chapter for policy analysis and policy readiness**, with policy analysis structured along the same policy areas (PA) as for the risk analysis or in different (larger) clusters. In this option, the policy

analysis could either be structured along the same PAs as for the risk analysis or in different (larger) clusters of PAs (as in EUCRA-1). Results would be reported in a separate chapter after the risk analysis.

- Advantage: easier to manage compared to option (A), since policy analysis can be treated as a rather independent activity. Cross-cutting policy issues can be expressed more explicitly.
- Disadvantage: policy areas appear twice, in risk analysis and in policy analysis. If policy areas are clustered differently from the risk analysis, a relation has to be built for the risk evaluation.

Risk evaluation (Urgency to act)

The risk evaluation represents the final stage of the risk assessment process, providing and applying a sound methodology to prioritise major risks and, thus, effectively inform policymaking. The risk evaluation process could be conducted to identify climate risks that call for urgent action in term of *policy actions* to boost policy readiness or in term of *further investigation* needed for increasing confidence in the assessment of risk severity. Risks with low confidence but high severity might also require precautionary measures that are reducing risks for a broad range of scenarios and increasing resilience.

Building on the concept developed in EUCRA-1, which remains valid, the risk evaluation process in EUCRA-2 would benefit from a deeper policy analysis, consideration of the effectiveness of potential adaptation options, and more thorough assessment of confidence (see “Policy analysis” sub-chapter above).
As in EUCRA-1, the engagement of the **Risk review panel** would be recommended to enhance robustness of the risk evaluation process and ensure that EUCRA authors' findings align with the state-of-the-art scientific understanding of climate risks (see “Potential actors of EUCRA-2” sub- chapter below).

Opportunities for response

To support timely and effective adaptation, EUCRA-2 should deepen its focus on **opportunities for response** (responses in the sense of adaptation, improved policies, …) by evaluating how well current policies are performing, identifying gaps in policy action, and providing practical guidance for improving **policy readiness**. It is essential to examine how non-climate policy actions in other sectors may unintentionally hinder adaptation efforts or increase vulnerability. This is important to ensure that adaptation is not undermined by conflicting objectives elsewhere and allow for conscious policy choices and prioritization of actions. At the same time, it is also crucial to identify synergies between climate and non-climate policy actions, where actions can strengthen adaptation efforts. EUCRA-2 should promote approaches that **prevent maladaptation** and explore ways to capture where more **transformational adaptation** may be needed to address the policy readiness gap. Throughout, the assessment should maintain a strong focus on **differential vulnerability** and **social justice**, recognizing how both risks and responses affect different groups in unequal ways. It has to be reflected in the scoping phase, to which extent the feasibility and efficacy of policy options can be assessed or if this would go beyond EUCRA and be more related to the European Adaptation Plan (ECAP) process.

Like EUCRA-1 and following the assessment of the **Urgency-to-act**, opportunities for response presented by EUCRA-2 could consider *knowledge-oriented* as-well-as *policy-oriented* actions. The former refers to actions needed to address important knowledge gaps and could ideally inform future research funding. The latter refers to actions that entails a policy response, such as adaptation-related regulations, investment, or changes in practices.

EUCRA-2's recommendations should build upon EUCRA-1's approach by integrating insights from policy analysis to identify key priorities for EU policymakers. These recommendations could be developed by policy area (PA) but could be further organised into "policy clusters" to account for cross-sectoral interlinkages and overlapping benefits, encompassing both sector-specific and cross-sectoral actions. EUCRA-2 recommendations could address, for instance, several crucial factors to enhance their effectiveness and applicability:

- **Prioritization:** recommendations could prioritize urgent adaptation measures, considering factors like feasibility, public acceptance, cost, and co-benefits.

- **Policy specificity:** recommendations could offer specific, well-defined measures at both sectoral and cross-sectoral levels, clearly linking to identified climate risks.
- **Granular resolution:** recommendations could indicate if measures are for continental or regional benefit and their time horizon. They could also account for unequal impacts on vulnerable groups and varying community risk management capabilities.
- **Policy coherence:** to effectively address policy coherence, recommendations could highlight cross-sectoral co-benefits and trade-offs. This includes identifying how policies could manage multiple risks and contribute to address other climate or non-climate risks, while also flagging potentially harmful policies.
- **Risk and policy ownership:** EUCRA-2 could explicitly assign risk and policy ownership — both horizontally (to Commission DGs) and vertically (across governance levels). It could also address unclear ownership and consider private sector involvement.
- **Limits to adaptation:** EUCRA-2 could examine the limits and effectiveness of adaptation, acknowledging economic and political constraints that hinder transformative solutions. This could be linked to the assessment of feasibility as mentioned under prioritization. However, this would require quite some effort in the analysis of the efficiency of potential adaptation measures under different responsibility, critical thresholds etc. EUCRA-2 might only be able to give some first indications on limits of adaptation.

