Just Resilience for Europe: Towards measuring justice in climate change adaptation

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Key messages

A new paradigm for justice in European climate change adaptation

- Justice has emerged as a key concept in adaptation in the last years due to growing evidence on how the most vulnerable people and systems are disproportionally at risk from climate change. These people and systems also often have less capacity and capabilities to adapt and are the least likely to be heard, recognised and prioritised in adaptation processes, resulting in fewer benefits from adaptation actions.
- The principles of just resilience and 'leaving no one behind' are key elements in several recent EU policies related to climate change adaptation, including the EU Strategy on Climate Adaptation, the European Green Deal and the EU Mission on Adaptation to Climate Change.

Principles of justice and resilience

- The concept of resilience, as formulated in European policies, is a broader term than adaptation. It includes the aim of enhancing the capacity of society and the natural systems we rely on to persist, adapt and transform, in anticipation of and response to disruption and crises.
- Three core dimensions of justice in adaptation can inform the future work on operationalising just resilience for Europe; distributive justice (who is affected and who benefits), procedural justice (fairness and legitimacy of the decision-making process) and recognition justice (the recognition of diverse values, cultures and worldviews). Additional perspectives, including intergenerational justice, intersectionality, capacities and capabilities approaches, the safeguarding of intrinsic values of nature and restorative and retributive justice also offer valuable insights to the definition of goals for just resilience for Europe and the development of indicators to measure, monitor, report on and evaluate progress.

Policy priorities and progress in Europe

- European policies on just resilience currently prioritise international dimensions of justice, societal transformations, employment and workers' rights and allocation of adaptation funding between EU Member States.
- Increasing attention is given by EU Member States to the social justice dimension of adaptation and to the social and cultural values at risk from climate change. Implementation is however still very limited, and countries do not yet have monitoring frameworks in place to measure just resilience. However, a few countries, such as Austria and Finland, have started to assess justice aspects at local level. Spain notes the importance of intergenerational justice and gender equality. Sweden is the only country that has in its reporting explicitly noted that justice in adaptation is an evolving field and work is being carried out to identify areas of action.

Sector-specific justice considerations

- Across policy sectors, certain groups are identified as particularly vulnerable to both the impacts of climate change and are of particular risk at having less influence on and benefit from adaptation planning and implementation. These groups include the young (infants and children), the elderly, poor or low-income households, people in poor health, people with poor social networks, immigrants and ethnic minorities. Particularly exposed populations are also identified, in particular low-lying areas, southern Europe, and both urban and rural areas. However, these categories broadly correspond to otherwise marginalised or

disadvantaged groups and contextual information (sector, location, population etc.) should be well considered before directly adopted.

- A few sectors are ahead in the development of knowledge and solutions for justice in adaptation planning and implementation, with a longer tradition of considering justice and diverging needs in planning and implementation. Particularly the Buildings, Urban, Health and Disaster Risk Reduction sectors. There is potential for cross-sectoral learning and synergies between sectors. Knowledge gaps persist across sectors on both the uneven burdens of climate change impacts and risk on places and people, as well as the process and outcome of adaptation action to build just resilience for Europe.

Existing datasets, frameworks and methodologies to develop just resilience indicators

- Several existing frameworks and datasets have been identified that could be used in the design and development of indicators in the measuring, monitoring and reporting on the process of and progress of justice and equity in climate adaptation for Europe. Most such existing datasets and frameworks monitor distributive dimensions of justice, based on available statistical data, although survey data and qualitative methods are also in use. Existing data and frameworks are available to monitor certain vulnerable groups but could also function as response proxies. Indicators focusing on capacities and capabilities were the second largest group of indicators found in this screening and could provide insight to the future development of indicators for just resilience at EU levels.
- Monitoring justice in adaptation cannot be limited to measuring the equity in distribution of benefits and burdens from climate impacts. Indicators were found that capture and address how measures affect various groups (preventive, mitigative and/or restorative) and the extent to which stakeholders have been consulted and involved in their implementation. During the screening, no indicators were found that directly assessed the recognitional aspects of justice.

Future priorities

- The scientific evidence and policy priorities provide a starting point to inform a framework for monitoring just resilience according to the different policy objectives that have been identified in sector policies, and at European and national level. Although existing indicators show potential, particularly at a country-level, they need modifications and adjustments in order to match policy needs and local contexts in monitoring just resilience for Europe.
- Clarity on the definition and goals of justice and equity in climate adaptation policy, including at European, national and sector level, would help the process of operationalising the concept, and facilitate that relevant policy documents and processes reflect the full range of issues which would require policy action.
- Structural and systems change lies at the core of both the justice and the resilience concepts. Evidence supports that pre-existing inequalities interact with adaptation feasibility and effectiveness (including limits to adaptation) and drive climate related vulnerabilities. Such structural elements are clearly echoed in the existing framework designs and indicators, including elements such as social cohesion, sense of community, trust in institutions and active citizen participation as core elements. Assessing progress towards addressing these underlying structural drivers of injustice and inequities would need to become part of a holistic agenda to transition towards a resilient society, which would include uprooting and confronting structural elements of injustice.

1 Introduction

1.1 Justice in European climate change adaptation

The recently published Sixth Assessment Report (IPCC, 2022b, 2022a) is the first IPCC report to highlight justice as a core element of climate change adaptation, alongside effectiveness and feasibility. Justice has emerged as a key concept on the back of much growing evidence regarding how the most vulnerable people and systems are disproportionally at risk from climate change. These people and systems often have less capacity and capabilities to adapt and are the least likely to be heard, recognised and prioritised in adaptation processes, resulting in fewer benefits from adaptation actions. The lack of justice considerations and due processes can also result in 'maladaptation' resulting in redistribution of burdens or even enhancing risk for regions or groups. This is daunting, especially considering that those disproportionately affected have often contributed the least to causing climate change in the first place (Thiery et al., 2021). There are two main arguments for dealing with justice and equity in adaptation: (i) they are moral imperatives in line with the EU core values, and (ii) scientific evidence show that adaptation measures can be more effective when justice is considered (IPCC, 2022b, 2022a; Breil et al., 2021).

The principles of just resilience and 'leaving no one behind' are also introduced as key elements in recent EU policies related to climate adaptation, including the European Green Deal and related policy instruments, such as the Just Transition Mechanism (EU, 2021c), the EU Strategy on Climate Adaptation (EC, 2021b), and the EU Mission on Adaptation to Climate Change (EC, 2022b). The Council Recommendation on Ensuring a fair transition towards climate neutrality (EC, 2022a) highlights the need for inclusivity in building climate resilience. As an emerging priority, much work is yet to be done to understand and formulate the purpose and means of achieving just resilience in an EU context, and to understand how to measure progress towards achieving justice in adaptation.[1]

Figure 1.The two core aspects of just resilience: dealing with unequal burdens (climate change impacts and risk) and leaving no one behind (inclusion in and effects of adaptation action).

[1] In this report the concepts "just resilience" and "just adaptation" are used interchangeably. The concepts of justice, equity, adaptation and resilience are defined, discussed and further explained in Chapter 2 below.

1.2 Focus, aim and structure of this paper

Justice is a broad term with many definitions and meanings, and there is currently scarce and fragmented information on methods and indicators to assess justice in climate change adaptation. Since the focus and interest on justice in climate change adaptation is growing, both in Europe and globally, there is an increased need to make the concept of "just resilience" operational.

This paper contributes to making just resilience operational by stocktaking and structuring the knowledge on just resilience in climate adaptation, with a specific focus on providing relevant information towards measuring progress on just resilience in the European context, including the identification of potential indicators. Building on the previous work of the European Environment Agency (EEA) and the European Topic Centre on Climate change adaptation (ETC/CCA) (Breil et al., 2021), four questions have been identified as guiding this paper, centred around the collection and integration of knowledge in three core areas: **policy priorities, scientific evidence, and existing indicator approaches and data,** illustrated in **Figure 2.**

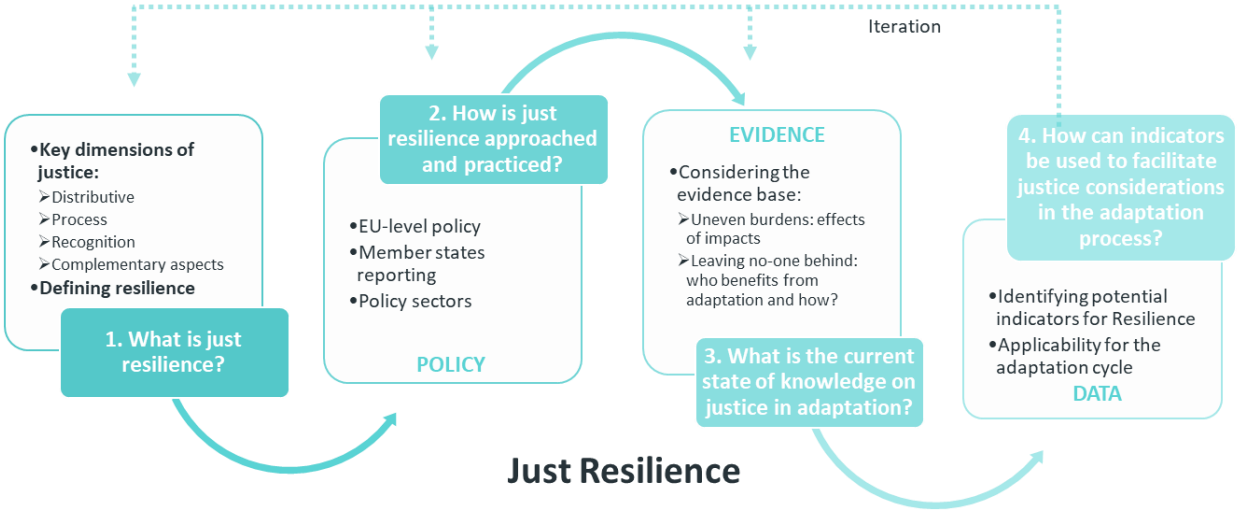


Figure 2. Just resilience concept in EEA knowledge context (developed from Breil et al., 2021).

To answer these questions, the paper follows the below focus and structure:

- to provide an introduction and description of core aspects of just resilience according to latest developments in the field, to support policy and practice as well as monitoring and indicator design (Chapter 2);
- to assess and analyse justice implications of climate change risk and impacts and adaptation interventions (policies and measures), including for current policy priorities for the EU and EEA Member Countries (Chapter 3) and in European policy sectors (Chapter 4);
- to provide an overview of existing indicators, frameworks and methodological developments that can be used in measuring, monitoring and reporting progress towards just resilience (Chapter 5);
- to cross-examine policy, evidence-base and available data and the potential to account for justice in each step of the adaptation planning cycle (Chapter 6), and,

- to summarise the key gaps and opportunities towards operationalising just resilience for Europe and priorities for advancing the knowledge on how to measure justice in adaptation (Chapter 7).

This initial exploration of knowledge and tools towards measuring just resilience complements current EEA work on adaptation indicators. Due to the complexity of issues regarding justice in adaptation, this has been done in a stepwise, transparent, and comprehensible way. The paper builds on and further develops the work carried out by the EEA and the ETC/CCA in 2021 (Breil et al., 2021).

1.2.1 Target audience

The main target audiences of the scoping paper are:

- Governmental decision-makers in Europe at EU, national and local levels and organisations supporting them; working on the operationalisation of just resilience, including development of indicators for measuring progress on resilience and adaptation as well as social policies.
- EEA Experts who will integrate just resilience indicators in their work to develop indicators for all aspects of adaptation in the scope of Climate Change Vulnerability Impact Assessments (CCVIA).
- Practitioners, working on adaptation at transnational, national and sub-national and local levels including issues related to climate adaptation and justice and equity, such as the related fields of social science and policy analysis.
- In addition, the scoping paper and potential indicators can be of interest to others working in the field of adaptation to climate change and just transition in general, such as experts working on adaptation in other (non-EU) countries, including low-income countries (e.g., in the policy area of international climate finance in the context of the UNFCCC).

1.3 On-going developments in the EU policy and knowledge context

The principles of just resilience and 'leaving no one behind' are introduced as key elements in several European policies related to climate adaptation. Measuring, monitoring and reporting on the progress of just resilience is becoming increasingly relevant in the scope of upcoming policies.

In September 2022, the European Parliament adopted a resolution on the consequences of drought, fire, and other extreme weather events, and has called for increasing the EU's efforts to fight climate change (European Parliament, 2022). The resolution recognised the uneven burden of disasters and climate change and included a set of recommendations to step up Europe's capacity to respond to climate change induced disasters. The Parliament drew attention to the **uneven exposure** to climate risks, with disadvantaged groups more vulnerable to the impacts of extreme events, and specifically **gender inequality**, with women more exposed to climate risks in the workplace. Members of the European Parliament called *"on the Commission to propose a comprehensive, ambitious and legally binding European climate adaptation framework"* addressing the **social implications** of climate change at the European and international levels.

The Parliament, in the aforementioned resolution, recognised the need for a clear and actionable information base and therefore urged the Commission to conduct a European climate risk assessment (EUCRA). This request refers to one of the actions in the EU Adaptation Strategy, in which the Commission commits itself to "*develop an EU-wide climate risk assessment and strengthen climate considerations in EU disaster risk prevention and management*" (EC, 2021b). If data on social inequality and their interaction with climate change risk can be made available in EUCRA, it could

contribute to a better understanding and consideration of the justice dimension in climate change adaptation processes at EU levels.

Even in the context of the Governance of the Energy Union and Climate Action Regulation (EU, 2018), a quantitative assessment of justice with regard to climate and adaptation policies could be applied. Indeed, the regulation requires EU Member States to monitor and report in a periodic and standardised manner the status of mitigation and adaptation policies in order to pursue "*a socially acceptable and just transition*" (EU, 2018, p. 4) across Europe.

The recently launched Mission on "Adaptation to Climate Change" (EC, 2022b), also makes frequent references to the just resilience principle. In particular, the implementation plan states that the Mission's monitoring, reporting and evaluation system will have to include "*an operational framework for monitoring just resilience with a set of indicators to measure its outcomes, outputs and impacts*" (EC, 2021a, p. 38). Tracking progress is vital for the Mission, which aims at initiating transformative processes for more than 150 communities across Europe.

Similarly, the Covenant of Mayors also refers to fairness in the climate transition process. In fact, the signatories commit to share a vision of "*a transition that is fair, inclusive and respectful of [the] citizens*"(Covenant of Mayors - European Office, 2021, p. 1). Moreover, in this case a common knowledge base on just resilience could be usefully integrated into the monitoring systems of local and regional Sustainable Energy and Climate Action Plans (SECAP) defined and managed by the Covenant of Mayors.

The Council Recommendation on Ensuring a fair transition towards climate neutrality (EC, 2022a), adopted as part of the Fit-for-55 package of the European Green Deal, emphasises the inclusivity aspects of climate resilience, by calling for risk management solutions addressing vulnerable economic actors and areas. It also refers to the need to adjust social protection systems and the occupational health and safety framework as a response to climate risks. The commission has also proposed a Social Climate Fund under the Fit-for-55 package to address any social impacts that arise from the revision of the EU emissions trading system (EU ETS) including the direct support of vulnerable households in relation to changes in the buildings and transport sectors.

The monitoring of just resilience can enable more justice focus and framing into adaptation policies (XI.1). However, despite the call for guidance to measure and monitor just resilience, it is ultimately at the local level that project developers and practitioners find themselves formulating policies and dealing with the complexity of social contexts, and it is at this local level that the application of methodologies and indicators for monitoring just resilience can meet the greatest need and have the greatest impact.

In short, the focus and interest in justice and equity in climate change adaptation is growing. Therefore, the need to have an approach to measure, monitor and report is growing as well. However, at present, although there is an abundance of definitions for 'social justice', there is little scientific consensus on methodologies or indicators that can represent the justice dimension of adaptation and monitor its outcomes. This scoping paper contributes to filling this knowledge gap. It furthermore contributes to on-going EEA work on developing knowledge on monitoring adaptation more broadly, to inform the ongoing EEA work on developing adaptation indicators.

1.4 Methodology

This paper is based on an iterative mixed-methods approach, combining literature, document and data screening, with interviews and stakeholder consultations, to gather and structure evidence from policy, scientific and other evidence as well as existing indicators and monitoring developments for just resilience. The iterative design allows for an explorative approach well suited for the subject of justice in climate adaptation, a nascent field with a variety of terms used[2] and involving highly diverse sectors, levels of governance and cultural contexts. A detailed methodology is provided in **Annex III.** The study draws on five main sources of information:

- Policy documents like thematic reports by institutional actors and documents describing specific sector policies and country reports.[3] Documents had been indicated by EEA member countries during two Eionet consultations by experts during interviews and expert meeting or identified via snowballing have been identified following resources received during interviews with experts and during the Eionet consultation in 2021 and 2022, further to the country reporting 2021. Additional sources have been identified via snowballing and targeted search to fill specific knowledge gaps.
- Scientific and grey literature: a structured literature review was conducted using as a baseline the methodology and findings of Breil et al. (2021). Literature was then expanded with relevant studies published until September 2022. This additional literature was identified via online search and review and complemented by expert comments including the IPCC AR6 WG2 report (IPCC, 2022a). A total of 145 articles and reports have been included in the evidence-based analysis (included in Chapter 4 and **Annex II**), with additional references providing scientific context for the paper, including concept and definitions (see References). For selection criteria etc. see **Annex III.**
- Indicator screening: A stepwise approach was used to identify potential indicators, including existing frameworks and datasets as well as recent methodological development, that can be applied or further explored and developed to measure progress towards just resilience at EU levels and for EU Member States. The screening was based on scientific and grey literature review, inputs from interviews, the expert group and Eionet consultation. A total of 32 existing frameworks, datasets and case studies have been included in the indicator screening, (included in Chapter 5, **Annex III**), with additional references providing scientific context for the paper, including concept and definitions (see References). For selection criteria etc. see **Annex III**.
- Semi-structured interviews were carried out with five stakeholders between March and April 2022, specifically targeting relevant policy actors; actors involved in relevant indicator development, testing and reviews; cases of lessons learnt in measuring just resilience, experts on justice and climate adaptation.
- Stakeholders were consulted through; Eionet Request for Information 2021 and 2022 and input from Eionet meeting in June 2021, and inputs from the Expert Group on Just Resilience, specifically created for the purpose of the EEA work on just resilience.

[2] Example of overlapping search terms: "just resilience", Justice in adaptation, just adaptation, equitable adaptation, fair adaptation etc. Chapter 2 further elaborates and defines these terms, see also limitation below.
[3] As part of the Governance of the Energy Union and Climate Action (EU, 2018), EU Member States must report bi-annually to the European Commission on climate change mitigation and adaptation actions (Art. 17), these reports are referred to as "Country Reporting". Reports submitted in 2021 followed the rules defined in the Regulation (EU) 2020/1208.

Limitations

- The subject contains not-yet agreed upon terminology, and spans across many fields with their varying concepts and preferred language. This can have resulted in scientific and grey literature search not rendering all relevant information, data and documents for the assessment as a whole. Multiple review rounds (3 in total) with experts in relevant fields as well as consultation with EEA member countries were carried out to verify and triangulate knowledge inputs.
- Not all policy sectors are equally covered, due to lack of justice-related aspects that could be found in the literature and in policy documents.
- The list of proposed indicators (presented in Chapter 5) is to be regarded as an initial list that could be further expanded and analysed. The search terms used focused on social justice elements and vulnerability indicators, rather than climate change impact indicators and frameworks As such the screening could be expanded to include more impact-driven indicators and to examine the cross-applicability of these different elements.
- It is beyond the scope (and time constraints) of this paper to assess the synergies and linkages to the parallel operationalisation and development of indicators for a just transition (in mitigation). No doubt, analysing the recent developments in indicator development as well as policy and evidence base for the equivalent task for mitigation, and lessons learned, could provide further insights to the work on just resilience.

2 Mapping justice for adaptation: key concepts and definitions

2.1 Conceptual overview

Concepts and definitions are core to how we understand, address, manage and monitor justice in adaptation. This chapter presents in brief the key justice types and their definitions and other core concepts used for shaping an indicator framework in this paper. It builds on and further develops the conceptual approach that was used in the 2021 ETC CCA Scoping paper (Breil et al., 2021). An overview of the key aspects and how they relate is provided in **Figure 3**.

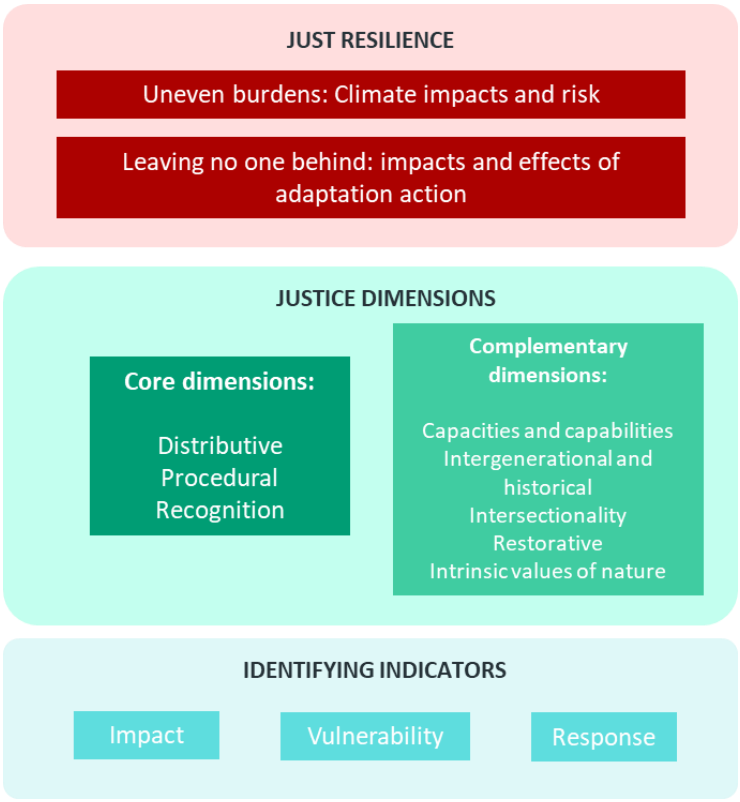


Figure 3. Overview of the core conceptual considerations for the development of indicators for just resilience for Europe.

2.2 Building just resilience

The term "Just resilience" is introduced in the EU Adaptation Strategy and refers to climate change adaptation measures carried out in a just and fair manner, forming the equivalent of "just transition" in climate change mitigation (EC, 2021b), XI1). The use of the term in this paper follows this definition given in the EU Adaptation Strategy. As such, two distinct aspects of justice in climate change adaptation are addressed in this paper (see also **Figure 1**):

- Climate impacts and risk–- 'Uneven burdens': the unequal distribution of climate impacts and risk due to unequal exposure to hazard, pre-existing inequalities and differences in adaptive capacities and capabilities (including e.g., socio-economic, historical and intersectional injustice) that result in exacerbated impacts and increased vulnerabilities.
- Adaptation action–- 'Leaving no one behind': the distribution of benefits and burdens of adaptation responses among social groups and also including fair and transparent processes with a fair distribution of political power and participation in policymaking. This includes avoiding maladaptive behaviour and targeting underlying causes of pre-existing inequalities.

2.2.1 Adaptation

Adaptation refers to adjustments in human or natural systems in response to actual or expected climate and its effects (IPCC, 2022a). It refers to changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change. In short, adaptation means anticipating the adverse effects of climate change and taking appropriate action to prevent or minimise the damage they can cause as well as taking advantage of opportunities that may arise (EEA, 2023). It has been shown that well planned, early adaptation action saves money and lives in the future. It is worth noting that according to the latest IPCC report, climate change impacts and risks are becoming increasingly complex and more difficult to manage (IPCC, 2022b, 2022a).

2.2.2 Resilience

Resilience is a term with a rich history of use and meaning. The definitions are similar in technical systems and disaster risk reduction, where resilience refers to the ability to 'bounce back' to a stable or previous state. In studies of socio-ecological systems, the resilience concept has included not only the capacity of a system to absorb and react to disturbance or crises while retaining is core functions, structure and identity, but also include the potential for a system to transition to a new state. Drivers of change or disturbance to a system can lead to the development of new pathways, and therefore also to beneficial transformation of a system into a new state (Folke, 2006; IPCC, 2022a).

With this broader definition, building resilience includes enhancing the capacity of society and the natural systems it relies on to persist, adapt and transform, in anticipation of and response to disruption and crises (Folke, 2006). In its 2020 Foresight report, the EU presents resilience as a "*new compass for EU policies*", and defines resilience in an EU-policy context as "*The ability not only to withstand and cope with challenges but also to undergo transitions in a sustainable, fair and democratic manner."*(EC, 2020b). Some authors have critiqued the concept of resilience in relation to justice, as resilience seems to frame climate risk as an external force, thus prohibiting sufficient attention is paid to the underlying causes of injustice in the processes to build resilience (Fainstein, 2015; Meerow and Newell, 2016). Synergies with the related just transitions topic is elaborated on in **Box 1**.

BOX 1: MITIGATION SYNERGIES

The IPCC AR6 report refers to the joint efforts towards mitigating and adapting to climate change as "*Climate Resilient development*"(IPCC, 2022a). The work on just transition in mitigation could be considered a frontrunner to justice efforts in adaptation, as the field has progressed further in developing strategies, concepts and tools for measuring progress towards a just transition to a climate neutral society compared to its climate change adaptation counterpart. Learning opportunities as well as co-benefits and trade-offs with mitigation and just transition initiatives are important aspects of moving towards and measuring just resilience in climate change adaptation, and for European societies. Mitigation and adaptation planning activities often share similarities, such as setting legal frameworks, providing the knowledge base and funding and could therefore potentially be measured with comparable indicators. Developing indicators to measure the progress on just resilience can potentially benefit from more advanced work done on measuring just transition in mitigation, including previous work done by the EEA.

2.2.3 Vulnerability

In this paper, IPCC's definition of vulnerability is used; "the propensity or predisposition to be adversely affected due to the inequalities in the socio-economic system" comprising "sensitivity or susceptibility to harm and lack of capacity to cope and adapt" (IPCC, 2022a). Vulnerability is multidimensional and furthermore a person cannot be defined by a single attribute such as an older person, a person with a low income, a certain gender or other. The GovReg reporting guidelines for Art. 17(2)(d) (EU, 2021b) include the following groups as potentially vulnerable:[4]

- Older people
- Persons with disabilities
- Displaced persons
- Socially marginalised persons
- Minorities
- Lower socioeconomic groups
- Gender
- Other

These categories are included in the aforementioned reporting guidelines (EU, 2021b) on "National circumstances': Vulnerabilities, including adaptive capacities and 'Monitoring and evaluation': Progress towards reducing climate impacts, vulnerabilities and risks". This list of vulnerable groups is not all-encompassing but to be considered a minimum assessment guide. This paper further explores identified vulnerable groups and intersectionality. Through this, it contributes to and informs justice in climate adaptation and indicator framework development for Europe.

2.2.4 Maladaptation

As with climate risk itself, adaptation action can accelerate already existing inequalities and vulnerabilities or create new ones. In a worst-case scenario, actors can take advantage of the adaptation agenda, proliferating on the urgency to their own economic gains or to elicit power at others' expense. Often though, negative consequences are unintended and the result of a too-narrow understanding of system interdependence. 'Maladaptation' has been coined to reflect these types of adaptation action that shift vulnerability to other sectors, locations or communities, erode sustainable development or result in an increased exposure or vulnerability to climate risk altogether (Juhola et al., 2016).

2.2.5 Difference between justice, equity, equality and inequality

Justice and equity are described as key criteria for the assessment of adaptation options in the most recent IPCC AR6 report: "Articulating the goals of adaptation at the international, national, and local levels thus requires engaging with the concepts of equity, justice, and effectiveness (high confidence)." (IPCC, 2022a, p. 160). The terms justice, equity and (in)equality and even fairness, are often used interchangeably when focusing on the "how" and "who" of procedures and access to resources or processes. Equity has been used interchangeably with "fairness" and "justice" in different disciplines (Nwadiaru, 2021). **Figure 4**, below helps illustrate the core differences between the different concepts. **Inequality** describes the state of unequal access to process or resource. **Equality** describes the equal means for access (such as equal right to education or health care), not accounting for differences in needs or other prerequisites. **Equity** goes one step further, engaging in the equal opportunity of access, taking into account different needs and privileges or starting points. Lastly, the **justice** approach includes addressing the structural elements that implements or reinforces injustices in the system as a whole. This paper focuses on justice and to some extent equity when analysing adaptation action as it also allows for the analysis of the

[4] The content of the reporting guidelines has been developed by DG CLIMA after consultation with the Member States.

structural elements that underpin the processes themselves, in line with the definition of resilience above.