EUCRA-2 may explore the potential for certain responses to act as entry points for **transformation** shaping how adaptation strategies are prioritised and integrated across sectors. Rather than treating all severe risks equally, the assessment will consider which risks and the related opportunities for response may open space for policy innovation or unlock synergies across climate and non-climate agendas. This approach acknowledges that not all risks are equally actionable, and seeks to sharpen the link between risk analysis, opportunities for responses and adaptive capacity/resilience across scales.

Uncertainty / confidence

EUCRA relies on heterogeneous evidence from various sources, including data, peer-reviewed papers, project results, and expert consultations, rather than a consistent data-driven approach. Consequently, a probabilistic risk assessment method is not feasible for EUCRA and could not be its aim. Instead, as for EUCRA-1, we recommend utilizing the well-established uncertainty/confidence approach developed for the IPCC[31]. Anyhow, since the focus of EUCRA is more on risk than on a complete review of evidence, confidence cannot be assessed for each major statement, but on the level of evidence for key risks.

Furthermore, as in EUCRA-1, we propose using confidence statements for the risk evaluation phase (see "Risk evaluation" sub-chapter above). This confidence is integrating not only the confidence of the evidence, but also the confidence of the authors and the risk review panel during the evaluation process. It can be discussed, if for this aspect another term could be used, even though confidence is a common concept even for risk evaluation. Following the approach from EUCRA-1 we recommend categorizing key risks with low confidence but high severity into specific urgency or response classes. This could include high urgency for creating more knowledge, monitoring the situation, or taking precautionary measures. Conversely, key risks with high confidence and high severity could lead to more targeted response opportunities.

Potential actors of EUCRA-2

Figure 3 (see "Potential workflow" sub-chapter) already indicates the role of main actors in a EUCRA-2 process. Here, we do not provide recommendations on the management approach for EUCRA-2 but instead offer reflections on some of the main content providers. The main contributors in the whole process are the **authors**. As in EUCRA-1, the **Risk Review Panel**, an expert panel that supports the assessment of risk severity and the overall risk evaluation, is crucial. Severity and policy

[31] https://doi.org/10.1016/j.gloenvcha.2017.02.005

readiness are attributes that cannot fully be assessed in an objective way and need a well-informed and diverse panel for an evaluation. **Stakeholders**, here mainly the DG CLIMA and other relevant DGs, might play a more pronounced and crucial role in risk assessment. They are not only the final recipients of EUCRA but have also explicit and partly exclusive knowledge on the relation of EU policies to climate risk. This includes knowledge on:
a) how EU policies can reduce and mitigate climate-related risks b) to which extent EC policy objectives are threatened by climate risk (for instance to recover biodiversity until 2030) and c) how synergies and conflicts between different EU policies are related to climate risks.

A specific group of actors are **JRC** and **ECMWF**. They can provide rich and tailor-made knowledge to EUCRA-2 through their running programs and initiative TRACE, C3S and DestinE. Depending on the design of authorship (see below), JRC and ECMWF experts could be either full authors or specific stakeholders.

In general, a wide and **well-structured consultation process** is recommended under the overall coordination of the EEA and/or a potential consortium, ensuring that different groups are involved at appropriate stages based on the purpose of each round.
The entire process should be designed from the early stages of EUCRA-2 development, clarifying key objectives, roles and responsibilities, different phases, and communication and information. The exact setting and involvement should be defined in the scoping process together with EEA and the EC.

Authorship

EUCRA-1 involved a large group of authors coordinated by the EUCRA team. The fast-track nature of the project and the usual EEA report style, typically concise and written by a small expert team, made this approach less effective and efficient. We suggest considering two alternative approaches or a mixture of both. In any case, a proper recognition of authorship is important.