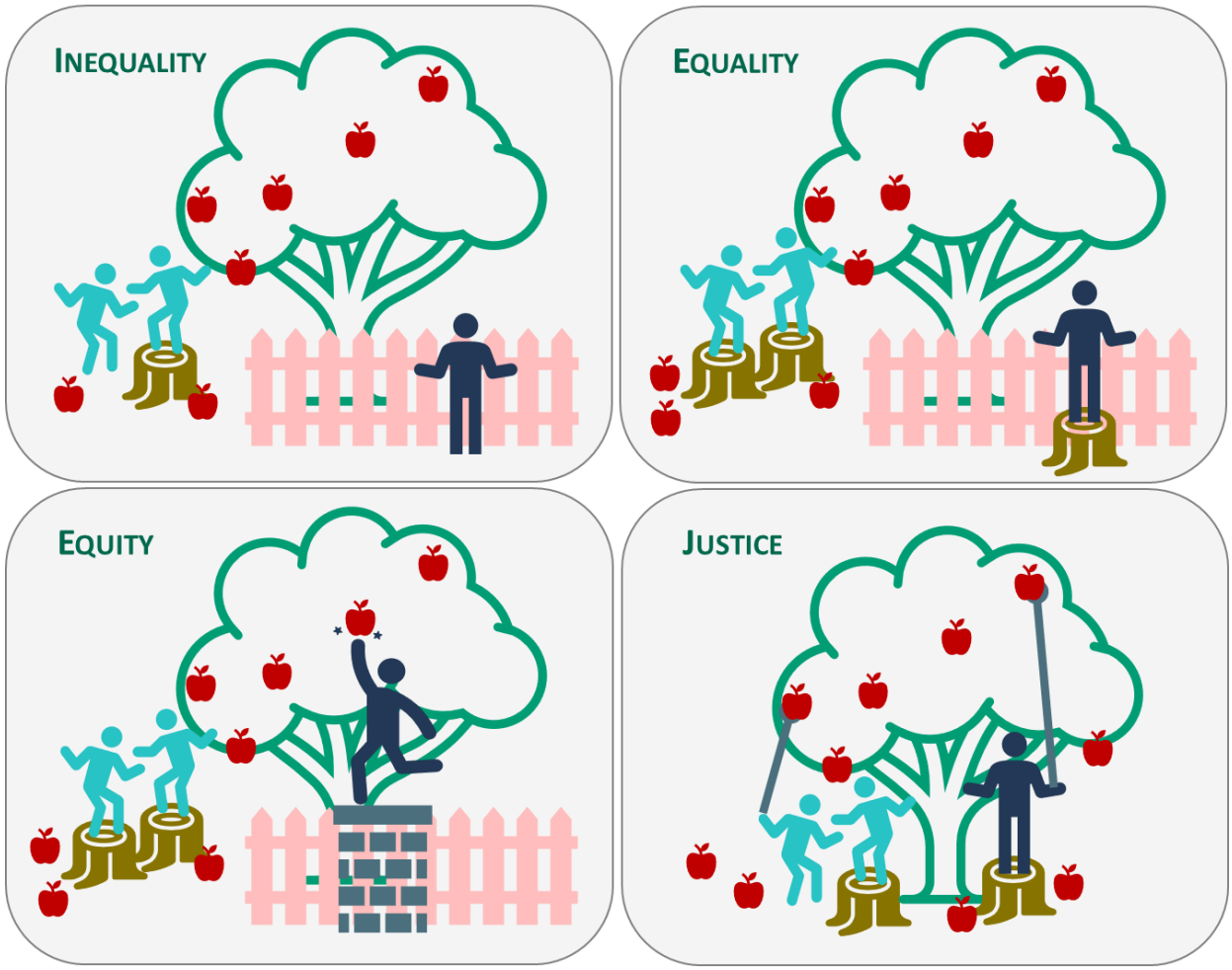


Figure 4. Illustration of the difference between inequality, equality, equity and justice.

2.3 The different dimensions of justice

The IPCC defines justice in adaptation through three core justice dimensions i) distributive, ii) procedural and iii) recognition justice, illustrated in **Figure 5** and elaborated on in **Table 1**. The rationale behind this prioritisation is that these three justice dimensions are most commonly used in adaptation literature, although recognition justice is more sparsely addressed due to a lack of scientific evidence on how to assess and address the issue. In a more general context, principles of justice have been debated for centuries in social sciences like law, economics and philosophy, resulting in a wealth of definitions and approaches. However, in the context of EU climate change adaptation specifically, there is no political agreement yet on the dimensions of justice that need to be considered in EU policies and hence determine the search for indicators to measure achievements towards just resilience. We have therefore chosen to also include a broader selection of justice dimensions in this screening (developed following Breil et al., 2021) introduced in **Table 2** below.

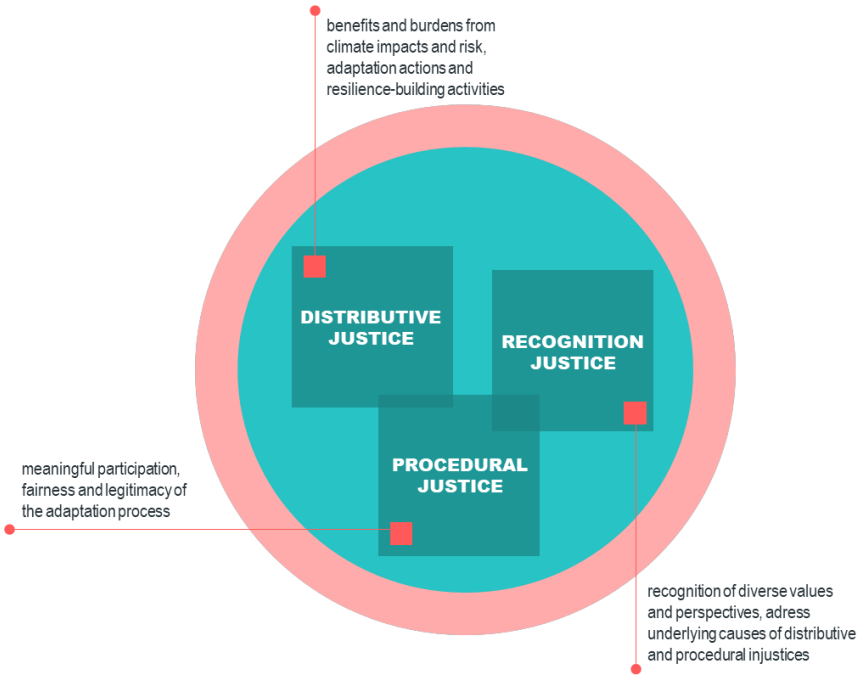


Figure 5. The three core justice dimensions: Distributive, procedural and recognition justice.

Table 1. Overview of core justice aspects

Core dimensions of justice	
Justice aspects	**Explanation**
Distributive justice	The concept focuses on the distribution of burdens (and benefits) due to climate impacts and risk, and the allocation of resources, benefits and burdens (maladaptation) for adaptation actions and resilience-building activities. Burdens for citizens may arise through the household income channel, primarily through lost or reduced income from employment, or through costs related to individual spending on resilience investment, physical damages, or health related expenditure. The AR6 report identifies three core aspects of distributive justice: justice between individuals, states, and generations (IPCC, 2022a, p. 1.50-51). In adaptation planning, practices of distributive justice often address the varying degrees and forms of social vulnerability, to ensure the protection of all communities from climate impacts and to analyse the consequences of adaptation action for different groups. (Breil et al., 2021; Brisley et al., 2012; Reckien, 2018; Reckien et al., 2018).
Procedural justice	Addresses the fairness and legitimacy of the decision-making process, including fair and transparent processes, inclusive and meaningful participation and respect for participants' rights. Procedural justice is linked to distributive justice as fair processes can lead to fair distribution outcomes. In adaptation planning, justice in participation can involve low threshold access options to information and meetings, and the promotion of active engagement of people with low political capabilities, using innovative platforms communication and bottom-up forms of involvement. (IPCC, 2022a; Paavola and Adger, 2002).
Recognition justice	Focus on the respect, fair consideration and robust engagement of diverse values, perspectives, cultures and worldviews in measuring the impacts of climate change and adaptation action. Recognition justice is both a normative principle and a functional principle that addresses the underlying causes of distributive and procedural injustices, as it addresses issues of what is valued and safeguarded. Recognition is often linked with a bottom-up perspective, such as involving groups and communities to identify their own needs (IPCC, 2022a; Preston and Carr, 2018; Reckien et al., 2014; Schlosberg et al., 2017; Juhola et al., 2022).

Table 2. Overview of complementary justice aspects

Complementary justice aspects	
Justice aspects	**Explanation**
Intergenerational and temporal justice	Focus on the temporal dimensions of climate risk and adaptation action, including the uneven distribution of impacts and therefore decisions on the resources that will be left or safeguarded for future generations, and the subsequent moral responsibilities that fall on current generations to ensure that future generations can live a good life. Intergenerational justice is therefore a core principle of sustainability. Future generations and temporal aspects are often under-represented in adaptation planning, with particular challenges in participation. However, those aspects should be considered in a coherent policy perspective to take sustainable development into account. (Page, 1999; Jourdan and Wertin, 2020) .
Intersectional justice (intersectionality)	Focus on the various forms of social characteristics such as gender, race, ethnicity, disabilities, class and other forms of discrimination. These characteristics "intersect" i.e. interconnect and overlap to create dynamics of inequality and vulnerability in response to climate impacts and risk and climate adaptation responses. Neglecting intersectional dimensions of exposure and vulnerability can result in a lack of recognition of needs and representation in decision-making processes. Intersectionality is seen as crucial to understanding and addressing the established power inequalities that can result in unequal and maladaptive processes and outcomes. (Amorim-Maia et al., 2022; Collins and Bilge, 2020).
Capacities and capabilities	Adaptive capacity is the potential or ability of a system, region, community or person to adapt to the effects or impacts of climate change, and is closely linked to socio-economic status, age, gender and intersectional characteristics. A distinction is often made between specific and general capacities, where specific capacities refer to the specific abilities to deal with climate impacts such as drought or heat waves, whereas general capacities lie closer in definition to 'capabilities', referring to the extent of a person's or group's ability to respond to an impact or risk. (IPCC, 2014) The 'capabilities' approach, similarly, focuses on people's different abilities to function, including their well-being and their freedoms in relation to climate impacts and risk and adaptation action. It closely relates to aspects of distributive, procedural and recognition justice as capabilities enable people to engage and benefit from adaptation planning and action (e.g. political capabilities). (Coggins et al., 2021; Sen, 1985; Nussbaum, 2013).
Intrinsic values of nature	Acknowledges the right of nature and of all species to be protected from climate change, independent of their value for human society (Piccolo et al., 2022).
Restorative and retributive justice	Focus on repairing the harm that has been experienced by an individual, group or community in the past. Also referred to as compensatory justice. Examples of compensation with regard to adaptation are re-naturalising areas, and compensation for loss of livelihood. (Forsyth et al., 2021; McCauley and Heffron, 2018).

2.4 Measuring, monitoring and reporting and the adaptation cycle

Monitoring is often presented as a specific step in the adaptation cycle (see **Figure 6**, step 6). But the role of indicators and monitoring of just resilience is of relevance throughout the whole process. **Table 3** specific different functions of indicators throughout the adaptation cycle. Iindicators can help clarify to what extent injustice or uneven burden can be felt or expected. They indicate areas where interventions would be needed to make adaptation more just. And they help to demonstrate if progress has been made in adaptation processes to become more just.

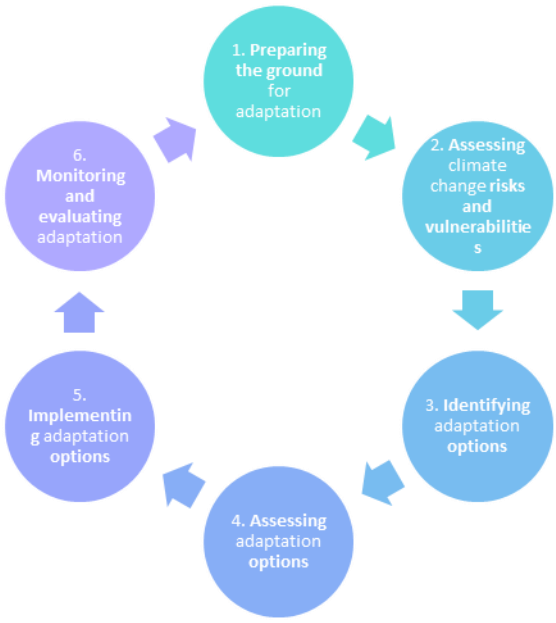


Figure 6. The six steps of the adaptation cycle (adapted from EEA's Climate-ADAPT webpage[5]).

Table 3. Overview of the function of indicators at each of the steps of the adaptation cycle. Adapted from (Juhola et al., 2022)

Monitoring purpose	Steps in adaptation cycle	Justice dimension
Monitor just resilience progress in more equal involvement and engagement of stakeholders, including the vulnerable people.	Steps 1 – 6	Procedural justice
Monitor just resilience progress in assessing how social and cultural values are included in impact assessment and development and implementation of adaptation measures.	Steps 1,2, 3,4, 5	Recognition justice
Monitor justice by assessing which social groups experience an uneven burden due to climate change – who is more vulnerable, in order to set up goals for policy making for just adaptation.	Step 2	Distributive justice, recognition justice
Monitor just resilience progress by assessing the (un)equal distribution of costs and benefits from adaptation actions between different groups, and specifically the most vulnerable	Step 3, 4, 5	Distributive justice
Monitor just resilience progress by assessing the compensation and restoration of unintended harm due to maladaptation	Step 5 and 6	Restorative justice

[5] https://climate-adapt.eea.europa.eu/en/knowledge/tools/adaptation-support-tool

2.5 Scales and categories in this paper

2.5.1 Governance scales: from local to international justice

The level of governance is a key aspect to structure the stock-taking of policy, planning and implementation. These are classified into local (individual, household, community, municipality, and city level), national (states) and international (between EEA member countries, EU-external relations). Ideally, the indicator level for a monitored just resilience dimension matches the governance scale in which it can be addressed. A challenge for measuring progress on just resilience at the local-level scale for the EU is collecting comparable data for all EEA's 38 member and cooperating countries[6]. This paper has taken into consideration a local- to European level, with a focus on Europe, national and case-study based information and analysis. The specific considerations in relation to scale and granularity are discussed as part of the analysis.

2.5.2 Indicator types

In this paper, indicators[7] refer to parameters collected for the use of measuring or monitoring and reporting on the state, outcomes or progress in relation to a certain topic or phenomena. Such parameters can be collected using quantitative and qualitative methods. Examples of collection methods are statistical data, surveys, qualitative or quantitative document analysis (such as policy and planning documents), geospatial analysis (such as maps and land-use data), modelling (such as scenario based-analysis) or in-depth interviews or focus groups. To be categorised as an "indicator" in this screening, the collected information needs to be categorisable, and the method need to be replicable[8].

Based on the use of indicators in a potential reporting context, the identified indicators were classified into four categories: impact (I), vulnerability (V), response (R) and response proxy (RP), elaborated on in **Table 4** below. The categories refer to the EEA categorisation of indicators, widely used in EEA and EEA member countries' assessments. It can be attuned to the wider DPSIR framework (driving force, pressure, state, impact, and response), used by the EEA to design assessments, select indicators and communicate results on the interplay between the environment and socio-economic activities.

There are other relevant frameworks for indicator categorisation that could be considered for the tracking of justice in adaptation. One prominent example is the division of indicator types into (i) climate risk management indicators; (ii) resilience and related indicators; (iii) indicators of human wellbeing; and (iv) climate indices, developed by Brooks et al. (2014). The framework specifically allows different but complementary approaches to the assessment of adaptation results with a specific focus on resilience and human wellbeing, which makes it particularly interesting for just resilience monitoring and evaluation. Another categorisation utilised for cities, national states and regions, companies, investors, and other subnational and non-state actors is the division into (a) targets, (b) inputs, (c) outputs, (d) outcomes and (e) impacts, developed by Hale et al. (2021). This type of structure is considered useful to a just resilience monitoring at local levels or for the reporting on project or programme level of adaptation interventions (see e.g. Goonesekera and Olazabal, 2022). The development of a comprehensive indicator framework would need to take into account the general standards for the evaluation of policies and interventions, used in international

[6] Encompasses the EEA entire knowledge network and includes, besides from the 27 EU Member States also the EEA member countries Iceland, Liechtenstein, Norway, Switzerland and Türkiye. The six West Balkan countries are cooperating countries. These include Albania, Bosnia and Herzegovina, North Macedonia, Montenegro, Serbia and Kosovo. See https://www.eea.europa.eu/en/about/who-we-are/our-knowledge-network-eionet

[7] For EEA's definition of "indicator", see eg. EEA, 2014.

[8] For general standards for the creation of indicators and their use in the evaluation of policies and interventions, the OECD DAC Framework (OECD DAC Network on Development Evaluation DAC OECD, 2010) and the Logical Framework Approach (EC, 2023c).

organisations that build on the OECD DAC Framework (OECD DAC Network on Development Evaluation DAC OECD, 2010) and the Logical Framework Approach established for monitoring and evaluation of policies and measures in the context of EU policies and interventions (EC, 2023c). In this paper, the EEA categorisation of indicator types was used for practical reasons and direct applicability to the current monitoring and reporting structures. A further exploration and development of indicator categories for the assessment of just resilience indicators could aid the development of an indicator framework for just resilience.

Table 4. Indicator types used in this paper

Indicator types		
Type	Explanation	Abbreviation
Impact	Monitoring the risk or impact of climate change on individuals, groups and/or places (driving force, pressure, state and impact)	**I**
Vulnerability	Monitoring the vulnerabilities of individuals, groups and/or places of relevance for adaptation recognition, process or outcome (state and impact)	**V**
Response	Monitoring the adaptation action (process and/or outcome) for individuals, groups and/or places (response)	**R**
Response Proxy	Monitoring the process or policy progress of an adaptation action, in cases where the adaptation outcome itself is particularly difficult to monitor (response)	**RP**

2.5.3 Categorising adaptation interventions: Key types of measures

Various catalogues of adaptation measures are in use at different governance levels that could be applied for structuring the topics to be addressed by reporting on the success of justice in adaptation policies and measures. The EEA, supported by the ETC CA, has developed "Key types of Measures" (KTMs) to provide an EU-wide categorisation system for adaptation measures in the EU, based on IPCC definitions and expanded to accommodate EU-specific requirements. One of the main purposes has been to provide a meaningful and practical basis to simplify and streamline the reporting of adaptation action by EU Member States. The KTMs have already been used in the 2021 adaptation reporting cycle. Eight EU Member States (Austria, Czechia, Denmark, Estonia, Germany, Hungary, Portugal and Slovakia[13]) reported in total 228 KTMs in 2021. This paper will use the proposed KTM structure for adaptation measures divided into the following categories:

- Governance and institutional: policy instruments; management and planning; and coordination, cooperation and networks.
- Economic and finance: Financing and incentive instruments; and Insurance and risk sharing instruments.
- Physical and technological: grey (physical infrastructure) and technological options.
- Nature based solutions and ecosystem-based approaches: 'green' (green infrastructure and natural and semi-natural land use management) and 'blue' (blue infrastructure and natural and semi-natural water and marine management) options.
- Knowledge and behavioral change: information and awareness raising (including research, communication and tools and databases); capacity building and lifestyle practices.

Scientific evidence and policy challenges related to the unequal distribution of climate impacts and risk are structured according to the KTMs. The purpose of this structure is to help to make the link between the identification of needs for measuring impact and vulnerability and the associated responses. These matrices play a core role in this analysis and can be found in **Annex Ia and b**.

2.5.4 Categorisation of impacts

The impact categories presented in this paper have been inductively derived, both related to climatic events and social or justice outcomes of those events, as emerging themes or topics identified through the evidence and indicator screenings. This approach was adopted to categorise impacts and risks as no common categorisation of impacts is used in the adaptation context for Europe. Thus, no pre-proposed categorisation of impacts was applied in this paper. The National Adaptation Reporting guidelines (EC, 2020a) includes a categorisation of climate impacts that was too detailed for the purpose of this scoping paper and do not adequately cover justice and social outcomes.

3 EU and its Member States: priorities and progress for justice in adaptation

Key messages

- Just resilience has emerged as a policy priority for Europe in the past years. Currently, European policy on just resilience is focused on international dimensions of justice, societal transformations, employment and workers' rights and allocation of adaptation funding between EU Member States.
- Increasing attention is given by EU Member States to the social justice dimension of adaptation and to the social and cultural values at risk from climate change. Implementation is however still very limited and countries do not yet have monitoring frameworks in place to measure just resilience. However, a few countries, such as Austria and Finland, have started to assess justice aspects at local level. Spain notes the importance of intergenerational justice and gender equality. Sweden has in its reporting explicitly noted that justice in adaptation is an evolving field and work is being carried out to identify areas of action.
- Where justice in adaptation is addressed, EU and Member State policies to a high degree emphasise the importance of distributive justice in climate adaptation, specifically the uneven burdens of climate change impacts and risk on vulnerable groups as well as the risk of maladaptation: the negative effects on vulnerable groups from adaptation measures that do not fit their specific circumstances. In addition, an increased but limited number of EU Member States, such as France, Spain, Sweden, Greece and Finland consider procedural justice, in particular with respect to the formulation of their national adaptation policies.
- A clearer definition and goal of justice and equity in climate adaptation, including at European, national and sector level, could help the process of operationalising the concept, and facilitate that relevant policy documents and processes reflect the full range of issues which would require policy action. Further work is needed to increase the consideration and participation of vulnerable groups in planning, implementation, monitoring and evaluation of adaptation in Europe.

Chapter overview

This chapter explores how just resilience is treated and positioned at EU level and at the national level for EU Member States and Türkiye [9]. The policy analysis provides information on related priorities and goals in Europe and can inform the development of indicators or frameworks for measuring, monitoring, and reporting on just resilience. First, the chapter provides an overview of how just resilience is interpreted and integrated in European policies, followed by an analysis of national policy and reporting from the EU Member States and Türkiye. This chapter is based on the analysis of European and national policy documents and interviews with key policy officers. For a comprehensive overview of the methodology, see **Annex III**.

[9] The latest EEA analysis of the adaptation progress and reporting for Europe covers EU Member States and Türkiye. Therefore, the analysis is focused on the 27 EU Member states plus Türkiye, rather than the broader array of EEA member and cooperating countries as little information was available to cover these. The reporting available is further explained in 3.2 EU Member States below.

3.1 Priorities for just resilience in European policies

3.1.1 International dimensions of justice

The first reference to resilience in the EU Adaptation Strategy relates to international dimensions and to transboundary and cascading impacts of climate change:

> *"The EU already is, and will increasingly be, affected by climate impacts outside Europe through cascading and spill over effects on trade or migration. This makes international climate resilience not only a matter of solidarity, but also of open strategic autonomy and self-interest for the EU and its Member States." and "Even if adaptation challenges are local and specific, solutions are often widely transferable and applicable on a regional, national, or transnational scale. Many climate change impacts have a strong cross-border dimension (e.g., in the Arctic region, macro regions, or river basins), or international dimension (EU outermost regions and Overseas Countries and Territories) and there are EU-specific impacts on the Single Market. Solidarity across and within Member States is essential to achieving resilience in a just and fair way." (EC, 2021b).*

These transboundary and cascading effects of climate change may increase threats to international stability and security, and this affects, in particular people, who are already in fragile and vulnerable situations. Adaptation measures by the EU can also have negative consequences for third parties (Lager et al., 2021). There are two policy areas that currently consider these international justice implications to a certain extent. Firstly, in development aid, where a few EU Member States are explicitly working on making their development assistance for climate resilience more just by supporting least developed countries (LDCs) who are disproportionality exposed to climate risk and simultaneously have contributed the least to climate change historically. Examples are climate proofing development aid to prevent maladaptation and to reduce inequalities, for instance by Ireland and Finland (see **Box 2**).

Secondly, international dimensions are included in policies related to the energy transition. The energy transition and subsequent transformation of the economy, consumption patterns and geopolitics in the EU and elsewhere will have a significant effect on international trade, e.g., affecting prices for food and agricultural products, energy and material inputs including metals and minerals and organic material (e.g.: wood). Subsequently, the transition risk interacts with climate risk and adaptation and poorer and least-developed countries will be disproportionately affected by these secondary impacts, potentially driving food and water scarcity. To enable a globally just resilience it will be necessary to unlock adaptation investments and address political conflicts properly to lower barriers to adaptation (Medinilla and Knaepen, 2022).

BOX 2: EXAMPLES: INTERNATIONAL JUST ADAPTATION ACTION IN IRELAND AND FINLAND

Among EU Member States, **Ireland** pledges to increase its international climate action for international climate justice and just resilience as part of the national Climate Action Plan 2021 (Government of Ireland, 2022). They are committing to financial aid and cooperation, in particular climate proofing of development assistance, increasing of financial resources and particular engagement for least developed countries and small island developing states foreseeing in particular investments in the health sector and in "just resilience" (Government of Ireland, 2022),

Another EU Member State example is the **Finnish** development policy which is grounded in the Paris Agreement on Climate Change and the goals of the 2030 Agenda for Sustainable Development. Here the main goal set for international cooperation policies is to eradicate poverty and reduce inequalities. Climate resilience is one of the cross-cutting objectives, which is mainstreamed into all activities and informs, as a consequence, also international cooperation policies (Finnish country profile: Climate-ADAPT, 2022).

3.1.2 Societal transitions: mitigation and adaptation intersections

Societal transitions seem to be more observed in the context of mitigation than adaptation policies and subsequently, according to an interviewee (XI.5, 2022), mitigation policies still receive more funding than adaptation policies. However, recently introduced and updated EU policies such as the European Green Deal include both mitigation and adaptation aspects and acknowledge the increasing awareness about how climate change affects people. Assessments of and attention to equity, well-being and in particular working conditions in relation to adaptation policies are slowly gaining traction (XI.5 2022). For example, the European Green Deal mentions that "*The most vulnerable are the most exposed to the harmful effects of climate change and environmental degradation. At the same time, managing the transition will lead to significant structural changes in business models, skill requirements and relative prices"*(EC, 2019). In a similar manner, the new EU climate law (EU, 2021d) and the EU Regulation on the Governance of the Energy Union include an integrated view on energy and climate mitigation and adaptation dimensions and include adaptation in the social/just transitions dimension.

3.1.3 Focus on employment and workers' rights in the EU Adaptation Strategy and the Green Deal

Breil et al. (2021) highlight that the focus in the EU Adaptation Strategy and the European Green Deal with regards to just transition is primarily on employment and worker's rights, largely reflecting the objectives and design of the just transitions for mitigation movement (EC, 2021b, 2021a). These policies highlight an increased need for education, training and skills to support new green jobs and economic diversification, which can enable a labour force mobility to green growth sectors and away from those sectors impacted by climate change (Breil et al., 2021). The EU Adaptation Strategy furthermore highlights the need to better understand the effects of climate change on living and working conditions, health and safety and how to address consequent distributional effects (Breil et al., 2021; EC, 2021b). There is already some evidence on the impact of climate change on health for outdoor occupations in agriculture and building sector. Loss of jobs are also projected for Southern Europe in the agriculture and tourism sectors. Other sectors that are expected to lose employment opportunities are manufacturing, public utilities, retail and leisure, as well as business and public services (Susova and Mailleux, 2020).

3.1.4 Climate adaptation has become a high-level policy area in Europe

With the increasing importance of adaptation in European policy, the procedure of making adaptation policy at EU level is gradually changing. For example, a whole-of-government approach is used. This means that DG CLIMA involves all EU Commission services at director level in inter service group meetings to develop and implement the EU Adaptation Strategy.