One option could be to appoint a **group of 10-15 lead authors** responsible for conducting the analysis and drafting the report. This core team would be supported by a broader consultation process involving interviews and workshop with additional experts (see more details on the consultation process below). **Alternatively**, similarly to the IPCC process, an open call for authors could be launched to engage a larger group of contributors throughout the drafting process. However, due to the demanding nature of EUCRA-2 both in development and coordination, this option is considered less preferrable.

A **scientific steering group** would be needed for scientific and technical oversight, at the very least a team of scientific coordinators / co-chairs for the report.

Given its complexity, **effective and well-structure coordination** is crucial throughout the entire development and drafting process. To achieve this, it is recommended to provide authors with **clear and timely guidance documents** and facilitate **regular exchanges** between them and with the coordinating team to **ensure consistency and coherence**. Some of the materials developed for EUCRA-1 could be further refined and re-used, where relevant and appropriate.

Stakeholders

In EUCRA-1, the role of stakeholders was focused on consultation meetings and review rounds. On one hand due to the fast-track character of EUCRA-1, on the other hand to keep an independent and scientific character of EUCRA. We propose to conduct a proper stakeholder mapping and involve stakeholder more extensively in EUCRA-2 to benefit from their knowledge and experience and co-assess and evaluate risks. The exact degree of involvement and the

process how to involve stakeholders might be defined by the EEA team leading EUCRA-2. Here, we can only report on some preliminary reflections.

Both the **scientific and policy communities** could be connected and engaged through multiple consultation rounds, each designed to meet specific objectives. In this regard and according to the proposed methodology, it is recommended to include in the process:

- A first phase “building credibility and legitimacy”: the scientific community presents, discusses and revises with a panel of experts and direct policy stakeholders, such as few representatives of key DGs, the selection of key drivers and risks, with the aim of validating of and legitimizing major dimensions of risks to consider. Additionally, the purpose is to identify additional risks and drivers that are considered to be relevant and within the scope. Another iteration, consisting of workshops and interviews, is also suggested as part of the risk analysis for each policy area/thematic area to increase consistency between risk analysis and policy/thematic areas.
- A second phase “embedding and consolidation for salience”: a broader consultation round with all policy stakeholders, such as DGs, EIONET scientific advisors policy community after the risk selection phase to collect insights into the effect of identified risks on the policy area, understand current risk ownership as well as relevant policies, and discuss policy gaps.

Guidelines for stakeholders should be provided in advance, specifying the timeline and expected level of effort required. This will allow experts to plan their contributions effectively and facilitate meaningful participation throughout the process.

Risk Review Panel

For EUCRA-2, it would be crucial to clarify the **panel’s role**, its way of engagement, and how its contributions should then be considered and integrated into the evaluation process. Specifically, a balanced approach to the verdicts generated by both the Risk Review Panel and the EUCRA-2 authors would be essential to maximize reliability and robustness. To achieve this, developing a clear protocol for assigning relative weight to the verdicts from each party would significantly enhance the transparency of the final verdict generation.

5 Potential chapter structure of EUCRA-2

The chapter structure of EUCRA-2 should reflect on one hand the continuity with EUCRA-1 and on the other the potential improvements mentioned in Chapter 4. Major changes recommended are:

- Removing the distinction of “thematic fact sheet” chapters and “storyline” chapters by having unified chapters per systems or policy areas, using storylines as additional elements (e.g. boxes) and more in the strict sense of plausible tail-risk scenarios on complex and cascading impacts;
- Integrating the results of the policy analysis stronger into the risk assessment chapter (see two options below);
- Integrating the social justice and cohesion aspect (which was an independent chapter 12 in EUCRA-1) stronger into the risk analysis together with other cross-cutting priorities (such as security).

The structure described here is just a first reflection and has to be adapted within the scoping process.

1 Executive summary

- Main target group: policy maker on European and national scales.
- Around 10 pages.
- Key messages with a focus on key risks, urgency to act, and opportunities to respond.

2 Introduction

- Objectives of EUCRA
- Relation to EUCRA-1
- Policy context
- Method (with reference to a separate method report)

3 Climate risk drivers (climatic and non-climatic)

Climatic impact drivers / risk-drivers

- Timeframe: past, current/near-term, mid-term, long-term
- **Climate impact-drivers / climate-related hazards** could be classified in-line with IPCC CIDs and ETC CA report (see Chapter 4).
- A section on recent extreme events, including how well presented they are in CMIP/Euro-CORDEX results, tail risk events, climate tipping points with potential relevance for Europe. Climate storylines could be added

Non-climatic risk drivers

- Non-climatic risk drivers could describe specifically those drivers that are increasing the vulnerability of systems (or their exposure to climatic risk drivers) such as environmental systems, social systems, policy / governance / institutional systems, technical / infrastructure systems, economic, / financial systems, geo-political context, … (see Chapter 4).

Common scenarios

- Option: Common scenarios (a combination of climatic and non-climatic drivers)

4 Risk analysis - major risks per policy area

This structure reflects the intention to have a more policy-oriented structure of the whole risk analysis. Policy Areas (PAs) include systems, that are governed by policies (e.g. built-up area and infrastructure) as well as their respective policies. Climate risks include risks to the system itself, as well as risks to (not achieve) policy targets.

Social aspects (that were a separate chapter in EUCRA-1) would be described in each PA and, more explicitly, as risks within the "Social" PA. Further PAs could address new topics that are affected by risks or contribute to risks (e.g. migration, security) as well as policies that could contribute to solutions (e.g. civil protection, spatial planning). The "PA approach" would allow to bring the risk analysis and PAs closer together and focus on a solution-oriented approach. The potential content items below are a "maximal" scenario. Concrete content items have to be negotiated in the scoping phase.

<u>Potential policy areas (PA) - examples</u>

- Ecosystems and Ecosystem services (e.g. forest, other terrestrial, coastal, marine, soil; carbon sequestration, natural heritage …)
- Water and water security (e.g. water scarcity, water quality, water security, water management …)
- Agriculture and food security (e.g. agriculture in EU, fisheries and aquaculture in EU, food manufacturing / production, food security including external dependencies and risks …)
- Health + health infrastructure (e.g. health risks due to heat, infectious diseases, physical + mental health, health system, …)
- Built environment and critical infrastructure
- Energy security + Energy Transition
- Economy + Industry (e.g. competitiveness/single market, supply chains identifying main sector exposures including external; specific sectors such as tourism, production, construction, …)
- Finance (e.g. economic governance/fiscal policy, financial policy - markets, insurance, banking, supervision, …)
- Social (education, labour / employment, Inequality and just resilience, solidarity mechanisms, …)
- Other PAs that are affected and / or provide solutions: Migration, Domestic Security, Civil Protection, Spatial Planning, Cohesion Policy, …

Potential content per policy area (order TBD) - example

- Description of the system managed by this PA, current situation of the system (general situation including non-climatic risk drivers and trends)
- Description of policies including key policy targets
- Risk Analysis
  - General link to climate change and impact chains (climatic risk drivers, vulnerabilities, impact cascades from / to other systems, …)
  - Current impacts: observed impacts, losses and damages (incl. environmental, social, economic, security aspects, ...); major hazard, vulnerability and exposure factors that led to these impacts. Current risks to policy targets
  - Potential future impacts and risks; major hazard, vulnerability and exposure factors that may lead to these impacts. Future risks to policy targets
  - Tail risks, blind-spots, tipping points per PA (eventually illustrated by storylines)
  - Current capacities to prevent, prepare, cope, recovery, adapt
  - Key risks + risk severity (near, mid, long-term) + confidence; Including key risks to policy targets

5 Risks for specific regions

Risks for specific regions in Europe

(Optional. The risk analysis itself would be based on the risk analysis per PA and just be a subset with a specific perspective on certain regions)

- Coastal
- Mountains
- [Urban]
- ….

Climate risks in Outermost regions

6 Outside-in-risks

As “outside-in risks” we understand cross-border climate risks emanating from outside the EU’s borders. The depth of this analysis has to be further discussed in the scoping phase.
Also these risks should be already considered in the risk per policy area. Here, they could be explained in more detail and for reference.

- Risks from climate-related impacts from outside Europe

7 Risks across sectors and policy areas including tail risks

Tail risks and linkages across sectors, systems and PA should be already addressed in the single PA risk reports. This chapter would be based on this risk analysis and just provide an explicit perspective.

- Major risk transmission pathways across PAs (impact chains across PAs)
- Storylines of tail risks and systemic risks across PAs
- Demand for responses to treat crosscutting and tails risks

8 Policy analysis

This chapter can be either integrated into chapter “risk analysis per policy area” or treated separately (see option A or B in Chapter 4)

- Policy areas covered in the analysis
- Methodology for policy analysis
- Risk ownership, policy readiness, policy horizon
- Policy gaps and interlinkages.