However, a stronger focus on horizontal policy integration would be beneficial, for example in relation to just resilience, there is a need to better connect aspects such as employment and workers' protection, gender issues, adaptation finance, trade policies, development practises, and this is not yet practiced in EU Member States (XI.5, 2022). Other policy areas where consideration of justice issues in relation to adaptation is of urgent need (as identified by experts) are the areas of trade, finance, and EU development cooperation (XI.1 and 5, 2022).

3.1.5 Allocation of funding between EU Member States

Between EU Member States, equity and justice considerations mainly address allocation of the costs of mitigation, adaptation, and compensation *between* countries (Charveriat, et al., 2019). However, assessing these aspects is not straight forward, given the different concepts and forms of operationalisation of equity and justice that are already used to allocate funding among Member States Some examples of such are: the polluter-pays principle, the ability-to-pay principle, the

beneficiary-pays principle, historical responsibility and the right to sustainable development (Charveriat, et al., 2019). A further operationalisation of these concepts could be valuable.

3.2 EU Member States

The latest EEA analysis of the adaptation progress and reporting for Europe[10] (EU Member States and Türkiye) finds that social justice and cultural values at risk from climate change has been given an increased amount of attention in the 2021 reporting compared to previous European assessments (EEA, 2022a, EC, 2018). It also notes that there is a positive development in Member States where increasingly, vulnerable groups have been given a role in developing national and regional adaptation policies in several countries and are increasingly involved in the prioritising of adaptation measures. Despite this positive trend, key knowledge gaps and a lack of targeted measures and ways of monitoring, reporting and evaluating justice considerations and outcomes in adaptation persist across Europe.

The section below presents the EU Member States that have come furthest in emphasis on social justice of their adaptation policies, illustrated in **Figure 7**. The most common approach is a specific focus on vulnerable groups or individuals (mainly the elderly, children, people in poor health, minorities) and the climate risks they are exposed to. As such, these Member States have adopted a distributive framing of justice, particularly in relation to the health, urban (also related to the issue of energy poverty), and agricultural sectors. Some countries such as France, Spain, Finland and Greece also include considerations of procedural justice, ensuring that identified vulnerable groups are included in the design of equitable adaptation policies. Finally, Spain and Finland refer to elements that might be considered forms of recognition justice. Sweden is the only country that has in its reporting explicitly noted that justice in adaptation is an evolving field and work is being carried out to identify areas of action.

The ensuing sections provide an overview on practices currently on-going in Member states, based on information extracted from various sources, including feedback received from an Eionet consultation among EEA member countries and co-operation countries made in 2022, interviews to experts (see **Annex III**), the reports made by member country information provided in the climate adaptation section of the periodic reporting related to the Governance of the European Energy Union and Climate Action (EU, 2018) which is used for the description of Country profiles on the Climate-ADAPT platform (Climate-ADAPT, 2022).

[10] As part of the Governance of the Energy Union and Climate Action (EU, 2018b), Member States must report to the European Commission on climate change adaptation actions (Art. 19). In 2021, the first reports from the member states provided a framework for bringing to light the state of adaptation in Europe (EEA, 2022a). This framework also provides an information base for understanding whether Member States are concerned with the social implications associated with their adaptation policies and, if so, where they focus their policy action.

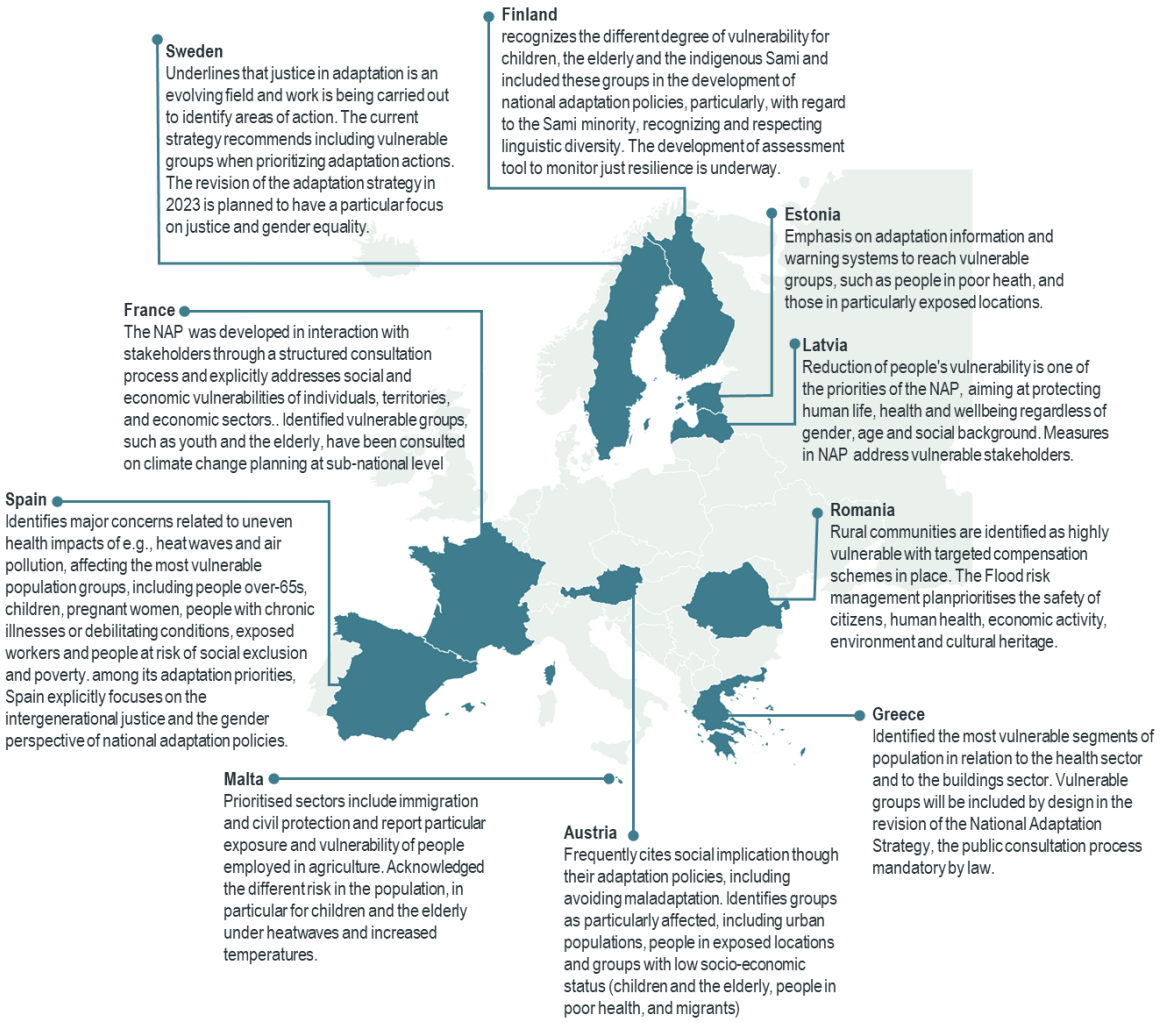


Figure 7. Overview of the EU Member States covered in this analysis: Austria, Estonia, Finland, France, Greece, Latvia, Malta, Romania, Spain and Sweden.

3.2.1 Austria

Austria is among the countries most frequently citing the social implications of adaptation policies in current policies. An overall goal stated in the Austrian Adaptation Strategy is to strengthen adaptive capacity across social, natural and technical domains, while avoiding *social downsides* and minimising risks to democracy, health, security and social justice. According to the Austrian country report, adaptation activities that conflict with other key objectives, such as environmental protection or climate change mitigation or that disadvantage social groups should be prevented (Climate-ADAPT, 2022).

Among key affected sectors, Austria has included the urban sector, with increased risk to low-income groups. Drought, heavy rainfall and heat waves alongside with low air quality which exacerbates effects of high temperatures, will represent an additional pressure on the health of the urban population, especially for those with neither the knowledge nor the financial resources for taking precautions. Austria reported that specific population groups will be particularly affected by climate change and by potential adaptation measures due to their location and/or socio-economic situation including the children and the elderly, people in poor health and people living in areas particularly exposed to climate risk. Austria also reported a specific attention to migrants. Through the CCCapMig project[11], it was found that new citizens have a lower general awareness of risks

[11] https://boku.ac.at/en/rali/ilap/projekte/cccapmig/

compared to long-term resident, with the exception of citizens living in territories where, due to frequent flooding, the citizens are regularly informed.

Furthermore, Austria reported that the adaptation policies (National Adaptation Strategy and National Adaptation Plan - NAP) are designed to avoid maladaptation. In particular, no-regrets and win-win adaptation measures are identified as means to provide further social, ecological, or economic benefits regardless of the extent to which climate change is accelerating. Moreover, to prevent maladaptation, Austria created EIA 'climate-fit portal' (UVPklimafit Infoportal[12]): a portal that supports project developers and authorities to anticipate the consequences of climate change in the design of the projects that are subject to Environmental Impact Assessment. The aim is to adapt infrastructure and by design prevent design potential negative impacts on people.

3.2.2 Estonia

The main objective of Estonia's National Adaptation Strategy is to increase the readiness and the capacity of the state, the regional and local level to adapt to the effects of climate change. As a consequence, particular emphasis is put on the provision of warning systems and adaptation information to reach vulnerable and particularly exposed groups, identified as people in poor health, people located in coastal areas and in the oil shale region (Ida-Viru County). In its country report, Estonia addresses the social dimension of adaptation in mainly distributional terms. In addition, strategic environmental assessment reports must include any potential impact on human health and social needs.

3.2.3 Finland

In its country report, Finland refers to the distributional procedural and recognition dimension of justice in adaptation. The report recognises the different degree of vulnerability for children, the elderly and the indigenous Sami. These three categories were included in the process of developing adaptation policies, particularly, with regard to the Sami minority, recognising and respecting linguistic diversity. Finland has started initial efforts at government level to develop an assessment tool to monitor just resilience (XI3, 2022).

Finland reported that one study – CLIMINI project[13] - was launched at national level to better understand the conditions of and needs for climate adaptation of some vulnerable groups such as the reindeer herding community, which also includes members of the Sami minority. As stated in the country report, one of CLIMINI's main findings is that reindeer herding has a rather high adaptive capacity to the changes caused by climate change. Some adaptive strategies include technological change strategies, which may however lead to the abandonment of ancient practices, irreversibly transforming the traditional reindeer herding livelihood closer to agriculture. Other adaptation measures in reindeer herding include changes in the management schemes of cooperatives, the adoption of additional livelihoods (e.g., tourism), improving competitiveness by increasing the processing of reindeer meat and marketing.

Finland also reports on the sub-national activity of the Metropolitan area of Helsinki which has developed a set of indicators for understanding adaptation needs and evaluate the effectiveness of implemented measures. The national reporting document points to the fact that only few indicators can be updated more frequently, while "most of them are such that changes are only visible in the longer term or monitoring data is more difficult to obtain" (EU, 2021e Finland).

[12] https://uvpklimafit.boku.ac.at/
[13] https://www.arcticcentre.org/FI/climini/climini-EN

3.2.4 France

France pays particular attention to the procedural dimension of justice. It reported that the French National Adaptation Plan (NAP) was developed in interaction with stakeholders through a structured consultation process. According to the reporting, the most vulnerable populations are included in the development of the NAP via public services implementing social policies and represented through consultation with associations representing vulnerable groups. France reported that vulnerable groups – such as youth and the elderly – have been consulted on climate change planning at sub-national level. Through the mechanisms provided by the Regional Plans for Planning, Sustainable Development and Territorial Equality (introduced by Law No. 2015-991), regional authorities can involve stakeholders. Beyond the national reporting, France addressed justice in adaptation in other policy documents. The second French Climate Adaptation Plan (NCCP 2) (République Francaise, 2018) explicitly addresses social and economic vulnerabilities of individuals, territories, and economic sectors, and aims at addressing both exposure and adaptative capacities in accordance with the principle of climate justice. Justice considerations are based on input by the Economic, Social and Environmental Council (Jouzel and Michelot, 2016). During the Eionet consultation in 2021, responses from France pointed to a report on climate impacts on workplaces and different research activities regarding differences in heat impacts in urban areas, in particular in the region of Paris. With regards to measures to address heat vulnerability, a scientific article was cited which reported on the fact that the measures undertaken for protecting persons vulnerable to heat did not effectively reach those most vulnerable or in need (Laaidi et al., 2019).

Particular disadvantaged regions have been identified in France that "... combine both climate vulnerability, situations of inequality and concentration of poverty". These situations would require preventive action (as the National Office for Water and Aquatic Environments already does) rather than resorting to specific solidarity funds for local authorities in cases of natural disasters (Jouzel and Michelot, 2016). The same report indicates that in general, some regional typologies are of particular risk of inequalities with respect to just resilience, such as the mountainous, the coastal and the rural areas, affecting populations which because of their low incomes and or age are not able to adapt to climate change (Jouzel and Michelot, 2016, p. 29).

3.2.5 Greece

Greece refers to both the distributional and procedural dimensions of justice in their adaptation reporting. One of the main goals of Greece's National Adaptation Strategy is to strengthen the adaptive capacity of the Greek society through awareness and dissemination actions. Greece aims at creating a national Adaptation Knowledge Hub to provide adaptation information to reach vulnerable groups, pooling together relevant data, information, good practices and approaches for targeted stakeholders to help address different types of vulnerability to climate change impacts. Greece reported that vulnerable groups will be included by design in the revision of the National Adaptation Strategy. The public consultation process has become mandatory according to Law 4414/2016 (Article 42).

In its country report, Greece identified the most vulnerable segments of population in relation to the health sector and to the buildings sector. To climate proof the building stock to the expected climate conditions, Greece reported that it has implemented a series of ambitious incentive programmes for private houses renovations: Housing Saving Programme I and II. The programmes envisage a series of measures to prioritise those groups that have been identified as most vulnerable.

3.2.6 Latvia

In its country report, Latvia refers to the social dimension of climate change in distributional terms. Latvia indicates the reduction of people's vulnerability as one of the priorities of its National Adaptation Plan, aiming at protecting human life, health and wellbeing regardless of gender, age and social background from the adverse effects of climate change. The National Adaptation Plan identifies the elderly, children, people with disabilities, people employed in agriculture, forestry and tourism, and people living on coastal and flood risk areas as the most vulnerable groups.

According to the reported information, almost all of the 80 adaptation measures in the NAP address vulnerable stakeholders, such as the improvement of early warning system (especially on weather extremes), access to free drinking water in public places, awareness raising among educational and social care institutions, and development of recommendations for social care institutions and social workers on health prevention measures during heat waves.

3.2.7 Malta

Malta reported seven priority sectors for climate adaptation (according to the vulnerability assessment carried out for the Maltese National Communication to the UNFCCC in 2017 as well as the country's Low Carbon Development Strategy). Among the sectors, Malta listed immigration as one of the priority areas, along with health and civil protection, implicitly indicating policy areas where the effects of uneven distribution of societal implications of climate change can be monitored.

A further focus on the social dimension of climate change relates to the agricultural sector. Malta reported that potential impacts could be suffered the most by the agricultural sector through thermal stress of livestock, leading to decreased animal welfare standards, and to decreased yields for farmers or higher financial costs needed to maintain acceptable animal welfare. Malta reported that under those harsher weather conditions, the population employed in the agricultural sector might abandon their land. Finally, Malta acknowledged the different incidence of risk in the population, in particular the risk for children and the elderly under heatwaves and increased temperatures.

3.2.8 Romania

In its country report, Romania included the agriculture sector and rural development among the key sectors affected by climate change and at the same time, having clear social implications. Rural communities are identified as highly vulnerable. To reduce the vulnerability, a compensation scheme is reported to be in place. The Ministry of Agriculture and Rural Development has launched the sub measure 17.1 "Crop, animal and plant insurance premiums" for providing compensations for the damages generated by droughts (with an initial allocation 24,7 million euro). Nevertheless, with the projected change in climate, the likelihood of future risk under different scenarios may increase. A further reference to the social dimension of climate change in Romania's report is found in relation to flood risk. Under its Flood Risk Management Plan, Romania mentions its objective to reduce the negative consequences of floods for the safety of citizens, human health, economic activity, environment, and cultural heritage.

3.2.9 Spain

The Spanish country report indicates a focus on the distributional dimensions of justice in adaptation. It identifies major concerns related to uneven health impacts of e.g., heat waves and air pollution, affecting the most vulnerable population groups (over-65s, children, pregnant women, people with chronic illnesses or debilitating conditions, exposed workers and people at risk of social exclusion). Climate change interacts with an existing, already fragile health and socio-demographic condition: an increasingly ageing society and an approx. 21,5% of population in or at risk of poverty (Spanish country reporting), which includes energy poverty. Beyond concerns about uneven

distribution of heat-related vulnerabilities, procedural justice is an additional focus of the Spanish Adaptation Strategy (PNACC). In fact, in the climate assembly, part of the participative process for climate policies, different social groups were well represented, and efforts were made to also involve minorities in the formulation of policies (Eionet consultation 2022).

Among its adaptation priorities, Spain explicitly focuses on the intergenerational justice and the gender perspective of national adaptation policies. A report for the Spanish government has investigated in particular gender inequality in relation to climate policies, which recognises those women that are heads of single parent households to be particularly vulnerable due to their socio-economic status, as well as of other structural social inequalities resulting in reduced adaptive capacity due to wage gaps and discrimination and exploitation of female climate migrants. Such reduced adaptive capacities translate, for instance, into energy poverty defined in national statistics as "not being able to keep the dwelling at adequate temperatures" and "high shares of income spent for heating and cooling" (Gisbert Velasco et al., 2020),

3.2.10 Sweden

The information reported by Sweden focus on the distributive dimensions of justice. Sweden has based its National Adaptation Strategy on the predicted consequences for society, underlining that justice in adaptation is an evolving field and work is being carried out to identify areas of action. The Strategy recommends including vulnerable groups when prioritising adaptation actions. The revision of the Swedish Adaptation Strategy in 2023 is expected to have a particular focus on justice and gender equality.

Heatwaves are increasing in both frequency and severity, exposing people in risk groups to even greater danger. These risk groups include older people, disabled people, young children and pregnant women, and people with cardiovascular diseases. Several adaptation initiatives have been put into place to engage and reduce the vulnerability of these segments of the population, for example the development of action plans to be implemented in the case of a heatwave, the preparation of specific care measures such as dietary changes, spending less time in the sun, the increased intake of liquids and reduced physical activity.

Sweden reported that the municipality of Kristianstad in the south of Sweden has implemented several actions addressing heat vulnerabilities. A particular problem arises in Sweden as buildings in urban areas are generally connected to district heating, while responsibilities for keeping dwellings and spaces cool lie with the individual household or owners. (Eionet consultation) The vulnerability of the elderly to infectious diseases is an additional concern in Sweden, as well as the specific exposure and vulnerability of ethnic minorities to loss of livelihoods, affecting Swedish and Norwegian Sami people. Sami women in particular are identified as being under stress from climate impacts (and future perspectives for their livelihoods).

3.3 Synthesis and reflection to inform monitoring and indicators

With the weight given to just resilience in the new EU Adaptation Strategy (EC, 2021b), the EU is making important steps to move forward on the integration of justice into national and local climate adaptation policies. Although 'just resilience' was only formally mentioned in the new EU Adaptation Strategy in 2021, there are already several EU policies and national policies that have integrated (aspects of) justice in adaptation approaches, as illustrated in this chapter. Furthermore, in 2022, the Commission has explicitly underlined the connections between fairness and adaptation stating that properly designed adaptation action should create co-benefits in terms of climate mitigation, but also "… improve social and economic resilience in a fair manner, considering the uneven regional and societal impacts of climate change and weather extremes.". The policy assessment has demonstrated that several EU level policies cover enabling actions to ensure that adaptation is actioned in a more just way. At the same time, only very few justice policy

formulations are specific enough to give clear guidance for a policy-driven selection of just resilience indicators. An overview of the core aspects and priorities across European and EU Member States policies is provided in **Table 5**, below.

This chapter has clearly indicated that just resilience is slowly starting to be integrated in policies at European level and at EU Member State level. The policy analysis is of relevance for the selection and development of indicators, as it provides insights into policy areas to be supported by data and of policy outcomes to be monitored concerning just resilience. At the **European policy level,** priorities to develop indicators and monitoring framework for just resilience are identified as:

- The transboundary and cascading impacts of climate change on European trade, migration and stability.
- The impacts of development aid on justice dimensions beyond the European Union.
- The justice dimensions of European adaptation policies and measures on people living outside the European Union.
- The justice dimensions of climate change and adaptation on employment and workers' rights and the topic of labour mobility.
- The level of mainstreaming of just resilience into different European sector policies.
- The justice dimensions regarding the scope of allocating funding between EU Member States.

Based on the analysis at **Member State level**, it can be concluded that just resilience is a rather new topic for many countries. However, about one third (10) of the Member States makes note of justice in the existing national reporting on adaptation progress. These reports address different aspects of measuring just resilience:

- *Distributive justice*: The identified distributional justice dimensions focus on vulnerable groups, identifying and making specific consideration to the most vulnerable and adaptation measures are adapted to the specific contexts of vulnerable communities (including preventing maladaptation). 7 out of the 10 countries are aware that adaptation measures may aggravate vulnerability and may result in maladaptation with regard to these groups, when their specific needs and circumstances are not considered. Most of the countries hence focus on assessing the physiological inequalities to heat vulnerability (exposed elderly and children, and people in poor health). Vulnerabilities and inequalities of burdens driven by socio-economic drivers (like poverty, gender, occupational exposure to heat, etc.) are considered only in isolated cases.
- *Procedural justice*: 5 countries have already recognised the importance to closely engage vulnerable groups in the development of national adaptation plans.
- *Recognition justice*: 2 out of the 10 countries pay specific attention to the different values patterns and circumstances of social groups, including the specific recognition of future generations, women, or cultural minority groups.

The analysis also indicates that just resilience is considered at a national level specifically with regards to sectors like health, agriculture, urban and building sectors. Inequalities are identified in relation to economic sectors which are particularly sensitive to climate impacts (mainly agriculture) or a specific traditional form of livelihoods (i.e., the case of reindeer herding in Sweden and Finland), generally without differentiating between more or less vulnerable actors within the sector.

Other relevant observations of this chapter are:

- Few EU Member States have (yet) prioritised actions or approaches to justice in adaptation relevant to the priorities formulated in the EU Adaptation Strategy on international dimensions of justice or in relation to the climate proofing their development cooperation projects in their adaptation reporting.
- Local action is mentioned in only a few cases with regards to measures identified to address uneven burdens. A stronger connection between local and national level reporting on progress towards just resilience can increase transparency and knowledge sharing.
- The identification of vulnerable groups, activities or regions have only in rare cases been followed by specific monitoring activities or by efforts to build up monitoring systems which are able to address inequities with regards to vulnerabilities and adaptation measures.

Table 5. Overview of finding from policy analysis, European and EU Member State policies and priorities.

Country/ Region	Type of justice	Key sectors	Vulnerable groups	Climate impacts and risk	Policies implemented	Good practices	Possible indicators
Europe	Distributive	agriculture, building sector, tourism	Outdoor workers	Health impacts from heat		Coordination between policy sectors for the development of the EU Adaptation Strategy	
	Distributive	manufacturing, public utilities, retail and leisure		Job losses			
Austria	Distributive	urban and specific locations at risk	Low-income groups (without knowledge or resources for taking precautions) or living in particular locations, migrants	Health risks from drought, heavy rainfall, heat waves	NAS and NAP call to avoid maladaptation, recommend win-win and no regret solutions	Climate proofing of infrastructures (UVPklimafit Infoportal)	location and/or socio-economic situation
Estonia	Distributive		People with poor health, exposed groups (residents in coastal areas)		Strategic environmental assessment reports need to report on potential impacts on health and social needs	NAP	Health status, location
Finland	Distributive		Elderly, children, indigenous population (Sami)		Vulnerable groups included in the development of adaptation policies	NAP	Assessment tool for monitoring just resilience
	Distributive/ recognitions	*traditional livelihoods (reindeer herding)*	*i.e., Sami*	*Loss of livelihoods traditions/ culture*		*Climini project explores specific adaptation needs*	
		urban (Helsinki Metropolitan area)					*Set of indicators adaptation needs and effectiveness of measures*
France	Procedural		e.g., young people, elderly,	Heat stress	Involved in policy making, e.g., NAP		
	Distributive		individuals, economic sectors		NAP		
	Distributive	geographical territories	People living in specific territories with low income		Preventive action rather than compensations after extreme events requested		
Greece	Distributive		whole society, vulnerable groups	Low adaptive capacity	knowledge hub for reaching out to vulnerable groups		
	Procedural		Vulnerable groups included in revision of NAS				
	Distributive	health sector					

Country/ Region	Type of justice	Key sectors	Vulnerable groups	Climate impacts and risk	Policies implemented	Good practices	Possible indicators
	Distributive	building sector			incentive programmes for private houses prioritising vulnerable groups		
Latvia	Distributive	agriculture, forestry, tourism coastal and flood risk areas	Elderly, children, people with disabilities employees in vulnerable sectors/areas	Heatwaves, flooding	Adaptation measures in NAP address vulnerable stakeholders	Early warning systems, drinking water in public spaces, awareness rising/recommendations for health preventions in care institutions	
Malta	Distributive	health, civil protection	Elderly, children	Heat waves, increased temperatures			
	Distributive	agriculture		Thermal stress of livestock, income losses for farmers			
	Distributive	migration	(Mentioned only as an area of concern)				
Romania	Distributive	agriculture	Rural communities	droughts	Compensation scheme for losses		
	Distributive		Society as a whole	Flood risk	reduction of negative consequences		
Spain	Distributive	health	Elderly, children, pregnant women, people with health conditions, at risk of (energy) poverty	Uneven health impacts from heat waves and air pollution			
	Recognition/ Distributive		*Women, female migrants*	*Socio-economic inequalities translate in reduced adaptive capacities, e.g., energy poverty*		*Report commissioned by the Spanish Ministry on gender inequality in relation to climate policies*	*Indicators for socio-economic status (e.g., single female parent households, energy poverty)*
Sweden	Distributive/ Procedural				NAP recommends including vulnerable groups when prioritising adaptation actions		
	Distributive	buildings	elderly, disabled, young children, pregnant women, people with cardiovascular diseases	Heat	Heat wave action plans, specific care measures	Actions at municipality level: need to address cooling of dwellings	
	Distributive	health	elderly	Infectious diseases			
	Recognition	agriculture	Minorities (Sami), women in minority communities	Losses of livelihood and culture causing stress			

4 Justice in adaptation for European policy sectors

Key messages

- Across policy sectors the evidence base on justice or equity concerns and outcomes on a sector level in Europe., repeatedly identifies specific groups as particularly vulnerable and of particular at risk of having less influence on outcomes from decision making processes. These groups include the young (infants and children) and the elderly, poor or low-income households, people in poor health, people with poor social networks, immigrants, and ethnic minorities. Particularly exposed populations are also identified, as residents in particular low-lying areas, in Southern Europe, and in both urban and rural areas.
- Some sectors are ahead in the understanding and development of solutions for justice in adaptation planning and implementation, as these sectors have been confronted with justice related aspects before. Particularly the building sector (especially in relation to energy efficiency and energy poverty), the urban policy sector (where inequalities related to urban transformation were high on the agenda already prior to the introduction of urban adaptation policies), the health sector and disaster risk reduction sector.
- Some adaptation measures may themselves aggravate injustices if the underlying inequalities and social mechanisms are not sufficiently considered in the design and implementation, such as green infrastructure and relocation measures.
- Many sectors still lack sufficient evidence on justice in adaptation, across all three dimensions of justice: distributive, procedural and recognition and how to overcome them. These knowledge gaps need to be addressed to further develop a systematic and robust framework of indicators to monitor, report and evaluate just resilience across all policy sectors.

Chapter overview

This chapter investigates the impacts and adaptation interventions relevant for exploring just resilience in relation to the different areas of policy intervention. Specifically, it focuses on the European policy sectors, to further provide the scientific information base for indicator development. There is currently no common categorisation of policy sectors at EU levels used for adaptation policy and planning. The policy sector division used here to structure the scientific evidence applies the categorisation that is used by Climate-ADAPT[9] and that is also complementary with the sector structure of the National adaptation reporting under the EU Climate Law (EU, 2021d), including: Agriculture, Biodiversity and Nature-Based solutions[10], Buildings, Coastal areas, Disaster risk reduction, Energy, Financial, Forestry, Health, Marine and Fisheries, Transport, Urban, Water management, illustrated in **Figure 8**.[14] A "cross-cutting" sector topic has been additionally introduced, since a significant number of identified justice aspects and outcomes transcends the sector division. Where a justice topic spans over several sectors, the most relevant sectors have been chosen and referred to in the respective sectors, the reader is therefore guided to engage also with linked sector information.

This categorisation of policy sectors allows for the analysis of distinct policies that are being implemented in Europe. Overlaps between these policy sectors are unavoidable and addressed in the relevant sections, e.g. in relation to urban areas, as urban policies are able to address also health issues without becoming part of health policies.

[14] The sector division has been criticised for being a mix of economic sectors (eg. agriculture), geographical regions (eg. coastal, urban), and approaches (eg. Nature-based solutions) and is under revision. However, they provide an entry point to explore the relevant aspects related to just resilience.

Figure 8. Illustrative overview of the Climate-ADAPT policy sectors.

This chapter synthesises the evidence on justice implications that are connected to these policy sectors. The evidence indicates what *should* be measured, as part of a future monitoring framework. To get a better understanding of what indicators should be selected and developed to track progress in just resilience, evidence has been collected on (i) **the uneven burden of climate change impacts and risk** for people and regions and (ii) **adaptation action with justice outcomes** (leaving no-one behind) including potential responses, their processes and outcomes (including maladaptation). To collect this evidence, a systematic analysis (consisting of a review of 150+ articles and reports) has been carried out with a focus on evidence from studies in Europe. The methodology is described in full in **Annex III**. The evidence is presented in full in two matrices in **Annex I,** divided in the two categories: 'uneven burdens' ('IR'): unequal distribution of climate impacts and risks with justice implications (**Annex Ia**) and 'leaving no one behind' ('AD'): differences in justice outcomes from adaptation actions (**Annex Ib**).[15]

Approaches to indicator development need to take into account policy needs and scientific evidence to develop a transparent, scientific sound and actionable monitoring and reporting. Therefore, this evidence from scientific literature is combined with the structured screening of the EU policy documents from Chapter 3, to highlight the justice implications that are already integrated in the policies. As such, this screening provides guidance on what justice aspects are already considered in policies and therefore provides an understanding of the priorities for indicator development. Although the following chapter (5) explores existing indicators in depth, this chapter (4) provides a sneak preview of the indicator screening with an example of a potentially relevant indicator for each of the policy sectors, where possible. The example indicator focuses on *one* justice dimensions that is key for the respective policy sector and how this may be monitored. While acknowledging that it is not possible to entirely separate the different dimensions of justice, it is helpful to clarify the dominant dimensions of the justice implications for each sector. A more in-depth analysis on indicators and a proposed monitoring framework are found in Chapter 5 and 6 respectively.

[15] The codes 'IR' and 'AD' are used as id-numbers in Annex Ia and b, combined with the relevant KTM A-F. Such as the example in **Figure 9**: 'IR.B1.1'.

4.1 Policy sectors

4.1.1 Agriculture

Unequal burdens due to climate risks, impacts and vulnerabilities

The agricultural sector is confronted with the challenge of transforming its systems fundamentally in order to secure food production, livelihoods and the vitality of rural communities (IR.D1.1). This is due to increased variability in weather patterns, increased frequency of extreme events, increasing mean temperatures, environmental and health issues and land use changes amongst the sector challenges.

It is observed that climate impacts, specifically, can trigger reduced yields, losses of economic assets (place based) and reduced income (IR.B1.1). Uneven burdens can be found in these agricultural areas that are expected to be disproportionately exposed to climate risk, which is mainly due to their geographical location (e.g., Southern vs. Northern Europe, but also in-country differences) and also because of their geographical traits (place-based risk, such as coastal areas and along rivers, or types of soils). Specifically, Southern Europe is expected to experience a loss in crop productivity and loss of dairy production because certain areas are becoming unsuitable for production. In the meantime, parts of Northern Europe can experience positive effects as areas can become more suitable for crops that have not been produced there before (IR.B1.1). Income loss due to crop productivity relates to multiple aspects like management practices, farm characteristics, level of farm diversification, size, type of crop and climatic conditions may differ among regions. (IR.D1.1). **Figure 9** illustrates an extract of the evidence matrix across all policy sectors that can be found in Annex Ia. This matrix illustrates the described justice implications that the agricultural sector can experience as the result of income loss because of drought. Other relevant justice implications are described in the full matrix.

Impact/risk type	Description		Governance level	Key sector(s)	Justice dimension(s) indentified in literature	Source
	Identified impact or risk	Justice implication				
...	...	...	...	...	...	...
Drought, reduced water resources	**B1.1: Loss of economic assets and income** Climate impacts can have a physical impact on property values and trigger losses of economic assets (place based) and/or income revenues: examples are impacts on agriculture or tourism or due to increasing flood risk along coasts and rivers, extreme precipitation events or fire risk. *Links to A2 (physical planning), A3 (networks), C1 and C2 (grey I infrastructure) and e (knowledge and behavioural change).	**Unequal distribution of assests' value losses and income losses:** Certain populations disproportionately affected: place based (e.g. coastal areas and along rivers; farmers in Southern Europe due to international trade market.) and socio-economic groups). Women are disproportionately affected, due to unequal access to resources, education, job opportunities and land rights, aggravated by social and cultural norms and their diverse intersectional experiences.	National, local	Water management, Agriculture	Distributive	Country Reporting Bulgaria, Austria, Latvia, Romania and Slovenia. And: European Parliament 2018, EEA, 2019, Reidsma et al. 2010; Reidsma et al. 2009a; Reidsma et al. 2009b
...	...	...	...	...	...	...

Figure 9. Example of justice implication of climate risk and impact in the agricultural sector – extracted from the evidence matrix in Annex Ia.

Evidence shows that uneven burden can also be the result of different vulnerability among farmers. This farmer's vulnerability is determined by aspects like coping capacity, social capital and adaptative capacity (IR.B1.1). In addition, European farmers face multiple stressors. Farmers' economic viability has been in decline and farmers' mental health problems decrease their long-term well-being and capacities to adapt to changing conditions (Hagen et al., 2019; Kortetmäki, 2022). Furthermore, studies have also shown that farmers that cope well in current conditions are not necessarily better adapted to the projected climate variability (IR. B1.1). Furthermore, small- and medium-sized farmers in the global south, forming a crucial part of global food systems and European food security, are projected to further bear the brunt of climate impacts, while they have the least adaptative capacity, and have contributed the least to climate change. These existing vulnerabilities of farmers within the global systems have implications for food and agricultural

inputs for EU Member States and for extra-EU production as it may affect food trade, food security and affordability (IR.D1.4). Early research shows that the Mediterranean region in Europe is particularly vulnerable to international trade shocks due to its high dependence on food import from outside of Europe and due to the role of the food sector in the economy as a whole (IR B1.1).

Leaving no one behind

Several mechanisms are in place to support regions and farmers to make sure no one is left behind. One important mechanism is the EU Common Agricultural Policy (see **Figure 10**). Regulations on direct payments and rural development potentially continue to create disincentives for farmers to improve the resilience of their farms. Policy and adaptation planning in European agriculture have often been criticised for favouring the preservation of the status quo over more transformational changes that involve a significant re-structuring of the agricultural system (AD.A1.3). This is also related to existing power inequalities between large agricultural business and small- and medium scale farmers that have different influence on decision making (AD A1.3). However, the new EU Common Agricultural Policy (CAP 2023-2027) does include adaptation to climate change in its policy framework. The EU Member States have recently submitted their CAP strategic plans in which they elaborate how to implement the CAP-related and CAP-funded instruments to contribute to the European goals, including climate change. EU Member States need to meet specific spending requirements and performance standards related to environment and climate (EC, 2022d). It depends on the actual implementation of these plans whether the measures reduce vulnerability of farmers or may still result in farmers being left behind because regional assessment level may not succeed in revealing their underlying vulnerabilities (AD A1.3).

Description		Governance level	Key sector(s)	Justice dimension(s) indentified in literature	Adaptive/mal-adaptive outcomes (poitive/negative /both)	Source(s)
Identified response, adaptation measure or adaptation outcome	Justice dimension or implication					
...	...	...	...	...	...	...
A1.3: Agricultural policies including the EU Common Agrigultural Policy (CAP) Policy and adaptation planning in agriculture often critiqued for favouring the preservation of status-quo over more transformational changes that involve a significant re-structuring of the agricultural system. Best practice include adaptive capacity assessment/impact assessment at farmlevel to avoid unjust policy measures. Strategies can also specifically result in shifting farm practices, such as the rise in popularity, materially or discursively, of flex crops and climate resilient commodities; affecting land use and agricultural practices.	**Risk exacerbate inequalies due to power dynamics, pre-existing vulnerabilites and poor representation** Power inequalities between large agricultural business and small- and medium scale farmers related to influence, as well as intra- and extra EU power dynamics. Measures might increase vulnerability or might risk to leave certain farmers behind because assessment at regional level does not reveal underlying vulnerabilities. shifting practices can undermine small-scale, traditional and nature-based practices (and benefits large scale producers and monocultures.	International, EU, national and regional level	Agriculture	Distributive, procedural,	Positive or negative (to be determined with the new CAP)	EEA 2018, 2021; Zagaria et al. 2021; Reidsma et al. 2010; EEA, 2019; European Commission, 2022
...	...	...	...	...	...	...

Figure 10. Example of justice implication of adaptation measure in the agricultural policy sector – extracted from the evidence matrix in Annex Ib

Furthermore, the EC Directorate-General for Agriculture and Rural Development (DG AGRI) indicates the urgent need for policy action regarding the specific vulnerabilities of some regions, in particular with regards to the Western Balkans. It states that "*The rural areas of the region will also require assistance in adapting to possible consequences of climate change, which may result in water scarcity and extreme climate events, such as floods. Support to local development in rural areas, dissemination of good practices and innovations, and networking should enable rural communities to better respond to these challenges*"(DG AGRI, 2020, p. 24).

Adaptation in the agricultural sector also relates to the cross-border and international dimension of just resilience. This requires the EU to take measures to secure affordable food for EU citizens, for instance by targeting the most vulnerable people that have the least capacity to adapt (AD.A1.2). Although the EU has not yet used policy instruments to secure affordable food in the context of climate change, a mix of interventions have been promoted to secure affordable food in the context

of the global food crisis triggered by Russia's war of aggression against Ukraine[16]. Although not explicitly focused on climate change risk, the EU has developed a holistic policy to increase the fair commercialisation of agricultural products, for instance within the Farm to Fork strategy (EC, 2020c). Fair commercialisation is about giving everyone equal access to the market. This strategy also aims to provide benefits to all citizens and operators across value chains, in the EU internally and abroad. The strategy mentions that the EU is focused on supporting global food value chains to become more climate proof and more inclusive and fairer. However, when addressing resilience, the strategy is primarily focused on resilience towards diseases and pandemics, rather than explicitly referring to just resilience as part of climate adaptation.

Guidance for indicator development to assess just resilience in the agricultural sector

Just resilience in the agricultural policy sector is according to the evidence screening mainly connected to distributive dimensions of justice. Climate change risks affects certain European regions and farmer groups disproportionately. The adaptation measures that are already in place in the agricultural policy sector aim to reduce the vulnerability of regions and farmers. Monitoring just resilience can therefore be done by periodically assessing vulnerability of farmers and their income loss. Aggregating this information and combining it with sector information like job losses at the regional level will demonstrate the relevant justice implications among European regions. One example of an indicator for regional vulnerability of rural areas is the socio-economic climate vulnerability index that has been used in the study on the Southern Great Plan in Hungary, see **Figure 11**. This composed index included statistical data about environmental, economic and social vulnerability, in combination with adaptation capacity and exposure. It fits well for the purposes of the agricultural policy sector as it refers to groundwater availability, agricultural employment and labour income in the agricultural sector.

Case studies: methodological developments and novel approaches in scientific literature												
ID	KTM	Indicator type *	Climate impact/risk	Indicator focus	Name/Title	Description (general)	Indicator samples (what is measured/monitored)	Justice dimension(s)	Collection method	Scale and granularity	Sector(s)	Source or URL
CS3	A1, A2	I,V	Extreme temperatures and altered rainfall patterns	Health, regional vulnerability	**Geographical analysis of climate vulnerability at a regional scale: the case of the Southern Great Plain in Hungary**	The socio-economic climate vulnerability index: combines the physical, economic and social sensitivity, adaptation and exposure indices and relate to different climate impacts. Builds on the application on international indices at the local/regional level.	- **Environmental vulnerability**: groundwater level of main rivers, biomass production of forests and arable lands - Economic vulnerability: ratio of the agricultural sector in employment, labour income share of the small-scale agricultural sector, ratio of industry in employment. - **Social vulnerability**: Patients of respiratory and cardiac distress, number of visits to a general practitioner, proportion of people aged over 65 among permanent residents - **Adaptation capacity**: per capita income, proportion of graduates within the 25+ population, number of scientific, technical-technological enterprises (proxy for the intellectual, scientific and technical potential which can be used in the adaptation process) - **Exposure**: change of the number of heatwaves, change of rainwater quantity, volume of urban land, quantity of communal water supplied in settlements.	Distributive	Statistical data	National, Regional	Cross-cutting, Agriculture	Zsolt Farkas, J., et al., 2017

Figure 11. Example of indicator to monitor just resilience in the agricultural policy sector – extracted from the indicator matrix in Annex II.

4.1.2 Biodiversity and nature-based solutions

Uneven burdens of climate risks, impacts and vulnerabilities

Climate change is threating global biodiversity, and this has also been highlighted in IPCC report (IPCC, 2022a). Destruction of ecosystems weakness their capacity to regulate greenhouse gas (GHG) emissions and protect against extreme weather, thus accelerating climate change and increasing vulnerability to it. Especially artic ecosystems are facing huge change and biogeographical shifts due to climate change. The impacts will pose a disproportionate risk to livelihoods and cultures that are closely linked to these ecosystems in terms of their biodiversity and ecosystem services (natural and-semi natural land-use). Climate change is causing a loss of intrinsic natural values, culture and

[16] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/stronger-europe-world/eu-actions-enhance-global-food-security_en;
https://ec.europa.eu/commission/presscorner/detail/en/ip_22_1963

memories, but will also affect health and well-being, social networks, livelihoods and other benefits that these people derive from biodiversity (IR.D1.2). Social groups with strong cultural and livelihood-based ties to natural systems, specifically Indigenous people and ethnic minorities in Europe, are identified as particularly vulnerable. Often, these social groups are ethnic minorities and indigenous groups' values and nature's rights are underrepresented in policy and planning. Indicators should acknowledge the group's values and how they will potentially experience the impacts of climate change (Reyes-García et al., 2023).

Impact/risk type	Description		Governance level	Key sector(s)	Justice dimension(s) indentified in literature	Source
	Identified impact or risk	Justice implication				
Multiple risk	**D1.2: Loss in natural capital** And land-use change (driven by climate change) pose a risk to livelihoods and cultures closely linked to ecosystem services/natural land-use and cause loss of intrinsic natural values, memories and benefits from biodiversity. *Links to A1 to A3 (Policy and coordination, cooperation and networks) and E2 (empowering and lifestyle choices) It also relate to potential loss of social values that are connected to health, feeling of safety, belongingess, self-esteem, self actualisation.	**Nature-based livelihoods and historical injustice** Social groups that are at risk of losing their livelihoods due to the changing environmental conditions, including their culture, social networks, well-being, health and income basis, example is the Saami population and Basque example of losses of memories and mental health as a result of flooding. Most affected are indigenous groups and groups with strong cultural and livelihood-based ties to natural systems. Communities who contributed the least to climate change are suffering most from the consequences. Inter-generational loss of indigenous cultural heritage.	National, local	Cross-cutting, Eco-system based approaches, Coastal areas	Distributive, Procedural, Recognition, Intrintic values, Historical justice	Foudi et al., 2017; Guillaume and Neuteleers, 2015; Graham et al. 2013; Marzeion & Levermann, 2014; Fatoric and Seekamp, 2017, Karlsson et al. 2015; IPCC AR6 2021.

Figure 12. Example of justice implication of climate risk and impact in the biodiversity sector - extracted from the evidence matrix in Annex Ia.

Leaving no one behind

Nature based solutions

The advantages of nature based solutions (NBS) are emphasised in various EU policies as means for providing additional societal benefits beyond climate change adaptation and reduction of disaster risks (EEA, 2021b). The European Commission's definition of NBS states that these solutions are "… inspired and supported by nature", … "are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience." (European Commission, 2023). Ecosystem-based approaches and NBS are therefore often considered as best practices and valued as no-regret measures with multiple benefits. Adaptation that is regenerative, long-term and nature-based can furthermore provide co-benefits and can reconnect people with nature and their historical roots (AD.D.1.2, AD.D1.3). Therefore, these adaptation measures may play a significant role in making sure people that rely directly on nature for their livelihood are not left behind.

Such positive benefits for specific groups may take place in urban greening projects such as green and biophilic designs. This is elaborated in more detail in the sections on building and urban sectors. NBS for long-term coastal-zone adaptation management are also put forward as best practice, such as practices of afforestation, careful land use and the use of less impermeable surfaces. (AD.D1.3).

But urban NBS such as multifunctional parks also have been shown to come with a risk of aggravating existing inequalities and to lead to redistribution of risk or to only benefit the already privileged groups, for instance in the case of green gentrification (see **Figure 13**). Green gentrification happens when poor households risk exclusion from living in areas where nature-based solutions have been implemented due to rising real estate values and rental prices.

Therefore, such mechanisms deprive lower income groups of the benefits that NBS provides (AD C1.2). While, IUCN (2020) highlights that NBS should also be designed and implemented by adopting deliberate and purposeful design principles to meet human wellbeing needs (AD E2.3), market mechanisms driving urban renovation policies need to be addressed with dedicated and efficient measures (AD C1.2).

Description		Governance level	Key sector(s)	Justice dimension(s) indentified in literature	Adaptive/mal-adaptive outcomes (poitive/negative/both)	Source(s)
Identified response, adaptation measure or adaptation outcome	Justice dimension or implication					
C1.2 Urban greening and green infrastructure	Affordability of housing, risk of gentrification Risk of increasing inequalities due to action increasing increase housing prices – making the area unavailable to lower income households. Would need adequate policy measures for reducing this effect. Despite engagement processes, vulnerable groups can be worse off, due to the adaptation measures, as in the context of greening policies (e.g. Amsterdam)	City-scale, National-level	**Urban,** Health, Buildings	Distributive, procedural	Positive & Negative	Country reporting Sweden and Sharifi, 2021; Climate-ADAPT 2022a; (Anguelovski and Corbera, 2023).

Figure 13. Example of justice implication of adaptation measure in the biodiversity and nature-based solutions – extracted from the evidence matrix in Annex Ib.

Biodiversity strategy

The new EU Biodiversity Strategy 'Bringing nature back to our lives' (EC, 2020e) highlights that human wellbeing strongly depends on health and diverse ecosystems. This EU policy is highly relevant in the context of climate change as climate change is accelerating the destruction of nature and the unsustainable use of natural resources is a key driver of climate change (European Commission. Directorate General for Research and Innovation., 2020).

The Biodiversity Strategy aims to strengthen natural ecosystems and nature-based solutions and wants to bring nature back to cities. EU policies provide guidance for the assessment of nature based solutions for climate adaptation and disaster risk reduction by making synergies between biodiversity and just resilience visible (Veerkamp et al., 2021). It also indicates when adaptation measures, such as relocation, can lead to loss of intrinsic values of nature and biodiversity (AD.D1.1), as well as the uneven distribution of the benefits of biodiversity conservation and greening actions and unfair distribution of economic costs for protecting biodiversity between different societal actors (and supporting climate adaptation capacity). Furthermore, the EU Biodiversity Strategy calls for adopting the principle of equal and inclusive approaches to ensure participation of stakeholders across different socio-demographic groups.

Guidance for indicator development for the biodiversity sector

Evidence demonstrates that biodiversity sector policies need to take into account the uneven burden of climate change on populations that depend for their living on ecosystems. The evidence shows that nature-based solutions and biodiversity can come with positive and negative impacts and costs that may be unevenly distributed among groups. Both aspects indicate the distributive dimensions of just resilience. To prevent maladaptation from taking place it is important that NBS are designed with strong involvement of the different social groups. An example to monitor just resilience in the biodiversity policy sector is the NBS impact assessment framework (**Figure 14**). This indicator is a composed indicator that assesses the impact of NBS across twelve societal challenge areas. This example is relevant as it includes indicators to assess to what extent NBS design and implementation processes are open to engage the different social groups via the indicator on participatory planning and governance.

Available datasets and frameworks												
ID	KTM	Indicator type*	Climate impact/risk	Indicator focus	Name/Title	Description (general)	Indicator samples (what is measured/monitored)	Justice dimension (s)	Collection method	Scale and granularity	Sector(s)	Source and URL
I17	n/a	I, V, RP	multiple risks	Monitoring Nature-based solutions	**Evaluating the impact of nature-based solutions: A handbook for practitioners**	NBS impact assessment framework including set of indicators and methodologies to assess impacts of nature-based solutions across 12 "societal challange areas" including indicator sets to monitor natural and climate Hazards, participatory planning and governance, social capacity building and social justice and social cohesion. the indicators are classified as structural, process-based or outcome-oriented.	Sample indicators: - **Participatory planning and governance**: Openness of participatory processes, Proportion of citizens involved in participatory processes, Sense of empowerment: perceived control and influence over decision-making, Adoption of new forms of participatory governance, Policy learning for mainstreaming NBS: Number of newpolicies instituted, Trust in decisionmaking procedure and decision-makers - **Social justice and social cohesion**: Bridging– quality of interactions within and between social groups, Bonding – quality of interactions within and between social groups, Inclusion of different social groups in NBS co-processes, Trust within the community, Solidarity among neighbours, Tolerance and respect, Availability and equitable distribution of blue-green space	Procedural, Capacities and capabilities, Distributive	Geospatial analysis (I), statistial data (V) and surveys and project based and participatory data collection (quantitative and qualitative) (R, RP)	Local	Urban, Nature-based solutions, Cross-cutting	European Commission,2021 Directorate-General for Research and Innovation, Evaluating the impact of nature-based solutions : a handbook for practitioners, Publications Office of the European Union, 2021, https://data.europa.eu/doi/10.2777/244577

Figure 14: Example of suitable indicator to monitor just resilience in the biodiversity sector – extracted from Annex II.

4.1.3 Buildings sector

Uneven distribution of risk, impacts and specific vulnerabilities

Evidence on the justice implications of climate impact in the building sector can be found related to energy demand. Studies from the EEA (2018) show that in nearly all European countries, lower socio-economic status increased vulnerability to heat stress. Poor citizens live to a larger extent in poorly insulated homes with higher energy demands for cooling and/or heating due to extreme temperatures. High energy demands and energy prices interact with other stressors, such as food prices or inflation, and drive poverty. Often the same groups cannot afford to renovate their housing to an adequate level and are more likely to be tenants rather than house owners, with implications for possibility and means to change or improve the housing situation. When the indoor climate cannot be managed, the risk of health impacts increase. A recent EEA briefing indicated that in several countries, 9 – 20% of the population might be affected by overheating in buildings (EEA, 2018; WHO, 2018, 2021; European Quality of Life Survey 2016 - Data visualisation, 2020; EEA, 2022i) (IR. C2.1) (see **Figure 15**)

Impact/risk type	Description		Governance level	Key sector(s)	Justice dimension(s) indentified in literature	Source
	Identified impact or risk	Justice implication				
Increased temperatures and heat waves	**C2.1: Extreme temperatures and cooling/heating needs** Increasing temperatures and heatwaves, poorly designed buildings and lack of cooling systems (*see also C1.1). Poorly insulated homes and increased energy demand (cooling and heating) and transition risk (energy access and increased prices) and can increase occupational injuries - also related to C2 Technological infrastructure. *Links to A1, A2, A3 (Governance and institutional)	**Inequality in housing conditions and affordability** Access to cooling options inside the dwelling (good insulation of homes and availability/use of cooling devices) as well as outside (cooling centres, parks) are key elements in effectively adapting against extreme heat for the elderly population. Uneven burdens due to energy poverty (specifically mentioned by Hungary and Spain) and low-income groups, the elderly and the homeless. Furthermore, the montoring of heating is often included in the context of energy poverty policies, whereas the capacity to keep temperatures cool are rareley measured. Cooling needs are more prominennt in Southern Europe and Heating needs in norther Europe, lading to a risk sqewd proirity to northern geographical areas if colling needs are not adequately monitored in the context of energy poverty.	National, local	Health, Buildings, Urban	Distributive	Sánchez-Guevara et al., 2019; Benmarhnia et al., 2014; Nunes, 2018. Country reporting Hungary and Spain. Thomson et al. 2019, EU-SILC ad-hoc modules 2007 and 2012, EEA, 2018, WHO, 2018, 2021; Eurofund, 2020.

Figure 15. Example of justice implication of climate risk and impact in the building sector – extracted from the evidence matrix in Annex Ia.

Furthermore, the building sector may be confronted with energy transition risks that affect access to energy and increase prices as the result of the need for cooling and heating systems (IR.C1.1, IR.C2.1). There is also the damage that public and private buildings experience due to their location in the risk area as the result of flooding, landslides, sea-level rise and storms. This may also result in communities that are more prone to these damages, compared to others (IR.C1.2, IR.C1.3). It has been shown that low-income housing is more often placed in areas with higher flood risks, creating an uneven burden for these people. Furthermore, buildings that are located in areas with poor environmental quality are also at risk of aggravated impacts, such as, for instance, areas with a lack of green space, poor air quality or housing of poor quality (IR.D1.3).

Leaving no one behind

The building sector plays a major role in mitigation policy, as the sector represents the major single energy consuming sector in the EU, 42 percent of EU's final energy use and 35 percent of energy-related EU greenhouse gas emissions (EC, 2022a; EEA, 2022). The policies in this sector have already introduced instruments that consider the need for a fair and just energy transition in the EU. These instruments are also of relevance for just resilience. Many of the policy instruments focus on improving the energy performance of houses. Houses with poor energy performance are called energy poor buildings. The EU decarbonisation strategy promotes simultaneous end-user electrification in the residential sector, decarbonisation of the electricity sector, and improvements of energy efficiency in buildings (AD C1.1). The EU policy and the related EU energy efficiency goals (EU, 2010, 2012) are provided by the 'renovation wave strategy' (EC, 2022c). This renovation wave strategy aims to at least double the annual energy renovation rate (currently estimated at 1%) of residential and non-residential buildings by 2030 and to initiate deep energy renovations that could reduce buildings' energy consumption by at least 60% (EC, 2020d). The Energy Efficiency Directive, the Energy Performance of Buildings Directive and their respective 2021 recasts set out clear frameworks to achieve this (EEA, 2022b). (AD C1.1).

Tackling energy poverty and worst-performing buildings is one of the 3 focus area of the renovation wave strategy. In this way, the most vulnerable people are supported to make sure they are not left behind (AD C1.1) (EC, 2020d; Papantonis et al., 2022). Until recently, the focus for policies addressing energy poverty was mainly on heating. Although cooling is included recently (EC, 2022b, p. 35), but statistical data related to cooling are not yet systematically collected in the European statistical system (EU-SILC ad-hoc modules 2007 and 2012; EEA, 2022b). The recent EEA (2021) briefing also indicates that: "Increasing evidence also suggests that support for energy efficiency investments in residential buildings not only contributes to reducing energy poverty, but also has wider socio-economic outcomes" like better health. Better health of the most vulnerable is the result of building retrofits better outdoor air quality that improve their health and well-being (AD C1.1).

It is hence expected that co-benefits of these policy instrument to improve building performance and reduce energy poverty would be larger if subsidies would target specifically lower segments of the housing market, low standard buildings and the rental sector. Yet these low-income households stand at risk of being left behind. They are not easy to reach either because they are tenants and their landlords rent out low standard housing or are not interested to improve housing standards. And if landlords do invest, they would transfer the cost of investments onto tenants, making the dwellings unaffordable for this income class (Ástmarsson et al., 2013; XI 5, 2022).