9 Risk evaluation (Urgency to act)

- Methodology to conduct the assessment of the Urgency to act.
- Urgency to act scale and different types of actions (further investigation to increase confidence / policy actions).
- Ranking of major climate risks resulting from the risk evaluation process.
- Interlinkages across “most urgent” major risks.
- Conclusions – overall reflection on the results of the risk evaluation process.

10 Opportunities for response

It has to be discussed to which extent opportunities for response can be integrated into the risk reports per policy areas (Option A). Eventually, this chapter is just giving a more cross-sectoral perspective based on the detailed recommendations already mentioned for each policy area.

- Identification of major policy, knowledge and response gaps and challenges.
- Identification of cross-sectoral co-benefits and trade-offs. Analysis of how non-climate policy actions may hinder adaptation effort.
- Social justice considerations.
- Prioritization of suggested actions.
- Recommendations to improve policy readiness to address the most urgent major risks, clarifying policy ownership horizontally and vertically.
- Limits to adaptation

Annex: Key information sources

For each EUCRA-2 chapter, different key information sources (KIS) can be leveraged. This annex provides an overview on the main KIS, building upon and extending those presented in this reflection paper. The list also includes relevant climate and disaster risk assessments at global, transnational, pan-European, and national scales to take stock of and integrate key insights. Potential KIS cover both raw and processed data, as well as more qualitative or descriptive reports.

Table 1 below lists the selected KIS providing raw and processed data and links them to different EUCRA-2 potential chapters. The table also provides an indication on the readiness of the potential KIS.

In addition to raw and processed data, more qualitative and descriptive sources can provide valuable context and insights, particularly relevant for risk assessment and when exploring implementation challenges, adaptation needs, and emerging practices.
Such Key Information Sources include:

- DG ECHO scenario building initiative and reports
- Strategic Foresight Reports
- Overview of natural and man-made disaster risks in the EU
- EU comprehensive risks and threats assessment
- National Climate Risk Assessments (CRAs) and National Risk Assessments (NRAs) (Art. 6, Decision 1313/2013) – link to EIONET
- Adaptation reporting (Art. 19, National Energy and Climate Plans – NECP)
- Regional Climate Risk Assessments (e.g. MedECC)
- Mission on Adaptation regional profiles / risk assessments
- Sectoral assessments (e.g. CER Directive assessments)
- European Court of Auditors (ECA) reports
- Published policy progress reviews on the Member State level (e.g. ETC-CCA & EEA products)
- EEA and ETC CA reports
- Publications from research projects funded under Horizon 2020 and Horizon Europe (e.g. CLIMAAX, Pathway2Reslience, Myriad-EU, CASCADE)

Table 1 1 List of potential Key Information Sources (KIS)

Resource name (published until 2027)	Description	Provider	Coverage	Readiness	EUCRA-2 main chapters					Links
					Climatic risk drivers	Non climatic risk drivers	Risk assessment	Policy analysis & readiness	Risk evaluation	
European Climate Data Explorer (ECDE)	Interactive access to a selection of climate indices reflecting the priorities of the European Environment Agency (EEA). The underlying data is from the Climate Data store (CDS) of the Copernicus climate change service (C3S)	ECMWF	European	High	Y		Y			https://climate-adapt.eea.europa.eu/en/knowledge/european-climate-data-explorer/
Copernicus Climate Data store (CDS)	Climate Data store (CDS) of the Copernicus climate change service (C3S) is an open-access online platform that provides a wide range of quality-assured climate data, including observations, reanalyses, and climate projections	ECMWF	European	Low	Y					https://cds.climate.copernicus.eu/