To overcome the complex issues for tenants, EU Member States have adopted policies ranging from allowances to help low-income households to pay their energy bills to investments in energy efficiency and the formation of energy communities. The proposal for a revision of the of the Energy Performance of Buildings Directive (EU, 2021a) includes suggestions for several measures to address the difficulties for tenants to invest in or obtain energy efficient dwellings at affordable prices, and calling on Member States to alleviate energy poverty and support social housing (EU, 2021a). Papantonis et al. (2022) describe national policy approaches from Denmark, Belgium, Sweden, and Wales which attempt to tackle the problem of energy poverty in the private rented sector with specifically targeted communication, subventions dedicated partly to rent reduction and mediation between landlords and renters.

But also, low-income households that do own the dwelling, might struggle to find finance to make the structural investments in their energy efficiency (XI 5, 2022). For the sector of owner-occupied dwellings, Greece, which has a high share of low-income homeowners with low investment capacity, has offered subsidies for building renovation which are partly paid before the beginning of the works so that homeowners do not need to anticipate the costs of renovation while waiting for the

public subsidy, generally paid after the conclusion of works (Eurofound, 2021). Italy is offering a tax reduction of 110% (Superbonus) for homeowners to pay their invoice. This type of intervention helps to improve affordability of improving energy performance to the poorest and most vulnerable groups (Eurofound, 2021). Comparable financial support is also provided by EU Member States when they are promoting renewable energy to low-income householders. This enables them to overcome energy poverty. But next to providing financial support to low-income homeowners, measures would be needed to raise awareness on the existence of such financial support as non-take-up of available support often occurs among the most vulnerable people.

Description		Governance level	Key sector(s)	Justice dimension(s) indentified in literature	Adaptive/mal-adaptive outcomes (poitive/negative/both)	Source(s)
Identified response, adaptation measure or adaptation outcome	Justice dimension or implication					
C1.1 Housing energy savings Improving building insulation, using passive heating/cooling solutions, improving energy efficiency of heating and cooling devices, high-performance windows, shading and ventilation. Adaptation and health-effects.	**Dedicated policies to endure affordability** Particularly relevant for vulnerable populations at-risk from extreme temperatures. Requires dedicated policy packages, which frequently rely on incentives to the private sector. High risk of inequities (example Scotland), as the necessary investments to be incentivized by public policies are generally reserved to home owners and tend to exclude tenants. Energy poverty is increasing among both owner occupiers and tenants creating further limits to private investments in particular among poor households. MB Tenant households normally are not able to improve energy efficiency of their buildings, while landlords do not have an economic stake (energy bills being paid by tenants) Dedicated measures to improve affordability of renovation and higher energy efficiency will have the co-benefit that the health of the most vulnerable people is expected to improve as well.	Involve private actors MB support low income home owners, tenants	Energy, Buildings, Urban, Health	Distributive	Positive & Negative	De Cian et al., 2019; Ludden, et al., 2021; Oliveras et al., 2021; Scottish Government, 2020; Eurofound and EEA, 2021; Cabrita et al., 2021; Sharifi, 2021. EEA 2021

Figure 16. Example of justice implication of adaptation measure in the building sector – extracted from the evidence matrix in Annex Ib.

Evidence shows that there are also financial mechanisms for energy efficiency in place that may increase the risk of low income households to be left behind, as for instance carbon taxes, such as introduced by France (Gouvernement Francais, 2022). While such taxes may provide households with incentives to become more energy efficient (AD.B1.1), the tax affects energy prices which may create disproportional burdens on 'energy poor' and low-income households if no targeted compensation actions are set, as described above (AD.C1.1). Apart from increased building costs for energy performance that aggravate pre-existing inequalities between people, comparable mechanisms are observed in case of mandatory elevation of buildings for flood regulations (AD.A.2.8), greening policies and post-disaster reconstruction (AD.C1.4). These measures come with a cost too and may become unfair for poor people. Consequently, low-income groups may be excluded because they cannot afford such measures.

Procedural justice in the building sector refers to the ability to voice what one needs. The outcomes for and participation of vulnerable groups, including in the spatial planning and the design, focusses on affordability, inclusion and sustainability and green design (AD.A2.4, AD.A2.7) and adaptation in the social housing sector (AD.C1.3). Identified best practices include participative planning and implementation, retrofitting of public spaces in social housing areas, and policy and regulatory measures to limit gentrification (AD. C1.3).

Consideration for the design of indicators to assess justice related to the building sector

The evidence shown that there is a need to focus on indicators covering distributional and procedural aspects of justice in the building sector. Monitoring just resilience would mean tracking to what extent the low-income households are supported to make sure they will not be left behind. The example indicator is based on energy poverty but is extended with the 'keep a dwelling cool' component as essential criterion.

Case studies: methodological developments and novel approaches in peer scientific papers												
ID	KTM	Indicator type*	Climate impact/risk	Indicator focus	Name/Title	Description (general)	Indicator samples (what is measured/monitored)	Justice dimension (s)	Collection method	Scale	Sector(s)	Source and URL
CS1	C1, A1, A2	I, V	Extreme temperatures	Heat and energy poverty considering income and age.	**Population vulnerability to summer energy poverty: Case studies of Madrid and London**	Heat and energy poverty indices: exposure and vulnerability to high summer temperatures by exploring the geospatial connection between the urban heat island intensity, housing energy efficiency and overheating risk, and social vulnerability indicators.	**Impact**: urban heat intensity, housing stock energy efficiency **Vulnerability**: household income, population over the age of 65 Context specific proxies for each indicator and location.	Distributive	Modelling, statistical data	Local	Buildings; Urban	Sánchez-Guevara, C., et al., 2019

Figure 17: Example of suitable indicator to monitor just resilience in the building sector – extracted from Annex II.

4.1.4 Energy sector

Uneven distribution of risk and impacts and specific vulnerabilities ('uneven burdens')

The energy sector is closely connected to the building sector, the agricultural sector and water management sectors amongst others. The building sector section already described aspects like energy poverty and building performance, which are core issues for the energy sector as well. To summarise, relevant for the energy sector are changes in extreme temperature that affect the energy demand, in particular the demand for cooling during heatwaves. These increases in energy demand may result in increasing energy prices that affect the proportion of society that has low income (IR C2.1). See also the discussion of energy poverty in the buildings sector.

Furthermore, extreme events and slow-onset impacts may cause damage to energy infrastructure (flooding, storms and wildfires) or affect energy production (drought), driving up prices, resulting in power cuts and exacerbating energy poverty as well, especially affecting low-income households, children, and the elderly (IR.C1.1, IR.C1.2). In the most extreme situations, power outage may occur, that results in a cascading of social and economic impacts. This may have a disproportionate burden on vulnerable people, such as for instance ill people that need health care. There is evidence that power outage may interrupt health care services directly and indirectly, resulting in poor treatment of health conditions or even new conditions to emerge. In the worst case, power outage may even result in increased risk of death (C1.2).

Impact/risk type	Description		Governance level	Key sector(s)	Justice dimension(s) indentified in literature	Source
	Identified impact or risk	Justice implication				
Flooding and landslides	**C1.2 Flooding and landslides** From heavy rainfall damaging private and public resources, including infrastructure and property, inhibiting movement (short or long term) and has impacts on land-base management practices (see D). *Also links to land use planning and management (A2 and A3).	**Unequal losses and health effects** Documented 'worse' impacts on vulnerable groups compared to less vulnerable groups. Resources include a wide spectrum of assets, including the capacity of being able to voice ones needs. ** Identified knowledge gap: Aggravates pre-existing inequalities related to access to private and public transport systems (gender, age, socio-economic groups). May aggravate health conditions due to power outage.	National, local	Buildings, Cross-cutting, Water management, Energy, Transport, Coastal areas, Health, urban	Distributive, Procedural	Expert group consultations and: Lindley 2011; Foudi et al., 2017; Rey-Valette et al., 2015; Corfe, 2017, cited by Buser, 2020; Szewrański et al., 2018; D'Alisa and Kallis, 2016; EEA/ETC, 2018. Climate Change Committee Scotland, 2022b; Jessel et al. 2019.

Figure 18. Example of justice implication of climate risk and impact in the energy sector - extracted from the evidence matrix in Annex Ia.

Leaving no one behind

Subsidies and financial incentives directed at energy efficiency and regulations such as carbon taxes which aim at incentivising energy efficiency via market mechanisms can create disproportional burdens for low-income households and farmers and tend to further enhance existing inequalities including energy poverty (AD.B1.1). Measures related to housing energy savings are discussed in the building sector section.

Description		Governance level	Key sector(s)	Justice dimension(s) indentified in literature	Adaptive/mal-adaptive outcomes (poitive/negative/both)	Source(s)
Identified response, adaptation measure or adaptation outcome	Justice dimension or implication					
B1.1 Subsidies and financial incentives (green energy) directed at energy efficiency and regulations such as carbon taxes which aim at incentivising energy efficiency via market mechanisms.***strong link to mitigation	**Affordability** Owners vs. tenants. Energy price increase create disproportional burdens for low-income households and tend to further enhance inequalities including energy poverty (C1.1) and the vulnerability of farmers (D1.1) **Pro-active engagement with vulnerable groups**	EU and country level	Energy, Buildings, Transport, Cross-cutting	Distributive	Negative	De Cian et al., 2019; Ludden, et al., 2021; Oliveras et al., 2021; Scottish Government, 2020; Eurofound and EEA, 2021; Cabrita et al., 2021; Sharifi, 2021; Sánchez-Guevara Sánchez et al. 2017; Sánchez-Guevara Sánchez et al. 2019

Figure 19. Example of justice implication of adaptation measure for the energy sector – extracted from the evidence matrix in Annex Ib.

Consideration of the design of indicators to assess justice related to the energy sector

There is a focus in the energy sector on distributive and procedural aspects of justice. An example of an indicator that would be key in the energy sector could be the same indicator as has been demonstrated as an example indicator for the building sector. This indicator measures the vulnerability of people to health effects that is caused by their energy poverty in combination with building performance and extreme heat events. These people risk being left behind if they are not able to access affordable energy to keep them cool.

Case studies: methodological developments and novel approaches in peer scientific papers												
ID	KTM	Indicator type*	Climate impact/risk	Indicator focus	Name/Title	Description (general)	Indicator samples (what is measured/monitored)	Justice dimension(s)	Collection method	Scale	Sector(s)	Source and URL
CS1	C1, A1, A2	I, V	Extreme temperatures	Heat and energy poverty considering income and age.	**Population vulnerability to summer energy poverty: Case studies of Madrid and London**	Heat and energy poverty indices: exposure and vulnerability to high summer temperatures by exploring the geospatial connection between the urban heat island intensity, housing energy efficiency and overheating risk, and social vulnerability indicators.	**Impact**: urban heat intensity, housing stock energy efficiency **Vulnerability**: household income, population over the age of 65 Context specific proxies for each indicator and location.	Distributive	Modelling, statistical data	Local	Buildings; Urban	Sánchez-Guevara, C., et al., 2019

Figure 20: Example of suitable indicator to monitor just resilience in the building sector - extracted from Annex II.

4.1.5 Urban sector

Uneven distribution of risk and impacts and specific vulnerabilities ('uneven burdens')

Climate risks, impacts and vulnerabilities with justice implications in urban areas overlap with those identified in the buildings sector, in particular the exacerbation of energy poverty, the damage to physical infrastructure including people's homes, and factors enhanced risk in areas with low environmental quality (IR.C1.1, IRC1.2 , IR.C2.1, IR.D1.3). These aspects are discussed in the section on the building sector. Urban areas are highly diverse, attracting the most affluent citizens as well as the poorest and homeless, from diverse backgrounds and ethnicities. High and rising property prices in European cities (especially central and water-front areas) increase the risk of maladaptation in the form of gentrification triggered by costly adaptation regulations and measures and urban greening measures which directly or indirectly increase real estate prices and rents (AD.C1.2, ADC1.3 – this has been explained already in relation to the nature-based solutions and biodiversity sector. In many European countries, vulnerable communities live in dense urban areas with low environmental qualities and high levels of air pollution, and may thus be affected by compounding impacts from urban heat island effects interacting with air pollutants (EEA, 2018).

Historically, many European cities are established in or near coastal areas and rivers. As such, they are more prone to climate impacts due to their exposure to storms, flooding and sea-level rise (see Coastal areas, IRC1.2, IR.C1.3). The density and design of cities in Europe also increase their vulnerability to, for instance, heat waves, as high rates of hard surfaces and lack of green areas increase effect the urban heat island effect (IR. D1.6) and increase the intensity of surface flooding during intense precipitation events. Impacts on urban population are exacerbated by low air quality, low outdoor qualities due to urban design and low quality of urban public space (IR.C1.4). Impacts

on urban areas have a higher potential of affecting socially disadvantaged groups due to the role of cities in society. Interruptions due to climate impacts on their crucial or vital infrastructures and economic activities can cause interruptions which propagate through society, potentially affecting lower income groups more than others, these groups are also particularly vulnerable to shocks to external provisions (security of supply) such as water and energy (IR.C1.5) as impacts occurring far outside of a city (national and international) can affect systems essential provisions, finding low income households less capable to cope with such situations.

Impact/risk type	Description		Governance level	Key sector(s)	Justice dimension(s) indentified in literature	Source
	Identified impact or risk	Justice implication				
Multiple risk, heat	**D1.6 Uneven exposure for European cities** Urban morphology (size and form), and in particular the lack of urban green infrastructure makes some cities more prone to urban heat island effect, compared to other cities or rural areas	**Unequal risk and access to intervention** Justice implication is that some cities might require more systemic interventions in their morphology, compared to others. In addition, research has demonstrated that not all people have equally access to urban green infrastructure that is available in European cities - resulting in unjust circumstances (see C1.4). However, there is not yet a conclusion whether northern European cities' morphology is more vulnerable to urban heat island, compared to southern European cities. The density in southern European cities seems to create shade that is cooling the city, while surrounding areas suffer more from heat due to the fact that these are arid zones and heating up quite fast as well during hot and dry summer, therefore impacting the UHI estimation.	National, local	urban, ecosystem	Distributive	Zhou, et al. 2017

Figure 21. Example of justice implication of climate risk and impact in the urban sector - extracted from the evidence matrix in Annex Ia.

As low income and low social status in cities often coincides with low quality of the urban environmental and low capacities of these poor urban and building environments to absorb and mitigate impacts from extreme weather events, vulnerable groups including those living below the poverty line, the elderly, children and people with poor health are often particularly affected. Furthermore, low-income households and those at risk of poverty often live in areas exposed to other environmental impacts which exacerbate climate impacts, such as noise and air pollution. Generally, disadvantaged groups have less access and a lower possibility to use or benefit from ecosystem services of urban green spaces than high-income residents living in affluent areas (Kabisch et al., 2016; Nesbitt et al., 2019; Szaboova et al., 2020; EEA, 2022c; Kosanic et al., 2022). The location of affluent and poor neighbourhoods is a consequence of the housing and land use policies that can vary strongly between cities. Therefore, justice (especially distributive) should become a key criterion for urban development and land use planning policies to improve urban living quality and to avoid distributive injustice of urban environmental resources (Kato-Huerta and Geneletti, 2023).

While there is evidence that urban areas are generally more exposed to some types of climate impact, populations in rural areas are potentially more likely to be impacted by policy responses related to climate mitigation, due, for instance, to higher carbon costs of transport in sparsely populated areas (Charveriat, et al., 2019). In addition, rural populations are more vulnerable to climate impacts affecting transport lines with a resulting interrupted access to services. In Spain, depopulation of rural areas is seen as an issue for green transitions, considering, in particular, that mainly women leave rural areas and move to cities, leaving a predominantly male and old population behind (Gisbert Velasco et al., 2020). The effects of climate change (such as heat waves, drought, increased air pollution, and heavy rainfall) will represent an additional burden and could affect the health of this rural population (see the health sector).

Leaving no one behind

Cities are at the core of just resilience in climate adaptation. The UN SDG (Target 11) aims to increase the number of cities that are inclusive and climate resilient (UN, 2021). There are many communities and initiatives for enhancing sustainable development of cities, towns and municipalities. For example, initiatives such as Eurocities or ICLEI – Local Governments for Sustainability help cities, towns and regions to anticipate and respond to complex challenges, from

rapid urbanisation and climate change to ecosystem degradation and inequity. At the EU level, there is a dedicated initiative, the Covenant of Mayors for Climate & Energy for European cities which supports urban climate resilience policies. Furthermore, the EU Member States recently adopted the New Leipzig Charter for sustainable urban development (European Commission, 2020). The charter calls on cities to enhance their biodiversity, regenerate endangered ecosystems, and create green and blue networks. In addition, it highlights European cities that have already largely been working on socially just climate adaptation strategies, taking vulnerable groups into account (Yuang et al. 2021). However, there are specific challenges in providing and implementing guidance to support cities in key steps for addressing social vulnerability (AD.A2.2). In most cases, guidance documents are not comprehensive and lack specific methods for the identification of vulnerable groups and for their involvement in adaptation decision-making or fail to provide suggestions for monitoring the social outcomes of adaptation actions over time.

Description		Governance level	Key sector(s)	Justice dimension(s) indentified in literature	Adaptive/mal-adaptive outcomes (poitive/negative/both)	Source(s)
Identified response, adaptation measure or adaptation outcome	Justice dimension or implication					
A2.2 Urban adaptation planning Guidance documents to support cities in key steps for addressing social vulnerability (identifying, locating, and involving vulnerable groups).	Tracking and inclusion of vulnerable groups Guidance documents not comprehensive and, in most cases, lack specific methods for the identification of vulnerable groups and for their involvement in adaptation decision-making. They also do not provide suggestions for indicators for monitoring the social outcomes of adaptation actions over time. Best practice example from Glasgow (Scotland) involving organisations, community groups and businesses in adaptation planning.	national, local	Urban	Distributive, procedural,	Positive & Negative	EEA, 2018; Climate Change Committee Scotland, 2022a; Borras et al. 2018

Figure 22. Example of justice implication of adaptation measure in the urban sector - extracted from the evidence matrix in Annex Ib.

According to an EEA briefing, social inequalities in exposure to climate impacts in urban areas have already been addressed, to some extent, in local adaptation plans for several years now, yet participation of particularly disadvantaged groups in planning of adaptation measures is rarely granted, and the implications of adaptive actions for vulnerable groups are rarely considered in monitoring of adaptation outcomes (see EEA, 2022d; Olazabal and Ruiz De Gopegui, 2021). The lack of acknowledgement has implications on the beneficiaries of adaptation actions and results in a lack of involvement of diverse groups in adaptation planning. This makes it unlikely that the monitoring and evaluation processes focus or address uneven adaptation actions effectively (XI.5). More recently the number of local adaptation plans which include a larger extent of equity aspects and a broader range of vulnerable groups in their impact assessment and in planning of adaptation measures is increasing (EEA, 2022d citing Reckien et al., 2022).

Vulnerable groups can be worse off despite engagement processes, if unequal access to resources and income, as well as political capacity etc. are not explicitly taken into account. This highlights the need of citizen participation and co-creation of urban spaces, i.e. new planning cultures and practices for sustainability transformations (European Commission. Directorate General for Research and Innovation., 2020; van der Jagt et al., 2021; Kato-Huerta and Geneletti, 2023). Best practices do, however, include adaptation measures used for directly involving inhabitants, creating, for example, vocational training and employment programmes for residents (AD.E2.3, AD.E2.4). Ensuring a just set-up of participation processes for adaptation planning and managing hazards requires reflexive governance and addressing recognition justice, enabling active participation and addressing power inequalities within communities (political capability) (e.g. van der Jagt et al., 2021; Anguelovski and Corbera, 2023).

Consideration for the design of indicators to assess justice related to the urban sector

Often, urban systems have been forerunners in inclusive, 'green' and innovative adaptation planning and action, supporting the evolution of just practices for adaptation itself. Cities in the EU often have a semi-autonomous governance system, enabling innovative practices. To measure justice in the urban sector, it is necessary to focus on intersectional justice as well as procedural, distributive and recognition justice elements. Given that the "urban sector" covers a governance unit rather than a uniform sectoral policy area further to land use planning, the full range of justice related aspects is addressed in the single sector areas but needs to be monitored on the background of the specific socio-economic setting of urban areas.

An example indicator is illustrated in the table beneath. This is about an impact assessment methodology to evaluate the distributive impacts of adaptation policy, which has been applied to Scottish adaptation policy. This would be suitable as this methodology is able to illustrate the different impacts between different social groups, what is crucial to assess just resilience in the urban sector.

Available datasets and frameworks												
ID	KTM	Indicator type*	Climate impact/risk	Indicator focus	Name/Title	Description (general)	Indicator samples (what is measured/monitored)	Justice dimension(s)	Collection method	Scale and granularity	Sector(s)	Source and URL
CS12	A1, A2	I, R	Flooding	Climate policy distributive effects	**A Novel Impact Assessment Methodology for Evaluating Distributive Impacts in Scottish Climate Change Adaptation Policy**	Present a climate justice toolkit (indicator set and guidance) that enables the consistent assessment of distributive impacts of climate policy, including broad suite of policies that comprise the national adaptation programme. Target groups are communities of living, working and place	**Example indicator set** **- Household aspects and indicators:** Occupant Profile (Working age adults—no children, couples with children, single parent families, pensioners), Equality Groups (Disability and long term illness, gender, sexuality, race and ethnicity, religion and belief), Household Income (low-medium-high), Level of Awareness, Mode of Transport (Reliance on private transport, reliance on public transport, cycling, walking), Dwelling Type, Tenure Type, , Urban–rural (Urban, small town, accessible rural, remote rural), Flood-Risk (Coastal areas, islands, flood plains, other inland areas) **- Recognitionion justice**: (the strategy acknowledges that adaptation needs are	Distributive, procedural, capacities and capabilities, intersectional	Surveys, statistical data	local, natioanl	Cross-cutting	Dunk et al., 2016

Figure 23. Example of suitable indicator to monitor just resilience in the urban policy sector – extracted from Annex II.

4.1.6 Water management sector

Uneven distribution of risk and impacts and specific vulnerabilities ('uneven burdens')

The water management sector may be affected by drought, water scarcity and decline in water quality (IRD2.1) that affects disproportionally certain European citizens and their human right to access clean water, but also sectors that are dependent on water, such as agriculture (IR.D2.1, IR.D1.1), energy and navigation (IRD1.7). Access to clean water is expected to be compromised for 35% of European area by 2070 (IR D2.1). Risks to and impacts on the water management sector also relate to impact-prone areas facing increased risk of flooding, sea-level rise (IR.C1.2, IRC1.3), particularly in coastal areas and near rivers, as has also been described in the building sector and the urban area. Furthermore, flooding can cause unsafe drinking water through human made waste, consequently leading to health risks (IRD2.2) and sea level rise can contribute to salinisation of ground and surface water used for irrigation and drinking water. Studies have indicated that the effects of droughts aggravate the living circumstances of vulnerable groups. Because water prices may increase, these vulnerable groups may not be able to afford water anymore. The effects of floods and landslide risks and vulnerable groups are elaborated on in the Coastal areas, buildings and agriculture sections.

Impact/risk type	Description		Governance level	Key sector(s)	Justice dimension(s) indentified in literature	Source
	Identified impact or risk	Justice implication				
Drought	**D2.1 Drought, water access** Increased risk of droughts, leading to water scarcity (or quality decline)	**Unequal risk/impact and access** Documented exacerbated impacts on vulnerable groups compared to less vulnerable groups. If access to water of good quality is severely impacted, options to pay for water severely affects low-income groups, families with children and the elderly.	National, local	Water management, health	Distributive	Country Reporting Romania. And Duinen et al., 2015; Bernabé-Crespo et al., 2021; Zagaria et al., 2021; Alcamo et al. 2018

Figure 24. Example of justice implication of climate risk and impact in the biodiversity sector – extracted from the evidence matrix in Annex Ib.

Leaving no one behind

During drought, water demand may be managed. These water demand management measures may put an uneven burden on low-income households, families with children and the elderly, as they might need to reduce water consumption below levels which ensure healthy living conditions. This may result in health effects for these vulnerable groups (March et al., 2013). The use of water pricing as an adaptation measure acting on the demand for freshwater resources has potential implications on justice, as poorer actors might not obtain sufficient access to water. This is of particular relevance for the agricultural sector (Eionet response Türkiye) but also relevant for urban areas where basic health standards might not be reached for low-income families (March et al., 2013) (AD B1.5).

Description		Governance level	Key sector(s)	Justice dimension(s) indentified in literature	Adaptive/mal-adaptive outcomes (poitive/negative/both)	Source(s)
Identified response, adaptation measure or adaptation outcome	Justice dimension or implication					
B1.5 Market based adaptation options Insurance and water pricing for effective water management	**Dispropotionately affects low-income groups** while a potentially effective measure to reduce water usage, low income actors eventually cannot afford water prices or need to put different priorities and discard insurances	national	agriculture, water management, insurance	Distributive		Eionet country feedback Turkey

Figure 25. Example of justice implication of adaptation measure in the I water management sector - extracted from the evidence matrix in Annex Ib.

In relation to flood resilience management, procedures to include social and environmental vulnerability assessments have been suggested in order to prevent justice implications as they take into account poor and ageing populations, as well as the distribution of the areas vulnerable to floods (AD.A2.5). In addition, it is recommended to include benefit-costs and distributional components in tools like multi-objective decision criteria to make sure that risk reduction strategies are more equitable.

Consideration for the design of indicators to assess justice related to the water sector

Indictors for the water management sector should assess distributive, procedural and recognition dimensions. One example indicator to monitor just resilience in the water management sector could focus on assessing the population at risk of poverty, particularly at risk from water prices increases due to extreme events. There are several indicators that assess low-income households. An examples of these is the EU integrated poverty and living conditions indicator system as this indicator system includes aspects like people at risk of poverty rate, material and educational deprivation, housing costs amongst others.

Available datasets and frameworks												
ID	KTM	Indicator type*	Climate impact/risk	Indicator focus	Name/Title	Description (general)	Indicator samples (what is measured/monitored)	Justice dimension(s)	Collection method	Scale and granularity	Sector(s)	Source and URL
I2	n/a	V, RP	n/a	Poverty and living conditions	**EU Integrated Poverty and Living Conditions Indicator System**	Framework aim to improve monitoring, analysis and interpretation of the quality of life of vulnerable groups in Europe, across countries and over time. Specific focus on age (children, youth, the elderly, migrants and disabled persons). Collects a total of 50 indicators.	- **Material living conditions** (at-risk of poverty rate, matieral and educational deprivation, overcrowding, housing cost and deprivation rate etc.) - **Labour market and work-life balance**: (work intensity, formal child care etc.) - **Education and training**: (education, educational literacy rate etc.) - **Health and risk behaviour**: (birth weight, infant mortality, alcohol consumption, illicit drug use, attempted suicide etc.) - **Social connectedness and civic participation**: (participation in civic activities, niose from neighbours, pollution and other environemtnal problems, crime and violence, etc.) - **Policy and context**: (unemployment rate, fertility rate, women's age at childbirth, Gini coefficient, gender pay gap, life satisfation, social protection expenditure etc.	Capacities and capabilities, intersectional, Intergenerational, historical and temporal justice	Surveys, statistical data	Europe, National	Cross-cutting	InGRID, 2019: https://ipolis.tarki.hu/

Figure 26. Example of suitable indicator to monitor just resilience in the water management sector – extracted from Annex II.

4.1.7 Coastal areas sector

Uneven distribution of risk and impacts and specific vulnerabilities ('uneven burdens')

Currently, many people live in so-called low elevation coastal zones in Europe. The densely urbanised coastal areas of the North Sea and the Mediterranean coasts are particularly vulnerable due to the high number of assets at risk of flooding and, in the case of the Mediterranean, the relevance of coastal settlements for local tourism-based economies (IR.C1.3). For this reason, in coastal areas, many of the policy issues mentioned in relation to buildings and urban areas and health have the same origin. With high levels of exposure of buildings, transport and energy infrastructure and agricultural sector, communities living in areas near coasts and rivers run enhanced risks from sea-level rise, storm surges and flooding, which will cause important losses, such as loss of material assets (public and private, including property values), economic resources (e.g. infrastructures for tourism) (IR.B1.1, IR.C1.2, IR.C1.3, IR.D1.3), but also assets of high immaterial value as related to material and immaterial cultural heritage, traditional values and cultures, social well-being, health and memories (IR.D1.2).

In European coastal zones, different groups are at risk from flooding and sea-level rise (in particular socio-economic status of coastal populations differs significantly across European countries as well as within coastal zones) with strong differences in their abilities as well as willingness to deal with this risk. While some studies have indicated elderly and low-income groups as particularly vulnerable, other studies indicate that vulnerability is mainly related to people's connection to a dense and supportive social network. Following this criterion for the identification of vulnerable groups, pensioners who have moved to the coast for their retirement appear eventually more vulnerable than poorer local residents as they lack social networks and local knowledge (IR.E2.2). Wealthy populations have also been identified as frequently exposed because of their high value properties in scenic but flood-prone areas (IR.C1.3).

Impact/risk type	Description		Governance level	Key sector(s)	Justice dimension(s) indentified in literature	Source
	Identified impact or risk	Justice implication				
Multiple risk	**E2.2 Poor social networks** People that have access to dense and supportive social network are more adaptive when confronted to climate impacts, compared to others.	**Social exclusion and poor networks** It is stated that elderly and poor are most vulnerable. However, it is necessary to better understand their connection to the community in order to assess their vulnerability. In terms of coastal communities, rich people that only live after retirement or in weekends and holidays in these coastal community might actually be more vulnerable, compared to the poor and elderly in general. This also has consequences in terms of decision to relocate these people to other communities	Local	Coastal areas, cross cutting	Distributive	Graham et al. 2018

Figure 27. Example of justice implications of climate risk and impact in the coastal areas sector (IR.E2.2) - extracted from the evidence matrix in Annex Ia.

Leaving no one behind

Since coastal management is a national, regional or local responsibility, planning and practice in protection against sea level rise differs between EU Member States, putting European citizens of countries with low protection standard at-risk of being 'left behind' (AD. A2.9). Specifically, one study suggests that France, Spain and Italy prepare for relatively *small* projected increases of sea level rise (SLR), despite large populations living close to coastlines, probably because of lower levels of storm surges in the Mediterranean, or longer coastlines which are more costly and more difficult and expensive to protect (AD.A2.9).

When planning for adaptation, the use of economic assessment tools can reinforce existing inequalities. Although economic assessment tools are commonly used and promoted as objective decision support tools driving efficiency of measures, they often favour wealthy communities and premises over lower income groups. In fact, these assessments based on the economic value of losses avoided by protection measures indicate measures protecting high value premises to be more efficient than those related to lower value assets. They leave room for subjective choices with regards to assessment criteria, the selection of losses to include and how to price them, and the scale to use in the assessment. Immaterial costs and benefits are rarely included in such assessments, due to a lack of data on monetary values. When the vulnerability of people is assessed within their communities and considered in combination with their social and community values, decisions on relocation or other protection measures would be more cost efficient and avoid aggravating inequality. This is supported by evidence from low density and agricultural areas, provided that such processes are managed in a fair way (AD E2.4).

Description		Governance level	Key sector(s)	Justice dimension(s) indentified in literature	Adaptive/mal-adaptive outcomes (poitive/negative/both)	Source(s)
Identified response, adaptation measure or adaptation outcome	Justice dimension or implication					
E2.4: Participatory planning Using citizen participation to choose adaptation options and education and champions, collaboration of different departments, agencies, and vulnerable groups to participate in the design of adaptation policies and actions;	**Recognising and involving vulnerable groups** Ensuring a just set-up of participation processes for adaptation planning and managing hazards though focusing on recognition and active participation and address power inequalities within communities. Sstakeholder involvement processes often fail to consider diversity and power issues within communities, or investigate how these diversities affect the possibility of people to engage in participatory spaces in egalitarian forms. Examples: Urban greening project in Gent (the Netherlands) and re-designing coastal protection measures in Timmerdorfer strand (Germany)	Cross-cutting	Urban, Cross-cutting	Procedural	Positive & Negative	Lioubimtseva and da Cunha, 2020; Loh and Kim, 2021; Shi et al., 2016; Brunner, 2008; Innes and Booher, 2004; Climate-ADAPT, 2022a; Breil et al. 2021, p. 41-42; Cattino and Reckien, 2021; D'Alisa and Kallis, 2016; Fernandes-Jesus et al., 2017, p. 1557; D'Alisa and Kallis, 2016; Planas Carbonell, 2021; NAS Kosovo, 2018; Therville et al., 2019; Krebs et al., 2013; Burnside-Lawry & Carvalho 2016.

Figure 28. Example of justice implications of adaptation measure in the coastal areas sector (AD.E2.4) – extracted from the evidence matrix in Annex Ib.

Adaptation actions such as managed retreat, 'decommissioning' and realignment practices can create uneven impacts for vulnerable groups. Uneven burdens from flood related adaptation such as halting maintenance of existing flood protection measures and relocation of settlements affect local residents and result in a decline in property values, and a decline in health and welfare (AD.A2.7). Decommissioning and announcement of relocating of settlements can harm in particular minority groups and the elderly, as this relocation process gradually erodes existing social networks, which are crucial for creating and maintaining political capacities and resilience of these communities. However, not relocating groups leaves them exposed to future risks, which reveals the ethical dilemma behind every retreat programme (AD. A2.10) To address these challenges, proactive expropriations of farmland prone to salinisation, erosion and storm surges protecting the economic assets of farmers has been presented as a means of managing coastal realignment without causing economic stress to residents (AD.B1.2). Analogous practices regarding proactive procedures for the relocation of settlements have not been found in this study. Participation and recognition are seen as core components to ensure fair and due processes. Flood resilience management procedures can include social and environmental vulnerability assessments to achieve inclusive procedures (taking

into account risk distribution, poverty and ageing populations), (AD.A2.5). Nature-based solutions for long-term coastal-zone adaptation management are also an option (for details see Ecosystem-based approaches below).

Consideration for the design of indicators to assess justice related to coastal areas

Justice aspects of distribution, process and recognition are in focus for the coastal zones and other flood prone areas, as well as restorative justice aspects, in cases where the risks are too high to be mitigated. Intergenerational justice is also strongly related to adaptation in coastal areas due to the risk of loss of historic memories and knowledge, culture and the livelihoods of entire communities. Governance is strongly tied to land-use planning (municipality, county, and country level). Coastal areas are strongly linked to buildings, urban systems, agriculture, marine and fisheries and water management.

One example of an indicator that can be of use in the coastal sector is the Adaptation Justice Index, see Figure 29. Example of suitable indicator to monitor just resilience in the coastal policy sector – extracted from Annex II.**Figure 29**. Specifically, the procedural justice sub-index, as it is important in the coastal sector to involve the most vulnerable people in a meaningful way. The procedural justice indicator contains data on participation in the strategy process, involvement in the different planning and implementation phases of the relevant people.

Included in Report tables as selected examples

Available datasets and frameworks

ID	KTM	Indicator type*	Climate impact/risk	Indicator focus	Name/Title	Description (general)	Indicator samples (what is measured/monitored)	Justice dimension(s)	Collection method	Scale and granularity	Sector(s)	Source and URL
CS13	A1, A2, A3, E1, E2	RP	General	Adaptation planning justice screening	**Connecting climate justice and adaptation measures: An Adaptation justice index**	Ex ante methods for assessing adaptation strategies and their planning processes. Indicator framework for four aspects of climate justice in the context of adaptation: recognition, distributive, restorative, and procedural justice. As adaptation planning is still a relatively new area of climate governance, the information produced offers valuable feedback for the development of analyses of climate justice in the planning phase. Framework rested in 5 European countries and their capitals	- **Recognitionion justice**: (the strategy acknowledges that adaptation needs are different across groups in society, the impact of existing societal structures on vulnerable groups in adapting to the impacts of climate change, adaptation as a way to secure basic rights) - **Distributive justice: (a** risk mapping/assessment is conducted, vulnerability assessment is conducted and there is a process for identifying vulnerable groups, - There is a process that assesses who benefits from adaptation, how costs of adaptation are divided, The strategy identifies the possibility of the distribution of negative impacts, i.e., maladaptation, of adaptation measures) - **Procedural justice**: (the strategy details who participate in the strategy process, involved participation during different phases of the process, allocates responsibilities related to adaptation, has a structured plan for participation in the implementation, has a plan for updating and evaluating the strategy - **Restorative justice:** (acknowledges the need to compensate for the diverging impacts of climate change, compensation measures to deal with maladaptation, The unequal distribution of resources for adaptation is compensated by redistribution	Distributive, procedural, recognition, restorative/historical justice	Qualitative content analysis	Local, national	Cross-cutting	Juhola et al., 2022.

Figure 29. Example of suitable indicator to monitor just resilience in the coastal policy sector – extracted from Annex II.

4.1.8 Disaster risk reduction (DRR) sector

Uneven distribution of risk and impacts and specific vulnerabilities ('uneven burdens')

Climate impacts will aggravate disaster risks and require enhanced risk reduction practices in Europe broadly (see also cross cutting issues). Disaster risks do not only refer to direct damages to assets and infrastructures, but also to long-term impacts that are the results of interruptions of infrastructure, loss or damage to properties, in particular among economic activities, (interruption of supply chains) but also for households and individuals (interruption of services, of commuting options to go to work etc.). The most vulnerable groups of society are struggling the most to recover from disasters and extreme events. Given the increase in frequency and intensity of disasters due to climate change, it is expected that vulnerable groups in particular will be severely affected by disaster risk, including increased death rates (IR. C1.2). In addition, these vulnerable people may be impacted by increased insurance prices that will be the result of increased disaster risks, which increases their living costs. Low-income households may be disproportionally affected by increased insurance prices as they may not be able to afford insurances (IR B.2.1).

Impact/risk type	Description		Governance level	Key sector(s)	Justice dimension(s) indentified in literature	Source
	Identified impact or risk	Justice implication				
Flooding	**B2.1: Increased insurance prices and needs** Increased climate risk affect insurance needs and prices. *Links to C1: physical infrastructure.	**Insurance affordability (and eligibility)** Unequal access to insurance - aggravates the inequal access of retribution of damage to assets and social security. Example Romania: Farmers, and SMEs, which represent a significant percentage of the Romanian population, cannot afford to pay insurance premiums related to mandatory disaster protection policies.	National, local	Finance, disaster risk reduction, Water management	Distributive	Country Reporting Romania and: Davoudi and Brooks, 2012; Luttenberger and Luttenberger, 2018

Figure 30. Example of justice implication of climate risk and impact in the disaster risk management sector – extracted from the evidence matrix in Annex Ia.

Leaving no one behind

National heat wave planning (AD.A2.6) and local heat wave protection measures (AD.C1.4) are examples of DRR practices that specifically address vulnerable groups through improved technological infrastructure, coordination and networks. The European Union Civil Protection Mechanism resilience goal includes a provision for the EU to work together with EU Member States and develop disaster resilience goals. These should take into account the immediate social consequences of disasters, ensure the preservation of critical societal functions and give special attention to the consequences of disaster for vulnerable groups (AD.A2.3). The IPCC AR6 report mentions the possibility to consider justice aspects in disaster risk management recovery planning through addressing welfare losses using quantitative well-being criteria (e.g., using the fraction of consumption loss at household level per income group rather than consumption losses in absolute terms in order to better recognise losses among low-income groups) and distribution outcomes in multi-objective decision-support tools for decision-making.

Description		Governance level	Key sector(s)	Justice dimension(s) indentified in literature	Adaptive/mal-adaptive outcomes (poitive/negative/both)	Source(s)
Identified response, adaptation measure or adaptation outcome	Justice dimension or implication					
A2.3 Cooperation on disaster risk reduction: the EU Civil Protection Mechanism Includes a provision for the EU to work together with Member States and develop Union disaster resilience goals.	**Special attention to vulnerable groups** The provision shall take into account the immediate social consequences of disasters, make sure to ensure the preservation of critical societal functions and shall give special attention to the consequences of disaster for vulnerable groups.	EU and country level	Disaster risk reduction	Distributive, procedural,	Positive	EC, 2021b

Figure 31. Example of justice implication of adaptation measures in the disaster risk management sector - extracted from the evidence matrix in Annex Ib.

With regards to available risk mitigation strategies, like insurances schemes, in particular small- and medium sized enterprises and farmers as well as low-income households might face difficulties in affording insurance premiums which will increase with raising damage costs (IR.B2.1). Extreme events can lead to loss of household-income. With regards to enterprises, insurance schemes might come too late to avoid secondary impacts of disaster related losses due, for instance to interruptions of supply chains etc. which can affect small and medium enterprises on medium-long term and might not be covered by insurances at all.

Consideration for the design of indicators to assess justice related to DRR

The indicators to assess just resilience in the disaster risk sector should be able to show the location and proportion of most vulnerable people that struggle to recover from extreme events, to ensure that adaptation measures support these specific groups in a tailored way. Many vulnerability indices would suit this purpose. One example is the INFORM Climate Change Index as this index is a future

projection to measure the risk of humanitarian crisis and disasters. The index incorporates climate and socioeconomic data to analyse how risks evolve, incorporating vulnerability and coping capacity aspects, amongst others.

ailable datasets and frameworks

D	KTM	Indicator type*	Climate impact/risk	Indicator focus	Name/Title	Description (general)	Indicator samples (what is measured/monitored)	Justice dimension(s)	Collection method	Scale and granularity	Sector(s)	Source and URL
	A1, A2, B2, C2	I,V	General	Coping capacity	**INFORM Climate Change Index**	The INFORM Climate Change Index is a future projection of the INFORM Risk Index – a composite index that measures the risk of humanitarian crises and disasters globally. The index incorporates climate and socioeconomic projections to analyse how risk will evolve as a result of climate change under different emission and socio-economic scenarios.	-**Hazard and exposure**: natural (earthquake, tsunami, river flood, coastal flood, tropical cyclone and wind, drought, epidemics), human (conflict intenity and probability) - **Vulnerability**: socio-economic (development and deprivation, inequality, aid dependency), vulnerable groups (unprotected people, other vulnerable groups) - **Lack of coping capacity**: institutional (DRR, governance), infrastructure (communication, physical infrastructure, access to health system)	Distributive, Capacities and capabilities	Statistical data, Geospatial analysis and scenario analysis	Global, national	Disaster Risk Management, Cross-cutting	European Commission 2023: https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Climate-Change

Figure 32. Example of suitable indicator to monitor just resilience in the disaster risk management sector – extracted from Annex II.

4.1.9 Financial sector

Uneven distribution of risk and impacts and specific vulnerabilities ('uneven burdens')

Climate change impact on the financial sector is related to increased insurance fees and increased investment risks. Climate impacts and risk put an uneven burden on people when it comes to increased insurance needs and related premiums as the very poor people may not be able to afford insurance. This enforces unequal access to insurance. It means that some parts of the population might be excluded from getting the damage covered and from social security (IR.B2.1), within Europe and beyond (IR.D1.4).

Leaving no one behind

The finance sector plays a major role in funding adaptation measures such as green infrastructure measures. Evidence indicates that there is no equal access to such funding mechanisms, with low-income groups particularly hampered in accessing innovative funding mechanisms (AD B. 1.3). Finance Watch (2020) has identified key barriers for access to finance; inability to provide the required legal documents, difficulty to meet the requirements to access funding (including phone, internet connection and certain amount of savings), and the lack of required skills and means (including people hard of hearing or with varying mental abilities). Depending on how investments on adaptation are taking place, the finance sector can either plan a role in aggravating existing inequalities or aid just adaptation and resilience building activities.

Description		Governance level	Key sector(s)	Justice dimension(s) indentified in literature	Adaptive/mal-adaptive outcomes (poitive/negative/both)	Source(s)
Identified response, adaptation measure or adaptation outcome	Justice dimension or implication					
B1.3: Innovative funding mechanisms Including local taxes and crowdfunding schemes.	**Targeting low-income groups** with limited access to resources and financial instruments **Remediating historical inequalities**	local	Finance	Distributive	Positive	Expert consultation and Climate-ADAPT, 2022a.

Figure 33. Example of justice implication of adaptation measure in the financial sector - extracted from the evidence matrix in Annex Ib.

Consideration for the design of indicators to assess justice related to the financial sector

To make sure just resilience is progressing in the financial sector, it is important that the indicator is able to assess access of low-income households to insurance and funding mechanisms. Although in the indicator list, no suitable indicator has been listed, it would be good to explore which existing financial inclusion indicators would fit for this purpose.

4.1.10 Forestry

Uneven distribution of risk and impacts and specific vulnerabilities ('uneven burdens')

Little evidence was found on the justice implications of climate change on the forestry sector. Impacts on forests overlap with uneven impacts on biodiversity regarding the intrinsic values of nature and generational justice and with agriculture sector, with small scale actors potentially being more vulnerable to damages and income loss due to drought, flooding and wildfire. A survey for forest owners and managers in seven European countries revealed that they are quite well aware of impacts of climate change to forests but less aware of how they should adapt their management practices (Sousa-Silva et al. 2018). In Finland, compensation for climate related damages to forests is on the policy agenda. The discussion is about who should pay for potential damages and losses in forests caused by climate change. Forest owner associations are worried that small-scale private forest owners will have to bear too heavy a burden and risk to be left behind (Venäläinen et al. 2020). There is a strong need for targeted climate change adaptation strategies to help small-scale private forest owners to adapt to climate change (Mostegl et al., 2019). In the Mediterranean region, large forest fires have become a serious problem causing a major threat for damage, health impacts and loss of life in rural areas and loss of multiple ecosystem services such as recreation or water treatment (IR B1.1).

Impact/risk type	Description		Governance level	Key sector(s)	Justice dimension(s) indentified in literature	Source
	Identified impact or risk	Justice implication				
Drought, reduced water resources (forest fires)	**B1.1: Loss of economic assets and income** Climate impacts can have a physical impact on property values and trigger losses of economic assets (place based) and/or income revenues: examples are impacts on agriculture or tourism or due to increasing flood risk along coasts and rivers, extreme precipitation events or fire risk. *Links to A2 (physical planning), A3 (networks) , C1 and C2 (grey l infrastructure) and e (knowledge and behavioural change).	**Unequal distribution of assests' value losses and income losses:** Certain populations disproportionately affected: place based (e.g. coastal areas and along rivers; farmers in Southern Europe due to international trade market.) and socio-economic groups). Women are disproportionately affected, due to unequal access to resources, education, job opportunities and land rights, aggravated by social and cultural norms and their diverse intersectional experiences. Small scale forest owners may risk to lose larger proportion of their income	National, local	Water management, Agriculture, Forestry	Distributive	Country Reporting Bulgaria, Austria, Latvia, Romania and Slovenia. And: European Parliament 2018, EEA, 2019, Reidsma et al. 2010; Reidsma et al. 2009a; Reidsma et al. 2009b; Mostegl et al., 2019.

Figure 34. Example of justice implication of climate risk and impact in the forestry sector – extracted from the evidence matrix in Annex Ia

Leaving no one behind

EU's new forest strategy does not address inequalities and justice issues explicitly. However, it acknowledges regional disparities in impacts, stating that parts of Europe have been hit harder by climate change than anticipated. The rural areas affected by impacts have suffered from the loss of income, livelihoods and lives caused by forest disasters. In these vulnerable areas there is a particular need to provide drivers for a transformation of cultivation practices and financial incentives to provide a broader range of ecosystem services, and to increase the resiliency of the forests (EC, 2021c).

Consideration for the design of indicators to assess justice related to the forestry sector

No evidence for prioritising specific justice aspects for indicators were found in the scientific literature for this policy area.

4.1.11 Health

Uneven distribution of risk and impacts and specific vulnerabilities ('uneven burdens')

Climate change may impact individual health with justice implications. This can be observed during extreme temperatures like heat wave and cold waves (IR.C1.1) and when there is a lack of cooling/warming systems (IR.C2.1). This in combination with poor environmental quality of areas where many low-income groups live, may affect the health of these vulnerable groups (IR.C1.4,

IR.D1.3). Impacts and risk with uneven health burdens also relate to insufficient access to and quality of water due to droughts (IR.D2.1) and increased physical risk in flood-prone areas (IR.C1.2). Underlying mechanisms of these health risks are elaborated on in the Urban, Buildings, Energy, Water management sectors and Coastal areas.

Urban dwellers and specifically older people, babies, people in poor health, low-income groups, and people with poor social networks are particularly vulnerable to be left behind and to suffer from health impacts. Coastal, flood and drought-prone areas also specifically at risk. The impacts of climate change can also have effects on workers conditions, health and safety (IR.E2.1). Workers particularly vulnerable to health risks due to climate change are particularly those with nature-based livelihoods and outdoor activities such as farming and fishing, coastal and marine tourism. In addition, workers in coastal and fishery sectors are also at risk of health impacts due increased frequency and intensity of storms.

Impact/risk type	Description		Governance level	Key sector(s)	Justice dimension(s) indentified in literature	Source
	Identified impact or risk	Justice implication				
Multiple risk	**E2.1 Workers and employment** The effects of climate change on workers and employment, working conditions, health and safety and livelihoods.	**Unequal distribution of losses of livelihood/income and productivity** Those who work in certain occupations are disproportionately exposed to high temperatures, for example those who perform physical work, use protective equipment or clothing, work outdoors exposed to the sun or work indoors with machinery that generates heat (WHO Europe, 2021). Emergency workers, such as firefighters, are particularly likely to be exposed to flooding and wildfires at work, putting them at risk of injury and death (European Climate and Health Observatory, 2022c, d). Labour supply will increase in northern European countries, due to climate change. Effective labour is expected to decrease in Southern Europe In addition, the risk for loss of livelihood are diproportunate in sectors that depend on a high quality, healthy environment.such as farming and fishing, coastal and marine tourism,	National, local	Health, Agriculture, Marine and fisheries, Cross-cutting	Distributive	Country Reporting Latvia. Dasgupta S. et al. 2021: WHO Europe 2021; EEA, 2022.; Susova L., Mailleux F 2020

Figure 35. Example of justice implication of climate risk and impact in the health policy sector - extracted from the evidence matrix in Annex Ia.

People with lower incomes are generally at higher risk of health problems. In many countries, this is connected to low levels of air quality in peoples living environment (see, e.g. EEA, 2018). If incentives are provided that stimulate people to use less carbon intense forms of transport, this would create benefits good for the health and disparate employment opportunities. (Expert interview 5, 2022)

Leaving no one behind

Examples of adaptation measures targeting the health of vulnerable groups (directly and indirectly) include national heat wave planning (AD.A2.6) and local heat protection contact networks (AD.C1.2), measures improving thermal performance of dwellings (AD.C1.1), urban greening, regenerative design and green infrastructure (AD.C1.2, AD.D1.2).

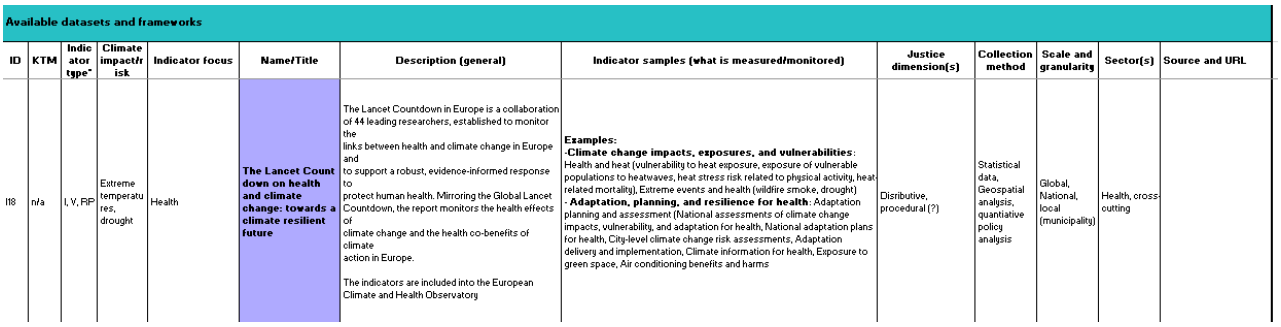
Description		Governance level	Key sector(s)	Justice dimension(s) indentified in literature	Adaptive/mal-adaptive outcomes (poitive/negative/both)	Source(s)
Identified response, adaptation measure or adaptation outcome	Justice dimension or implication					
C2.1 Heat wave protection measures at the local level	**Targeting vulnerable groups** In some countries/cities, special efforts are made to reach out and care for vulnerable groups through registers with regular phone check-ups (Paris) and hotlines, cool rooms and physical assistance (Paris, Bologna, Kassel).	Local scale, city scale	**Urban** Disaster risk reduction, Health	Distributive, procedural	Positive	Breil et al. 2018; Kazmierczak et al., 2020

Figure 36. Example of justice implication of adaptation measure in the health policy sector – extracted from the evidence matrix in Annex Ib.

Consideration for the design of indicators to assess justice related to the health sector

In relation to health policies, there is a high level of attention to distributional aspects of justice (distribution of health effects). An example of an indicator that could be used to assess just

resilience in relation to health is The Lancet Count down on health and climate change. They monitor the impact of climate change on health and include indicators related to climate change impacts and social vulnerability.



Available datasets and frameworks

ID	KTM	Indicator type*	Climate impact/risk	Indicator focus	Name/Title	Description (general)	Indicator samples (what is measured/monitored)	Justice dimension(s)	Collection method	Scale and granularity	Sector(s)	Source and URL
I18	n/a	I, V, RiP	Extreme temperatures, drought	Health	**The Lancet Count down on health and climate change: towards a climate resilient future**	The Lancet Countdown in Europe is a collaboration of 44 leading researchers, established to monitor the links between health and climate change in Europe and to support a robust, evidence-informed response to protect human health. Mirroring the Global Lancet Countdown, the report monitors the health effects of climate change and the health co-benefits of climate action in Europe. The indicators are included into the European Climate and Health Observatory	**Examples:** -**Climate change impacts, exposures, and vulnerabilities**: Health and heat (vulnerability to heat exposure, exposure of vulnerable populations to heatwaves, heat stress risk related to physical activity, heat-related mortality), Extreme events and health (wildfire smoke, drought) - **Adaptation, planning, and resilience for health**: Adaptation planning and assessment (National assessments of climate change impacts, vulnerability, and adaptation for health, National adaptation plans for health, City-level climate change risk assessments, Adaptation delivery and implementation, Climate information for health, Exposure to green space, Air conditioning benefits and harms	Disributive, procedural (?)	Statistical data, Geospatial analysis, quantiative policy analysis	Global, National, local (municipality)	Health, cross-cutting	

Figure 37.Example of a suitable indicator to monitor just resilience in the health policy sector - extracted from Annex II

4.1.12 Marine & fisheries sector

Uneven distribution of risk and impacts and specific vulnerabilities ('uneven burdens')

Identified climate risk and impacts to the marine and fisheries sector with justice outcomes relate to the effects of climate change on fish stock availability that consequently affect income (IR D.1.3) and employment (fisheries), and secondly also to change in the working conditions, health and safety of people in these sectors (heat wave, storms) (IR.E2.1) with transboundary (international) justice implications (IR.D1.4).

Impact/risk type	Description		Governance level	Key sector(s)	Justice dimension(s) identified in literature	Source
	Identified impact or risk	Justice implication				
	belongingness, self-esteem, self actualisation.	indigenous cultural heritage.				
Multiple risk	D1.3: Low environmental qualities exacerbates vulnerabilities Enhanced risk to impact-prone areas or places with low environmental qualities that exacerbate the impacts of climate change (e.g., in areas with a lack of green space and/or poor air quality, living in poorly drained areas affected by frequent flooding or living in housing of poor quality not adapted to protect from heat or withstand flooding, severe storms or increased fire risk). *See also C1.5.	**Unequal impacts and losses:** Socially vulnerable groups suffering from enhanced exposure can include, for instance, individuals or groups living in such areas and the homeless.	National, local	Buildings, Coastal areas, cross-cutting, water management, urban, health, working conditions	distributive	EEA 2018, 2021 (add urban literature, double check sources) Expert interview 1;

Figure 38. Example of justice implication of climate risk and impact in the marine & fisheries sector - extracted from the evidence matrix in Annex Ia.

A recent study indicated however that fisheries systems in the European seas are overall resilient to short-term stress due to climate change (Bastardie et al., 2022). It is important to keep the fish stocks healthy and well-assessed as they are expected to be highly resilient. Despite the evidence on the impact of climate change on fish stock, the study was not able to estimate the financial resilience of commercial fisheries to recover from short-term shocks in the fisheries system. However, it is expected that companies with low profitability will be most vulnerable to these short-term shocks and may risk losing their business. Low stocks go hand in hand with increased fuel costs, which aggravated existing vulnerabilities. Vulnerability is also connected to specific species, as for instance hake in the Mediterranean is declining in productivity, which means that fishers need to adjust their management to recover from potential income losses. The study also indicated that the fisheries sector may be negatively impacted by long-term trends in climate change if no adaptation measures are taken (Bastardie et al., 2022).