C3S Atlas	The Copernicus Climate Change Service (C3S) Interactive Atlas enables flexible exploration and analysis of past and future climate monitoring and change information using data from the observational, reanalysis and climate change projection datasets available in the C3S Climate Data Store (CDS).	ECMWF	European	Medium	Y					https://atlas.climate.copernicus.eu/atlas
ERA Explorer	User-friendly web application developed by the Copernicus Climate Change Service (C3S) that provides access to over 85 years of global climate data derived from the ERA5 reanalysis dataset.	ECMWF	European	High	Y					https://era-explorer.climate.copernicus.eu/
Coupled Model Intercomparison Project phase 7 (CMIP7)	CMIP7 will be the next-generation framework for climate model intercomparison, improving the understanding of past, present, and future climate changes.	WCRP	Global	High	Y					https://wcrp-cmip.org/cmip-phases/cmip7/
Coordinated Regional Climate Downscaling Experiment (CORDEX)	CORDEX is a global initiative providing high-resolution regional climate projections, with EURO-CORDEX specifically focusing on detailed climate simulations for the European region. The CORDEX community will be implementing a flagship activity to downscale CMIP7 simulations, including dynamical and ML emulated downscaling.	WCRP	European	High	Y					https://cordex.org/strategic-activities/taskforces/task-force-on-preparation-of-cordex-cmip7/
Inter-Sectoral Model Intercomparison Project (ISIMIP)	ISIMIP provides climate and socioeconomic datasets, as well as consistent modeling protocols, to support cross-sectoral climate impact assessments across sectors and scales within a multi-impact model framework. CMIP7-driven simulations, with and without adaptation, are in preparation.	PIK, IIASA	Global / European	High	Y	Y	Y			https://www.isimip.org/

Emergency Management Service (CEMS)	CEMS integrates satellite, in-situ, and model data to aid civil protection authorities, humanitarian organizations, and other stakeholders in effective disaster risk management.	Copernicus	European	Medium	Y					https://emergency.copernicus.eu/
DestinE	Digital Twins integrating Earth system models, AI, heterogeneous sources. Growing set of use cases	ESA-ECMWF	European	Low	Y	Y	Y			https://destination-earth.eu/destination-earth/
DRKMC - Risk Data Hub	Interactive platform for geospatial data exploration of disaster risk components across Europe, including the Vulnerability Dashboard presenting the DRMKC RDH vulnerability framework.	JRC	European	High		Y	Y			https://drmkc.jrc.ec.europa.eu/risk-data-hub/#/
INFORM Climate Change	Upgrade of INFORM Risk Index. It includes climate and socio-economic projections. The results are intended to inform policy choices.	JRC	Global	High	Y	Y	Y			https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Climate-Change/INFORM-Climate-Change-Tool
PESETA V (TRACE) and PESETA IV	The main goal of JRC PESETA programme is to try to understand the scale and distribution of climate risks in Europe, providing a science-based, quantitative and consistent multi-risk assessment for a broad set of specific risks. The first results of JRC PESETA V have already contributed to the regional climate impacts section (Chapter 4) of the 9th Cohesion Report published in March 2024.	JRC	European	High		Y	Y		Y	https://joint-research-centre.ec.europa.eu/scientific-activities-z/peseta-climate-change-projects/jrc-peseta-v_en

"Beyond GDP" indicators	Review of indicators collected by the project "SPES – Sustainability Performances Evidence & Scenarios"	several	Global	Low		Y	Y	Y		e.g. see https://www.sustainabilityperformances.eu/wp-content/uploads/2023/10/SPES-D3.1_29_DEF.pdf
OECD Wellbeing	Interactive tool that measures and compares well-being across 447 regions in OECD countries using eleven key dimensions—such as health, education, environment, and life satisfaction—to assess quality of life beyond economic performance.	OECD	European	High		Y		Y		https://www.oecdregionalwellbeing.org/
EUROSTAT - Green Deal	Statistics for the European Green Deal, aggregated at National level	EUROSTAT	European	Medium		Y		Y		https://ec.europa.eu/eurostat/cache/egd-statistics/
TPI - Transitions Performance Index	Scoreboard that monitors and ranks countries based on their economic, social, environmental and governance transitions to fair and prosperous sustainability	EC	European	High				Y	Y	https://research-and-innovation.ec.europa.eu/strategy/support-policy-making/support-national-research-and-innovation-policy-making/transitions-performance-index-tpi_en
CPR - Climate Policy Radar	Largest publicly available dataset with climate laws and policies	CPR CIC	Global	Medium				Y		https://www.climatepolicyradar.org/

European Topic Centre on
Climate change adaptation and LULUCF
https://www.eionet.europa.eu/etcs/etc-ca

The European Topic Centre on Climate change adaptation and LULUCF (ETC-CA) is a consortium of European institutes under contract of the European Environment Agency.

European Environment Agency
European Topic Centre
Climate change and adaptation
and LULUCF