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The European Commission has developed Common Fishery Policy to ensure an environmentally and sustainable fishery sector in the long term. Focus is on sustainably managing the European fishing fleets and conserving fish stocks[17] (EC, 2023) (EC, 2023a). To make sure no one is left behind, it is key that the CFP includes measures to make sure stocks remain resilient to short-term shocks, which helps to build resilience to long-term terms. In February 2023, the European Commission has launched an action plan to protect and restore marine ecosystems for sustainable and resilient fisheries (EC, 2023b). Part of the plan are instruments to ease access to available funding for innovative fishery practices (AD B1.3) as well as strengthening the shared knowledge base for sustainable fishing practices.

Description		Governance level	Key sector(s)	Justice dimension(s) indentified in literature	Adaptive/mal-adaptive outcomes (poitive/negative/both)	Source(s)
Identified response, adaptation measure or adaptation outcome	Justice dimension or implication					
B1.3: Innovative funding mechanisms Including local taxes and crowdfunding schemes.	**Targeting low-income groups** with limited access to resources and financial instruments - ease access to funding **Remediating historical inequalities**	local	Finance; Fisheries	Distributive	Positive	Expert consultation and Climate-ADAPT, 2022a; Finance Watch 2020

Figure 39. Example of justice implication of adaptation measure in the marine and fisheries sector – extracted from the evidence matrix in Annex Ib.

Consideration for the design of indicators to assess justice related to the marine and fisheries sector

No examples of measures targeted at the marine and fisheries sector with justice dimensions have been identified in this study. However, based on the evidence, the proposed indicator would assess the fish stocks, which seems to be complicated due to lack of knowledge on natural dynamics that affect fish stocks. Alternatively, the indicators should assess the financial resilience of the fishing companies, with specification of different types of companies.

4.1.13 Transport sector

Uneven distribution of risk and impacts and specific vulnerabilities ('uneven burdens')

The evidence on socially uneven distribution of climate change impacts on the transport sector is still fragmented. Evidence indicate that the most vulnerable people bear uneven burden like women, children and the elderly and low-income groups, in particular when located in remote and scarcely connected areas (IR.C1.2) as they depend on transport (cars, busses) to access basic services. Climate change and climate change mitigation policies may affect access to transport for low-income groups, for instance due to interruptions before, during and after extreme events, or due to rising transport costs due to higher energy prices. Therefore, also transport, would need to be considered as a face of energy poverty. Climate change will also impact the health of transport workers, as for instance while working during heat wave (IR E2.1).

[17] https://oceans-and-fisheries.ec.europa.eu/policy/common-fisheries-policy-cfp_en

Impact/risk type	Description		Governance level	Key sector(s)	Justice dimension(s) identified in literature	Source
	Identified impact or risk	Justice implication				
Flooding and landslides	**C1.2 Flooding and landslides** From heavy rainfall damaging private and public resources, including infrastructure and property, inhibiting movement (short or long term) and has impacts on land-base management practices (see D). *Also links to land use planning and management (A2 and A3).	**Unequal losses and health effects** Documented 'worse' impacts on vulnerable groups compared to less vulnerable groups. Resources include a wide spectrum of assets, including the capacity of being able to voice ones needs. ** Identified knowledge gap: Aggravates pre-existing inequalities related to access to private and public transport systems (gender, age, socio-economic groups). May aggravate health conditions due to power outage.	National, local	Buildings, Cross-cutting, Water management, Energy, Transport, Coastal areas, Health, Urban, Disaster	Distributive, Procedural	Expert group consultations and: Lindley 2011; Foudi et al., 2017; Rey-Valette et al., 2015; Corfe, 2017, cited by Buser, 2020; Szewrański et al., 2018; D'Alisa and Kallis, 2016; EEA/ETC, 2018. Climate Change Committee Scotland, 2022b; Jessel et al. 2019.

Figure 40. Example of justice implication of climate risk and impact in the transport sector - extracted from the evidence matrix in Annex Ia.

Leaving no one behind

Action targeted to reduce greenhouse gas emissions resulting in increased fuel and transport prices can widen these inequalities if not addressed (AD.B1.1). Evidence shows that the most vulnerable people that may be risk to be left behind due to fuel taxes on private transport are households that rely heavily on private transport for work or access to services: middle-income, under 60 years, and employed; households that do not have access to public transport (no alternatives available) and large households that have more than 1 child (Ludden et al. 2021) (Ludden, et al., 2021)

Description		Governance level	Key sector(s)	Justice dimension(s) identified in literature	Adaptive/mal-adaptive outcomes (positive/negative/both)	Source(s)
Identified response, adaptation measure or adaptation outcome	Justice dimension or implication					
B1.1 Subsidies and financial incentives (green energy) directed at energy efficiency and regulations such as carbon taxes which aim at incentivising energy efficiency via market mechanisms.***strong link to mitigation	**Affordability** Owners vs. tenants. Energy price increase create disproportional burdens for low-income households and tend to further enhance inequalities including energy poverty (C1.1) and the vulnerability of farmers (D1.1)	EU and country level	Energy, Buildings, Transport, Cross-cutting	Distributive	Negative	De Cian et al., 2019; Ludden, et al., 2021; Oliveras et al., 2021; Scottish Government, 2020; Eurofound and EEA, 2021; Cabrita et al., 2021; Sharifi, 2021; Sánchez-Guevara Sánchez et al. 2017; Sánchez-Guevara Sánchez et al. 2019

Figure 41. Example of justice implication of adaptation measure in the agricultural policy sector – extracted from the evidence matrix in Annex Ib.

Consideration for the design of indicators to assess justice related to the transport sector

Indicators that measure justice in the transport sector should relate to the proportion of vulnerable people in remote areas and the impact of increased prices on the access to transport by these groups, measuring, in analogy to what is suggested in relation to energy poverty, the share of income spent on transport. However, in the current list of indicators (Chapter 5) no suitable indicator for the transport sector was identified.

4.1.14 Cross-cutting

Uneven distribution of risk and impacts and specific vulnerabilities ('uneven burdens')

Many cross-cutting topics emerge in planning and implementing climate adaptation. Cross-cutting topics relates to more than 1 sector. They can emerge in a primary sector as agriculture or fisheries but then can have secondary effects on rural or coastal communities, but also more generally on lower income groups, due to changes in food affordability (IR.D1.1) and occupation, risk to livelihoods and community cultures or changes in land use (IR.D1.2). Cross-cutting also refers to enhanced risk for impact-prone areas or places with low environmental qualities that aggravate and enhance climate change impacts (IR.D1.3), exacerbated vulnerabilities due to complex global systems changes that are related to prices changes of food, energy and commodities and therefore ultimately affecting livelihoods of citizens within and outside the EU (IR.D1.4) and lastly the effects of climate change on workers and employment, working conditions, and health and safety (IR.E2.1).

Impact/risk type	Description		Governance level	Key sector(s)	Justice dimension(s) identified in literature	Source
	Identified impact or risk	Justice implication				
	values that are connected to health, feeling of safety, belongingness, self-esteem, self actualisation.	are suffering most from the consequences. Inter-generational loss of indigenous cultural heritage.				
Multiple risk	D1.3: Low environmental qualities exacerbates vulnerabilities Enhanced risk to impact-prone areas or places with low environmental qualities that exacerbate the impacts of climate change (e.g., in areas with a lack of green space and/or poor air quality, living in poorly drained areas affected by frequent flooding or living in housing of poor quality not adapted to protect from heat or withstand flooding, severe storms or increased fire risk). *See also C1.5.	**Unequal impacts and losses:** Socially vulnerable groups suffering from enhanced exposure can include, for instance, individuals or groups living in such areas and the homeless.	National, local	Buildings, Coastal areas, cross-cutting, water management, urban, health, working conditions	distributive	EEA 2018, 2021 (add urban literature, double check sources) Expert interview 1;

Figure 42. Example of justice implication of climate risk and impact across policy sectors - extracted from the evidence matrix in Annex Ia.

The justice implications of cross-cutting topics related to social groups that are disproportionally affected as older people, infants and children, people with poor health, people with poor social networks, low-income groups, ethnic minorities and indigenous people. People employed in farming and fishing and living in coastal and marine areas and people living in cities are particularly unevenly at risk. Loss of resources (affecting adaptive capacity and capabilities) includes a wide spectrum of physical, personal and social assets, including recognition of non-monetary values and the capacity of being able to voice one's needs. Cross-sectoral risks can, in particular, aggravate pre-existing inequalities (with uneven impacts due to gender, age, socio-economic groups). In countries with high climate risks, low adaptive capacity, poor governance and safety-net programs, cascading effects of climate change impacts may dangerously escalate tensions and increase existing vulnerabilities.

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Several examples of adaptation measures, approaches and best practices with cross-cutting focus or relevance across sectors are the following. First, several Member States integrate justice principles or consider specific social vulnerability aspects when designing adaptation plans and strategies (AD.A2.1). Furthermore, adaptation measures are designed while targeting e.g., vulnerable groups, or while minimising the risks democracy, health, security, and social justice.

In addition, there is the measure to acknowledge cross-border and international dimensions of climate change adaptation in national adaptation planning. Just resilience can be taken up by international actions for global climate resilience, supporting in particular the most vulnerable people with the least capacities to adapt (AD.A1.2).

Certain adaptation measures have shown to enhance procedural and recognition justice aspects and related capacity building. These include measures to improve local level engagement and participation in planning and managing climate hazards and adaptation (AD.A3.1), including education and formation of champions, collaboration of different departments, agencies, and vulnerable groups to participate in the design of adaptation policies and actions and access to innovative funding mechanisms (local taxes and crowdfunding) (AD.E2.4).

Description		Governance level	Key sector(s)	Justice dimension(s) identified in literature	Adaptive/mal-adaptive outcomes (positive/negative/both)	Source(s)
Identified response, adaptation measure or adaptation outcome	Justice dimension or implication					
	European indigenous groups abide.					
A3.1: Stakeholder networks Measures to enhance/improve local level engagement and participation in planning and managing climate hazards: Education and champions, collaboration of different departments, agencies, and vulnerable groups to participate in the design of adaptation policies and actions; another example is innovative funding mechanisms (local taxes and crowdfunding).	**Stakeholder practices and power inequalities** Stakeholder engagement does not automatically guarantee effective and fair adaption outcomes. The explicit recognition of climate change as matter of social justice could help address power inequalities in communities. Stakeholder involvement processes often fail to consider diversity and power issues within communities, nor do they investigate how these diversities affect the possibility of people to engage in participatory spaces in egalitarian forms.	Cross-cutting	Cross-cutting	Distributive, Procedural, Recognition, Historical	Negative	Climate-ADAPT, 2022a; Breil et al. 2021 p. 54-56.

Figure 43. Example of justice implication of adaptation measure across policy sectors extracted from the evidence matrix in Annex Ib

Ideally, such measures address the issue that stakeholder engagement does not automatically guarantee effective and fair adaptation outcomes. The explicit recognition of climate change as matter of social justice could help to address power inequalities in communities. Ensuring appropriate outreach and design of awareness raising and enabling measures towards vulnerable groups to improve their risk perception and adequate participation in adaptation planning and implementation (AD.E1.1). Concerns related to employment and working conditions (strongly linked to just transitions in mitigation) focus on increased need for education, training and reskilling leading to new green jobs and economic diversification, especially in low-income segments (AD.E2.1).

Gender is, in several EU Member States, treated as a cross-cutting dimension in adaptation planning. Adaptation actions and practices often include the integration of gender-relevant topics in climate policy programs and gender mainstreaming of national adaptation plans (AD.A1.1). Such practices consider gender differences in terms of access to information and training, differences in risk perception, different intentions for environmental behaviours and green lifestyles, but also the fact that women's different capabilities (voice, partake in the workforce, income etc.) and position in society can contribute to higher vulnerability to climate change and be less likely to be part of and benefit from adaptation measures and decisions. Women's (as well as people not identifying as male, such as queer or transgender) full, equal, and meaningful participation in key adaptation decision-making fora and the equal and balanced consideration of their input on solutions that take into account the different gender gaps roles in society is seen as a key action (AD.E2.2). Examples include the promotion of sustainable lifestyles considering women as active agents of change, by promoting their access to leadership position.

Consideration for the design of indicators to assess justice related to cross cutting issues

Cross-cutting issues are relevant for all types of justice. Besides distributional aspects of justice, specific focus is put to procedural and recognition justice aspects in the design and implementation of equal adaptation measures. Capacities and capabilities as well as intersectional justice are in focus for participatory measures, particularly discussed in relation to urban systems. Intergenerational justice and respect for the intrinsic value of nature are specifically relevant for long-term policy and planning. Relevant governance levels for cross-cutting issues span from the local to national and international scales.

An example indicator for justice on cross-cutting issues should be able to assess the location of the most vulnerable people. Many vulnerability indices exist. Another approach could be to monitor the inequality between people in society, which is possible for instance by the EU multidimensional inequality monitoring framework that included 346 country level inequality indicators.

Available datasets and frameworks												
ID	KTM	Indicator type*	Climate impact/risk	Indicator focus	Name/Title	Description (general)	Indicator samples (what is measured/monitored)	Justice dimension(s)	Collection method	Scale and granularity	Sector(s)	Source and URL
I3	n/a	V, RP	n/a	Quality of life	**EU Multidimensional Inequality Monitoring Framework**	The framework includes 346 country level inequality indicators to measure inequality between inhabitants in the EU. Published 2021. A first, but comprehensive, attempt to establish a 'common language' and a common framework for monitoring and analysing inequalities in the EU.	Structured into 10 domains: (1) knowledge and skills, (2) health, (3) material living conditions, (4) natural and environmental conditions, (5) working life, (6) cultural life and recreation, (7) political participation and voice, (8) social and family life, (9) bodily integrity and safety and (10) overall life experience. The framework encompasses five analytical approaches: (1) vertical inequality measures (inequality between individuals, eg. wealth or health distribution), (2) horizontal inequality (inequality between social groups such as ethnicity, gender, age etc.), (3) equality of opportunity approach (compensation and reward in relation to degree of effort), (4) capabilities measurement approach and (5) social mobility (inter- and intragenerational socio-economic mobility).	Capacities and capabilities,distributional justice, Intersectional, Intergenerational	Statistical data, surveys	Europe, National	Cross-cutting	European Commission, 2023

Figure 44. Example of suitable indicator for monitoring just resilience across policy sectors, extracted from Annex II

4.2 Synthesis and reflections to inform monitor and indicators

The analysis in this chapter makes clear that justice in resilience is about impacts that may risk leaving people behind directly, or indirectly due to poor health and increase poverty risks. It is also clear that many adaptation measures may aggravate these underlying inequality dynamics if certain aspects and mechanisms are not taken into account, such as for instance finance or market-based adaptation. Evidence on adaptation measures illustrates also that some adaptation measures have an important role to play in increasing just resilience, such as in engagement measures. However, there is still a lack of scientific evidence on how adaptation measures can improve justice for the different vulnerable groups. A cross-sector comparison indicates strong overlaps between some of the sectors. This means that these sectors may make use of comparable indicator approaches to monitor just resilience.

Evidence and knowledge on the uneven burdens of climate change impacts on people and places, and the uneven benefits and burdens of adaptation action have increased and improved in the past years. But just resilience is still a nascent field, where some policy sectors have had longer and come further than others in exploring the dynamics, processes and outcomes that contribute to inequity and justice in the respective fields. This screening has identified the urban, buildings, disaster risk reduction and health sectors to currently have the highest availability of knowledge and to have developed a wider understanding on who is most at risk and most likely to be left behind in adaptation action compared to other sectors. These sectors also have a better knowledge of key aspects to be considered for safeguarding vulnerable people and places at risk and have already made some progress in how to monitor these aspects. Error! Not a valid bookmark self-reference. below provides an indication of the availability of knowledge for each policy sector included in this analysis. “Availability of knowledge” refers to the strength of the evidence base that is currently available to inform the monitoring framework.

There is a growing awareness about the importance of considering underlying inequalities for the implementation of adaptation measures that can tackle uneven risks or prevent unjust outcomes. More targeted assessments with the aim of producing robust evidence to form the basis for the construction of indicators would however be instrumental to the development of indicator frameworks for these sectors.

Table 6. Indication of the availability of knowledge for each policy sector to guide the evidence-based development of just resilience indicators.

Sector	Availability of knowledge	Motivation (Key reasons or gaps identified as criteria for availability of knowledge)
Agriculture	medium	Information of climate impact and risk well advanced. Information related to regional diversity, characteristics of farms, differences in exposure and vulnerability to multiple climate change stressors (including farm type, climate risk profile, gender, income, insurance) in Europe is largely lacking. The cross-border and international dimensions of just resilience and adaptation action in the EU on external parties is also identified as a knowledge gap.
Biodiversity and NBS	medium	Impacts and risks well known and justice dimensions well integrated in biodiversity/NBS literature. Trade-offs/maladaptive outcomes accounted for in research. Links to adaptation policy and practice could be improved.
Buildings	high	Impacts and risks well known, and justice dimensions (particularly vulnerable groups) well assessed in literature. Trade-offs and maladaptive outcomes accounted for in research.
Energy	medium	Well represented in terms of energy poverty. Other aspects of justice in adaptation in relation to energy provision not found, including weak evidence on adaptation action and outcomes.
Urban	high	Impacts and risks well known, and justice dimensions (particularly vulnerable groups) well assessed in literature. Trade-offs and maladaptive outcomes accounted for in research.
Water management	medium	Justice dimension for flood management well accounted for in literature. The diverse impacts, exposure, vulnerability and justice in adaptation action in relation to drought largely lacking.
Coastal areas	medium	Impacts, vulnerabilities and responses in relation to flooding taking into account justice dimensions accounted for. More research needed to better understand drivers of vulnerability as well as adaptation outcomes with justice dimensions including maladaptation.
DRR	high	Impacts and risks well known, and justice dimensions (particularly vulnerable groups) well assessed in literature. Distributive, procedural justice (participation) and capacities and capabilities form core elements of DRR practices, also trade-offs and maladaptive outcomes are addressed in literature.
Finance	low	Screening found very little evidence on impacts and risks, vulnerabilities and adaptation action with justice considerations and outcomes in the finance sector in Europe. The cross-border and international dimensions of just resilience and adaptation action in the EU on external parties is also identified as a knowledge gap.
Forestry	low	Screening found very little evidence on impacts and risks, vulnerabilities and adaptation action with justice considerations and outcomes in the forestry sector.
Health	high	Impacts and risks well known and justice dimensions (particularly vulnerable groups) including maladaptation and trade-offs (e.g., mitigation) well assessed in literature.
Marine and fisheries	low	Screening found very little evidence on impacts and risks, vulnerabilities and adaptation action with justice considerations and outcomes in the marine and fisheries sector.
Transport	low	Screening found no evidence on impacts and risks, vulnerabilities and adaptation action with justice considerations and outcomes in the transport sector.

Across policy sectors, the evidence on justice in climate change adaptation repeatedly identifies specific groups as particularly vulnerable and of particular risk at having less influence on decision making processes. These groups include the young (infants and children) and the elderly, poor or low-income households, people in poor health, people with poor social networks, immigrants and ethnic minorities. Particularly exposed populations are also identified in low-lying areas, southern Europe, and in both urban and rural areas. This can be a good starting point where sector- or context specific analysis evidence is not available. However, such approaches may lead to generic assumptions limiting the scope to the "usual suspects" or those traditionally identified in literature. There is a strong need for more robust knowledge of which social groups benefit or are left behind by the respective adaptation measures. This is necessary to inform the development of indicator frameworks for the assessment and the monitoring of inequalities related to climate policies and the implementation of measures to increase resilience in a just way.

Sharing best practices and identifying synergies is one way to increase knowledge. The screening of evidence on justice in adaptation reveals commonalities and overlaps across and between policy sectors in relation to key justice aspects, such as:

- Urban, buildings and energy: overlap on energy poverty and building performance.
- Urban, water management, forestry and biodiversity: overlap on of nature-based solutions and biodiversity measures.
- Agricultural, fisheries and forestry: small and vulnerable businesses that risk of losing income due to productivity losses.
- Some sectors refer to specific geographical regions, such as coastal, agricultural/rural regions and urban with a strong overlap with policy sectors such as water management and buildings.

A few sectors have been identified as missing from the policy sector entirely, of high relevance for the analysis of justice in adaptation, such as the sectors of employment, business and trade (or economics), tourism and spatial planning. Therefore, future screening for evidence may revise the policy sector categorisation to better reflect the identified policy needs.

The evidence base has shown that many policy sectors are already considering vulnerable groups when it comes to climate change adaptation. It confirms that the need for addressing justice is already perceived as an urgency, in particular in policy sectors related to health, buildings and urban areas, agriculture and civil protection. However, the evidence base also shows that justice needs to be addressed also in relation to water management in agriculture, energy policies, disaster risk reduction and finance, while policy documents have not touched upon the topic of justice yet. This indicates clearly that there is a need to further mainstream justice into adaptation processes in each of the related policy sectors.

5 Indicator screening: a review of existing datasets and frameworks to measure justice in adaptation

Key Messages

- Several existing frameworks and datasets have been identified of potential use in the design and development of indicators for measuring, monitoring and reporting on the process and progress of justice and equity in climate adaptation for Europe. Most such existing datasets and frameworks monitor distributive dimensions of justice, based on available statistical data, although survey data and qualitative methods are also in use. Existing data and frameworks are available to monitor certain vulnerable groups but could also function as response proxies. Indicators focusing on capacities and capabilities were the second largest group of indicators found in this screening and could provide insights to the future development of indicators for just resilience at EU levels.
- Monitoring justice in adaptation cannot be limited to measuring the equity in distribution of benefits and burdens from climate impacts. Indicators were found that capture and address how adaptation measures affect various groups (preventive, mitigative and/or restorative) and the extent to which stakeholders have been consulted and involved in their implementation. In the screening, no indicators were found that directly assessed the recognitional aspects of justice.
- The screened case studies using local and regional level indictors or exploring indicator methodologies focus primarily on the social dimensions of vulnerability in sectors such as health, buildings and water management. More work is needed to identify and develop indicators for sectors such as transport and energy.
- A strong focus on the national or the local level (within the same neighbourhood or city) was observed in the screened datasets and frameworks. This can be explained by the local nature of implementation of adaptation as well as by the observation that national statistical data show the largest current opportunities for monitoring adaptation progress. As a result, the selected sample of indicator proposals does not include indicators to monitor justice related to sectoral as well as transboundary climate impacts.

Chapter overview

Indicators for just resilience can be designed for different purposes, such as for supporting setting up goals for policy making on not causing harm or leaving no one behind, assessing or monitoring processes or progress on justice considerations in adaptation planning and implementation. In this paper, the term *indicators* is used, meaning parameters, supported by quantitative and qualitative data collected for the use of measuring or monitoring state, outcomes or progress in relation to justice-related topics or phenomena in adaptation. This chapter presents how social and environmental justice and vulnerability is currently identified, assessed and measured and the kinds of indicators that have already been developed. The overview is intended to aid the work ahead of crafting just resilience indicators for the EU.

To do so, this chapter provides an overview of (a) **existing global and EU level datasets and frameworks** and **(b) case studies** of implemented indicators at regional or local levels or methodological innovations that can be utilised for the development of indicators to measure, monitor and report on justice in climate change adaptation at EU levels. It describes the different types of existing datasets and frameworks to measure and monitor elements relevant for justice considerations in adaptation or that could have potential for future development of justice indicators (or proxy indicators). The findings of the screening are provided in full in **Annex II.** The

screening and analysis of indicators are based on literature and data review as well as interviews with selected experts (see methodology in **Annex III**). Databases, frameworks and case studies that measure climate impacts or risk with no specific element of vulnerability, justice or equity/inequality have been excluded from the screening (but prominent examples are discussed below).

Given the increasing awareness about the need to consider justice and equity in adaptation policies and practice, the development of indicators for assessing adaptation processes, outcomes and efficiency is underway for the EU and globally, including the need for monitoring tools as part of the Global Stocktake under the Paris Agreement[18]. This paper aims at supplementing the ongoing work on adaptation indicators, catering for the needs and viewpoints particularly addressing justice and equity in these processes.

5.1 Indicator screening results

The screening identified 18 existing frameworks and databases with potential use for monitoring justice aspects in climate adaptation and 14 case studies (scientific papers with case studies and/or methodological innovation) that have developed methodologies specifically to measure or monitor justice or equity in climate adaptation or adjacent fields relevant for Europe. The results have been categorised according to (i) what is being measured (vulnerability, impact or response) (ii) which dimension of justice is measured (distributive, procedural etc.), (iii) which adaptation interventions (key types of measures: if applicable) are considered, (iv) relevant policy sectors, (v) governance scales and (vi) and the data source. In addition, the case studies have been labelled according to (vii) climate risk/impact type and (viii) justice implication to facilitate a cross-analysis with the evidence in Chapter 4. **A selection** of the findings of the screening are presented in tables below for illustrative purposes. The selection of these examples has been done with a specific emphasis on providing a breadth and depth of approaches, showcase applied approaches (real-world examples) and best practices. The entire indicator screening results of databases, frameworks and case studies, are presented in **Annex II.**

5.1.1 Existing indicator frameworks and datasets (a)

The screening found no comprehensive dataset or framework that has been designed or dedicated specifically to the monitoring and evaluation of **justice or equity in climate adaptation**. However, several existing datasets and frameworks comprise of or collect data that could partially be directly applicable or relevant for this purpose. 18 such datasets and frameworks were identified in this review. A selection of these is listed in **Table 7** below with a brief description. The selection is based on direct applicability and diversity to provide the reader with a comprehensive overview of the findings. The full list and descriptions are provided in **Annex II**. The list of examples is followed by an aggregated analysis of the structure and content of the screening results, summarised in **Table 8**.

[18] For more information on the Global Stocktake see eg. https://unfccc.int/topics/global-stocktake

*Table 7. Selection of 7 out of a total of 18 identified existing datasets and frameworks that can be applied to measuring justice/equity components in adaptation. *The Id (first column) is a reference to the index number to its detailed description in Annex II. **Indicator type: I: Impact, V: Vulnerability, R: Response and RP: Response Proxy.*

Id*	Type **	Topical focus	Name	Description	Measurement sample	Justice dimension	Data sources	Scale	Source
I1	V	General	*DG Regio Eurostat Database*	DG Regio collects sub-national disaggregated data on a number of classifications of potential relevance for assessing vulnerability in relation to Just Resilience in Europe.	Demographics, economic accounts, education, health, tourism, transport, labour markets, digital economy and society, environmental and energy, poverty and social exclusion, crime, etc. (NUTS3 European regions)	Distributive justice, capacities and capabilities,	Statistical data	Sub-national, National, Europe	DG Regio
I3	V, RP	General inequality focus	*EU Multidimensional Inequality Monitoring Framework*	Include 346 country level inequality indicators to measure inequality between inhabitants in the EU. Published 2021. Data disaggregated by individuals, social groups such as gender, age, ethnicity etc., and inter-generational mobility and opportunity.	Structured into 10 domains: (1) knowledge and skills, (2) health, (3) material living conditions, (4) natural and environmental conditions, (5) working life, (6) cultural life and recreation, (7) political participation and voice, (8) social and family life, (9) bodily integrity and safety and (10) overall life experience.	Distributive justice, capacities and capabilities, intergenerational and intersectional justice	Statistical data, surveys	National, Europe	European Commission
I5	V, RP	Human development and wellbeing	*EUROSTAT Quality of Life framework*	Measure human development and wellbeing beyond GDP including perceived wellbeing such as life satisfaction, emotions and sense of purpose in life. Collection of 45 indicators in 9 categories.	Data samples (3 categories): Economic and physical safety: wealth, dept, income security, crime, perception of physical safety - Governance and basic rights: trust and/or satisfaction in institutions and public service - Overall experience of life: life satisfaction, affects, meaning and purpose	Distributive, Capacities and capabilities	Statistical data, surveys	National, Europe	Eurostat
I8	I, V, RP	Social and economic equity, including health and education.	*Resilience Dashboards*	Monitors enablers and opportunities (capacities) and obstacles or challenges (vulnerabilities) in relation to the green, digital and fair transition. Includes over 100 indicators over four dimensions: Socio-Economic, Green, Digital and Geopolitical	Sample: Social and economic: poverty or social exclusion rate, employment in energy intensive sectors, government expenditures on education, Health, education and work: gender employment gap, long-term unemployment rate	Distributive, capacities and capabilities, Intersectional	Statistical data, surveys.	National, Europe	European Commission

Id*	Type **	Topical focus	Name	Description	Measurement sample	Justice dimension	Data sources	Scale	Source
I10	V	General	*Social Justice Index (SJI)*	Measure changes in areas related to social justice to facilitate improvements in national and European policymaking on inclusive growth, social justice and social conditions. 46 indicators over 6 justice dimensions.	Sample: Social cohesion and non-discrimination (policy, political participation, gender and foreign/native born disaggregated) Intergenerational justice (environmental, pension and family policy, R&D spending, GHG emissions, footprint consumption etc.)	Capacities and capabilities, intersectional justice, Intergenerational, historical and temporal justice	Statistical data and qualitative policy analysis	EU and OECD, national	Hellman et al (2019)
I13	RP	Gender equality	*The Gender statistics database*	Collects data for EU Member States on women's involvement in climate change decision-making.	Sample: Collection women's representation in environment decision-making in EU institutions, national governments and public administration.	Procedural justice	Statistical data	Sub-national, national, Europe	EIGE (European Institute for Gender Equality)
I17	I, V, RP	Monitoring NBS	*Evaluating the impact of nature-based solutions: A handbook for practitioners*	NBS impact assessment framework, comprising of a set of indicators and across 12 "societal challenge areas" such as: natural and climate hazards, participatory planning and governance, social capacity building and social justice and social cohesion.	Sample: Participatory planning and governance: Openness of participatory processes, Proportion of citizens involved in participatory processes, Sense of empowerment: perceived control and influence over decision-making,	Procedural, Capacities and capabilities	Geospatial analysis, statistical data, surveys and project based and participatory data collection	Local	European Commission

Table 8. Summary of analysis of structure and elements of existing datasets and monitoring frameworks (the analysis included all 18 findings, in-depth description of each is available in Annex II).

Element	Finding
Indicator type	- Vulnerability data/frameworks was the most common type (included in all but one dataset/framework, - more than half include data potentially useful as response proxies (10 out of 18), depending on how wide adaptation goals are framed, - on a few (three out of 18) datasets/frameworks cover climate impacts and risks in relation to justice and/or equity - No existing dataset or framework measuring climate change adaptation responses were found
Climate impact and risk	The three indicators that did identify climate impacts and risk (see above) are related to specific policy sectors, namely disaster risk reduction, nature-based solutions and health), These treated general climate impacts/risks as such as extreme temperatures/extreme events.[19]
Indicator focus	Mostly broad/general focus, mainly focusing on: - quality of life or wellness and health, - economic equity, including human development and poverty.
Justice dimension	Datasets and frameworks address: - distributive justice (14) - capacities and capabilities (7) - intersectionality and intergenerational justice (2) - procedural justice (2) This echoes the general focus of the screened datasets and frameworks, aimed at measuring a broad spectrum of distributive inequalities, capabilities and capacities (including social, environmental, institutional political etc.) along with some of the structural elements underpinning these aspects. Only two indices monitor aspects of procedural justice (gender statistic database and NBS handbook) looking at women's representation in environmental decision-making and participatory planning respectively.
Data sources	- Existing available statistical data (all) - Existing data in combination with surveys (8) mostly based on ongoing surveys by Eurostat). Outlier approaches (single cases): - Qualitative policy analysis (Social Justice Index) - Scenario analysis projecting future climate and socioeconomic scenarios (INFOM climate change index) - qualitative, project-based participatory process evaluation (Evaluating the impact of NBS) Three outlier approaches have been identified: one framework uses qualitative policy analysis (Social Justice Index), one incorporate scenario analysis projecting future climate and socioeconomic scenarios (INFOM climate change index), and one uses qualitative, project-based participatory process evaluation (I17: Evaluating the impact of NBS) as collection method.
Scale and granularity	Most existing datasets and frameworks collect data at national scale, with data for all European/EU countries available. The exceptions are: - Global indices like INFORM Climate Change Index, the SDG indicators, Sustainable Society index and the WEF Inclusive Development Index based on national level information - Regional databases like the Environmental Atlas for Berlin covers neighbourhoods in Berlin. The Environmental Atlas for Berlin, - EU wide databases like the DG Regio's statistical databases and EIGE's Gender statistical database provide examples of systematic data gathering that cover sub-national scales
Sectors	- Cross-cutting, (16) - Sector specific (2): (INFORM Climate Change index (DRR) and the Lancet indicators (health). This corresponds to the general focus of the indicators and the overarching/wide-spanning objectives.

[19] Note however that this screening did not focus on climate impact indicators, but specifically targeted at justice considerations in adaptation. Indicators with a specific focus on climate change impacts and scenarios are available, such as the Copernicus database: https://cds.climate.copernicus.eu/#!/home.

Overall, the screening results show that datasets and frameworks on justice (including inequality) of relevance to climate risk and adaptation have a strong focus on economic inequality with outcomes for individual well-being (or capabilities). Data collection is often based on indicators related to health, wealth or income, or vulnerable (including demographic data such as age) and marginalised groups (such as ethnic minorities). This type of statistical data is often easily accessible in Europe in national or regional datasets. Overall, this means that there is a strong emphasis on distributive justice aspects in existing indicator approaches and frameworks, and a tendency towards data-driven indicator and framework development. Outside of these available statistics, the diversity of culture, geography, governance scales and practices within the EU makes the development of comparable indicators challenging.

However, there are a few important exceptions to this general trend. Such is the case with the EIGE dataset, focusing on measuring representation of women in environmental decision-making (i.e., monitoring procedural justice) with a diverse collection methodology, incorporating several administrative levels (local to national). As well as DG Regio providing sub-national granularity of data. Statistical data and information collected though European surveys could be expanded to include adaptation-specific topics or issues pertaining to identified gaps, such as procedural and recognition justice and maladaptation. There are also examples in this screening of qualitative and survey data already collected in Europe that could potentially serve multiple purposes and/or be expanded to include specific measures for just resilience monitoring and reporting (such as the leaving no one behind index). The majority of frameworks and datasets identified within this paper have been audited and/or designed with a high degree of involvement of JRC or other European Commission bodies in the design, and co-funded by European sponsors, indicating high correspondence to European interests and priorities.

5.1.2 Case studies (b)

This section presents the local/regional level case studies and innovative methodological approaches identified in scientific literature in the screening. They differ from the above frameworks and datasets because they are not operationalised and readily available for use. The purpose of the screening of scientific case studies is to complement available frameworks and datasets with a wealth of approaches and to better understand contextual particularities and local needs. **Table 9** presents a selected subset of case studies, presented as illustrative examples out of the full table to maximise the representation of impacts, sectors, KTMs and justice dimension (e.g., distributive, procedural) and to avoid duplication of information. For the full table, see **Annex II**. The list of examples is followed by a synthesis of the entire screening results (14 entries in total), summarised in **Table 10**.

*Table 9. Selection of 5 out of a total of 14 identified case studies, the full list with in-depth descriptions is available in Annex II. *The Id (first column) is a reference to the index number to its detailed description in Annex 2. **Indicator type: I: Impact, V: Vulnerability, R: Response and RP: Response Proxy.*

Id*	Type **	Climate impact/ risk	Indicator focus	Name	Description	Measurement sample	Justice dimension	Data sources	Scale	Sector	Source
CS1	I, V	*Extreme temperatures*	*Exposure to heat and energy poverty considering income and age.*	*Population vulnerability to summer energy poverty: Case studies of Madrid and London*	Indicators measuring exposure and vulnerability to high summer temperatures. Geospatial correlation between urban heat island, housing energy, and social vulnerability indicators.	Sample: Impact: urban heat intensity, housing stock energy efficiency. Vulnerability: household income, population over the age of 65 Context specific proxies for each indicator and location.	Distributive	Modelling, statistical data	Local	Buildings, Urban	Sánchez-Guevara, C., et al., 2019
CS6	I, V, RP	*Altered rainfall patterns*	*Unequal distribution of loss of economic assets and income*	*Economic Value of Climate Change Adaptation Strategies for Water Management in Spain's Jucar Basin*	Economic losses indices. Measures the potential economic loss related to water scarcity related to potential allocation schemes, within a river basin and provides a monetary measure of equity between farmers.	Sample: Economic loss (equity of the system, assesses the relation between the losses in the demand over the potential maximum loss) -Withdrawal (percentage of water resources abstracted from the system)	Distributive	Statistical data, modelling	Regional, Local	Water management, agriculture	Escriva-Bou et al., 2017
CS9	RP	*Flooding*	*Unequal access to and quality of insurance*	*Flood insurance arrangements in the European Union: for future flood risk under climate and socioeconomic change*	Evaluate the ability of flood insurance arrangements in Europe to cope with trends in flood risk, including access to risk reduction measures and affordability. Combines models of insurance sectors, consumer behaviour, and flood risk.	Sample: - Unaffordability of insurance: (magnitude of unaffordability, measured as the portion of premiums that cannot be paid from a poverty-adjusted disposable income at the national level)	Distributive	Statistical data	National	Water management, Buildings, Disaster risk reduction	Hudson et al., 2019

Id*	Type **	Climate impact/ risk	Indicator focus	Name	Description	Measurement sample	Justice dimension	Data sources	Scale	Sector	Source
CS12	R	*Flooding*	*Climate policy distributive effects*	*A Novel Impact Assessment Methodology for Evaluating Distributive Impacts in Scottish Climate Change Adaptation Policy*	Present a climate justice toolkit (indicator set and guidance) that enables the consistent assessment of distributive impacts of climate policy, including a broad suite of policies that comprise the national adaptation programme. Target groups are communities of living, working and place	Sample: Household aspects: Equality Groups (Disability and long-term illness, gender, sexuality, race and ethnicity, religion and belief), Household Income (low-medium-high), Mode of Transport (Reliance on private transport, reliance on public transport, cycling, walking)	Distributive, procedural, capacities and capabilities, Intersectional	Surveys, statistical data	Local, National	Cross-cutting	Dunk et al., 2016
CS13	RP	*General*	*Adaptation planning justice screening*	*Connecting climate justice and adaptation measures: An Adaptation justice index*	Methods for assessing adaptation strategies and their planning processes. Indicator framework for four aspects of climate justice in the context of adaptation: recognition, distributive, restorative, and procedural justice. Framework tested in 5 European countries and their capitals	Sample: Recognition justice: (acknowledges that adaptation needs are different across groups in society, the impact of existing societal structures on vulnerable groups in adapting to the impacts of climate change, adaptation as a way to secure basic rights)	Distributive, procedural, recognition, restorative/historical justice	Qualitative content analysis	Local, national	Cross-cutting	Juhola et al. 2022

Table 10. Synthesis of structural components of the 14 case studies.

Element	Findings
Indicator type	Predominately vulnerability indices (11 out of 14), followed by climate impact and risk indices (6) and 4 methods that could potentially function as response proxies (4 out of 14). One case study is identified that measure climate change adaptation responses specifically was identified (the Scottish impact assessment)
Climate impact and risk	In falling order, the most common climate impact and risk focus are: flooding (4), altered rainfall patterns (2), followed by extreme temperatures (2) and extreme events (1) and general (1). Five of the case studies did not specifically consider climate risk but assess environmental degradation or status and/or hazards in general.
Indicator focus	The indicator focus of the case study was mostly broad with ca 1/3 (5 out of 14) focusing on social preparedness, vulnerability and or justice. Another 3 focused on quality of life/wellbeing and 2 on health. More specified case studies were also represented: 2 case studies focused explicitly on economic losses and access to insurance, another 2 on adaptation policy effects/design. Lastly, one case study covered energy poverty and another environmental poverty.
Justice dimension	All the case studies measure distributive justice. This was combined with intersectional (most often focusing on gender, ethnicity, and age) in 7 out of 14 cases, and capacities and capabilities justice approach in 6 out of 14 cases. One case study each covered intergenerational justice (CS4: Quality of Life Indicators for Vulnerability Assessment), and restorative/historical justice (CS13: Connecting climate justice and adaptation measures)
Data sources	All but one case studies used statistical data analysis, 4 are in addition based on surveys, 2 on modelling, and one utilized qualitative content analysis (analysing adaptation planning and strategy documents)
Scale and granularity	Most of the case study focused the data collection on a local-regional scale (12 out of 14). Half of the case studies also used or collected data with national coverage (7 out of 14).
Sectors	The most common policy sectors for the case studies were cross-cutting (5 out of 14) followed by buildings and urban (4) and disaster risk reduction (DRR) (4 out of 14 cases). Other policy sectors covered were water management (3 out of 14), agriculture (2 out of 14) and coastal areas (1).

A majority of case studies identified in this screening focuses on the local or regional level down to households or neighbourhoods[20]. To bridge contextual differences, proxies are often used. As an example, Sánchez-Guevara et al. (2019) measure housing stock energy efficiency in Madrid by means of theoretical cooling demand, and in London by indoor overheating, given the different climates in these two cities, and the low air conditioning ownership rate in London). The frequent use of local indicators is often explained or necessitated by the contextual and local nature of adaptation, with many variables affecting the adaptative capacity of people as well as the frequency of targeted and tailored approaches. Such tailored responses are in and of themselves recommended to ensure effectiveness, equity and justice in the process (Koks et al., 2015; Rosendo et al., 2015; Sayers et al., 2018; Zsolt Farkas et al., 2017). Hence, there is a possible trade-off between the implementation of just practices and the monitoring and evaluation effectiveness and accuracy of just adaptation action, particularly at a European scale.

[20] This is likely a result of the design of the screening, since innovative methods in scientific peer reviewed journals often only have the scope to cover a specific region/context. It should therefore not be interpreted necessarily as an inherent limitation of the methodology employed itself.

5.2 Synthesis and reflection to inform the development of a framework to monitor and report on just resilience

Uneven burdens and leaving no one behind: monitoring justice

The indicator screening has shown that there is a wealth of approaches and available data to measure justice and equity related to the uneven burden of climate change and adaptation processes and outcomes that is already experienced by different social groups. Although no existing database is yet in place to specifically monitor just resilience or just adaptation, several approaches could be adopted to inform developing EU level indicators for just resilience. There is a need to systematically pair climate data with vulnerability and capacity and capability indicators, such as with EU level social and health related data. Several ready-at-hand options to make the connection between justice and climate can be identified from this assessment, available from the Copernicus Climate Change Service (C3S)[21]

Distributive aspects of justice are predominant in measuring the uneven burdens of climate risk, both in existing datasets and frameworks, and in the case studies, analysed in this screening. This is due to a range of factors, such as that distributive data is often more easily available, cheaper and/or easier to collect, offers comparable time series and sufficient spatial disaggregation. Response indicators are typically focused on tracking stakeholder engagement (procedural justice) such as through checklists to ensure the fair representation of all stakeholders, in particular the most vulnerable, in all stages of adaptation policy, planning and action. Even when such indicators were developed for a specific sector or impact, they appeared to remain relevant to other contexts and sectors (such as the NBS handbook (EC, 2021e)). Another set of response indicators is focused on justice considerations in policy and planning through developing checklists to assess the consideration of different justice dimensions within (e.g., distributive, procedural, restorative, recognition) (see, e.g., Juhola (to be added) and Jafino et al., 2021)

Most datasets, frameworks and case studies identified in this paper had a broad or general justice focus, such as health and wellbeing, inequality in wealth or poverty and economic development spanning across policy sectors. When specific sectors *were* targeted, those were sectors typically closely linked to people and places, such as buildings and urban, health, agriculture and water management sectors. Technical sectors such as energy or transport were largely absent (although results, reported in the scientific evidence in Chapter 4, show that there is reason to target also these sectors). Response indicators were more common in the water management sector, in the context of floods, planned relocation and insurance. No impact or response indicators were identified for economic and financial measures other than insurances.

Although statistical data and approaches focusing on vulnerabilities to climate change risk, particularly in relation to health and wealth abound, the tracking of adaptation responses lags behind. The lack of indicators measuring responses (adaptation outcomes) reflects a general problem which has previously been encountered in the impact assessment of the 2021 EU Adaptation Strategy, where the baseline had to be built on policy implementation (XI.1, 2022). Applying an analogous strategy also for just resilience, looking at how much is spent on adaptation in a country and how it is divided by societal groups could be an option, but might eventually not lead to easy forms of quantification (XI.3, 2022).

Likewise, very few indicators have been developed to measure the negative consequences of the implementation of adaptation action (maladaptation, e.g., gentrification after urban regeneration or upgrading) and or to monitor the recognition of diverse values in adaptation process, planning and implementation. Indicators for remediating historical and intergenerational inequality or addressing injustice towards ethnic minorities or indigenous communities such as loss of culture or

[21] https://climate.copernicus.eu/

historic memories were largely absent. This may be a reflection of the more qualitative and specified measures needed for collecting such information, which is time-consuming and expensive to implement and maintain. However, this screening points to several good examples of how such aspects can be monitored, (see, for instance, the NBS Handbook). European Commission staff and experts (XI.1-5) call for the integration of just resilience concerns into national monitoring systems or anchoring of justice dimensions in vulnerability assessments which consider not only distributive effects from climate impacts and from adaptation measures (e.g., XI.3, 2022). At the same time, several experts point out that the collection of relevant data can be inhibited due to a difficulty to access particularly vulnerable groups such as people that do not have access to a computer, or in the example of people who have no political representation such as children and migrant workers without residence or work permits (XI.4, 5, 2022 and expert workshop). Furthermore, social vulnerabilities may be very contextual.

6 Connecting policy, evidence and indicator screening: a starting point to inform a framework to monitor just resilience

Key messages

- The scientific evidence and policy priorities provide a starting point to inform a framework for monitoring just resilience according to the different policy objectives that have been identified in sector policies, and at European and national level.
- Although existing indicators show potential, they need modifications and adjustments to fit with specific purpose of monitoring just resilience in European climate adaptation. In their current state, the existing indicators and datasets do not adequately consider vulnerable groups and justice dimensions.
- Several European-level datasets record data at a national level. There is however a lack of comprehensive and comparable datasets with sufficient level of detail to cover justice related aspects that relate to the regional and local contexts.

Chapter overview

This chapter connects and synthesises the findings from the analysis of policy objectives and needs for just resilience (Chapter 3), the sectoral analysis of scientific evidence (Chapter 4) and the screening of potential indicators (Chapter 5), to address the monitoring needs for just resilience for each policy sector. To do so, existing indicators are connected to the respective sector and government levels. In addition, to monitor just resilience, reliable data, rooted in sound science are needed to measure and monitor distinct aspects of justice. Ensuring that indicators meet these requirements is challenging, especially when regional and local situations can vary between and within EU Member States and over time. In addition, environmental or socio-economic situations can change drastically during the policy process. Some policy or climate adaptation actions can take many years, amplifying the need to include process indicators which measure progression towards the achievement of an outcome (Bours et al., 2014).

Therefore, this chapter presents a framework of indicators that can form the basis to monitor just resilience. This framework consists of three sections[22]:

- Indicators to monitor just resilience for **policy sectors;**
- Indicators to monitor just resilience at the **European policy level**; and
- Indicators to monitor just resilience of the **national policy level.**

6.1 A starting point for a monitoring framework for just resilience in policy sectors

As indicated in Chapter 4, there is an overlap between several policy sectors when it comes to uneven burdens of climate impacts or justice related aspects of adaptation actions. This overlap informs the framework to monitor just resilience for the respective policy sectors. In this section, a framework is proposed for indicators to monitor just resilience for the respective policy sectors. The analysis is to be interpreted as initial, as much work is to be done to further improve the understanding and dynamics of just resilience in these sectors. **Table 11** below provides an overview of the examples presented in Chapter 4 (one example per sector), connecting the aspects of climate impacts and risk, identified effect, justice dimension, identified responses, KTM, policy

[22] Ideally, indicators to monitor just resilience at local level would be covered in the paper as well. However, this level is beyond the scope of the analysis in this paper, as the focus was on sector, European and national level. To develop the knowledge base for a monitoring framework that fits with the local level, additional evidence collection would be required.

goals connected to the impact and effects, possible existing indicator development to match, the justice dimension monitored, data sources and scale. The proposed monitoring framework at a sector level in this chapter draws from these findings and synthesises insights based on similar traits approaches and challenges.

Table 11: List of example indicators that can be used as a basis to monitor just resilience in policy sectors.

Sector	Climate impact or risk	Identified effect	Justice implication	Identified response	KTM	Policy/intervention goal	Indicator or case study example	Indicator description or sample	Justice dimension	Data sources	Scale and granularity
Agricultural sector	Drought	Loss of income	Unequal distribution of income losses	Agricultural policy to finance measures to increase adaptive capacity of farmers	A1 - policy instruments and regulation	Reduce pre-existing vulnerabilities of farmers	Socio-economic climate vulnerability index of regions, with focus on agricultural impact	n/a	Distributive	Statistical data	Regional/local
Biodiversity sector and NBS	Multiple risk	Loss of natural capital, livelihood	People's values and nature rights are not recognised	Urban greening and green infrastructure	C1 - Physical infrastructure	NBS should be designed and implemented in line with the values and rights of the respective social groups that rely on nature	Participatory planning and governance indicator	Participatory planning and governance (openness of participatory processes, proportion of citizens involved in participatory processes), sense of empowerment (perceived control and influence over decision-making, adoption of new forms of participatory governance), and policy learning (number of new policies instituted, trust in decision-making procedure and decision-makers)	Recognition, procedural	Participatory data collection and surveys	Local
Buildings sector/energy sector	Heat and heatwaves	Extreme heat increases energy demand for cooling	Exacerbate energy poverty for low-income households in poorly energy performing buildings.	Improving energy performance of houses, providing subsidies to increase energy efficiency of houses	C1 - Physical infrastructure/B1 - financial instruments	Dedicated policies and financial instruments to ensure energy affordability and decrease risk to energy poverty of the most vulnerable people	Energy poverty indices	Energy poverty: measures exposure and vulnerability to high summer temperatures (such as urban heat intensity, housing stock energy efficiency), in combination with vulnerability indicators, (such as household income, population over 65 years).	Distributive	Modelling, statistical data	Local
Energy sector	Flooding and landslides	Damage to public infrastructure such as energy infrastructure, resulting in power outage	Interruption of health care services, disproportionally affecting people with health issues, increase fatalities.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Urban sector	Multiple risk, extreme heat	Urban dwellers particularly exposed due to urban morphology and population density	Some cities will need more systemic interventions in their morphology than others	Urban adaptation planning	A2 - management and planning	The inclusion of data and methods to assess the location of the most vulnerable people and using this as a basis for management and adaptation planning	Climate justice toolkit that assesses household characteristics	Ethnicity, household income, modes of transport (Reliance on private, public, transport, cycling, walking), dwelling type, tenure type, urban–rural (urban, small town, accessible rural, remote rural).	Distributive	Surveys, statistical data	Local
Water management sector	Drought	Water scarcity leading to decreased water access (quality and price)	Decreased access to water for poor or disadvantaged households, particularly affecting people in poor health.	Market based adaptation like water pricing	B1 - Financing and incentive instruments	If market-based adaptation for water demand is taking place, it should consider if the low-income groups can still afford access to water in order to be considered as a just adaptation measure	EU integrated poverty and living conditions indicator system	Material living conditions, health and risk behaviour, social connectedness.	Distributive	Surveys, statistical data	Regional
Coastal areas sector	Multiple risk, e.g., flooding	Coastal regions particularly exposed to flood risk, sea-level rise.	Poor social networks (example groups) inhibiting recovery from climate impacts	Participatory planning	E2 - capacity building, empowering and lifestyle practices	Recognizing and involving vulnerable groups to manage uneven burden and to build the social networks	Adaptation justice index	Involvement of vulnerable groups in the planning and implementation processes, allocating responsibilities related to adaptation.	Procedural and recognition	Qualitative content analysis	Local/national

Sector	Climate impact or risk	Identified effect	Justice implication	Identified response	KTM	Policy/intervention goal	Indicator or case study example	Indicator description or sample	Justice dimension	Data sources	Scale and granularity
Disaster risk reduction sector	Flooding	Increased insurance prices and needs	Low-income households may not be able to afford insurances, leaving some groups behind in high-risk areas	Cooperation on disaster risk reduction	A2 - management and planning	Special attention to the vulnerable groups to make sure they can cope with societal consequences of disasters	INFORM Climate Change Index	Future projection to the risk of humanitarian crises and disasters due to climate change, including most vulnerable groups.	Distributive, capacities and capabilities	Statistical data, geospatial analysis and scenario analysis	National (ideally should be disaggregated to regional/local level)
Financial sector	Flooding	Increased insurance prices and needs	Low-income households may not be able to afford insurances, leaving some groups behind in high-risk areas	Innovative funding mechanisms	B1 - Financing and incentive instruments	Providing finance to low-income groups to protect their houses	n/a	n/a	n/a	n/a	n/a
Forestry sector	Drought	Loss of income	Small-scale private forest owners particularly at-risk	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Health	Multiple risk, extreme or high temperatures, flooding, wildfires and storms	Health impact of climate change on workers due to change in working conditions	Certain occupations disproportionately exposed, including impacts on health, labour productivity and labour.	Heat wave protection measures	C2 - technical infrastructure	Using regular phone check-ups, cool rooms and physical assistance to protect vulnerable groups from health impacts	The Lancet Count down on health and climate change	Monitor the link between health and climate change in Europe. This includes heat stress risk due to physical activity, extreme events and health.	Distributive	Statistical data, geospatial analysis, quantitative policy analysis	National, local
Marine and fisheries sector	Multiple risk	Low environmental quality exacerbates vulnerabilities	Unequal distribution of income loss and productivity	Innovative funding mechanisms for protection	B1 - Financing and incentive instruments	The funding mechanisms should make sure that the most vulnerable groups are able to access the funding	n/a	n/a	n/a	n/a	n/a
Transport sector	Flooding and landslides	Inhibiting movement and damage to infrastructure	Rural citizens particularly affected, due to remoteness and poor access public or alternative transport system	Subsidies and financial incentives	B1 - Financing and incentive instruments	The funding mechanisms should make sure that the most vulnerable and exposed groups are able to access the funding	n/a	n/a	n/a	n/a	n/a
Cross cutting	Multiple risk	Low environmental qualities exacerbate vulnerabilities	Unequal distribution of income loss and damages - the most vulnerable people will suffer the most	Stakeholder networks	A3 - coordination, cooperation and networks	Stakeholder engagement can be set up in a way that it recognises the inequalities between people, targeting the most vulnerable groups.	EU multidimensional inequality monitoring framework	[add more specific info] Country level inequality indicators to measure inequality between inhabitants in the EU.	Procedural, distributive	Statistical data, surveys	National

6.1.1 Monitoring income changes in agriculture, forestry and fisheries sectors

Evidence has shown that the agriculture, forestry and fisheries sectors can be disproportionately affected, bearing uneven burden of climate change in terms of disproportionate income loss. Climate change is expected to decrease the productivity in these sectors, such as crop productivity, yield of woodland and declining fishery stocks. Some businesses are more vulnerable to these climate impacts than others, and at a risk of bankruptcy. Just resilience would therefore include adaptation measures that decrease their vulnerability by improving access to financial instruments and providing policy instruments and regulations that foster their resilience. The new European Common Agricultural Policy (CAP) and Common Fisheries Policy acknowledge that business' resilience need to be increased to deal with climate change impacts and risk.

As these income changes are of relevance for certain geographical regions in particular, it is useful to monitor just resilience by regional socio-economic vulnerability indices that rely on productivity and income data of the respective sectors. The most vulnerable regions could thus be detected with a better understanding of which subsectors would require additional support to prevent that people will be left behind.

6.1.2 Monitoring health impact, workers' safety and labour impact in agriculture, forestry and fisheries sectors and its connection with health policy sector

People risk being unevenly burdened due to the health impacts of climate change during work. In particular outdoor employment is prone to these disproportionate health impacts, which can be found in the agriculture, forestry and fisheries sectors. Health impacts consequently also affect labour supply (number of working hours), as workers are less productive or work tasks become entirely unmanageable. To ensure just resilience, these outdoor workers can be supported by early warning systems that help them to adjust behaviours and technical support to prevent health impacts and impact on workers. These just resilience aspects are currently not yet included in the policy objectives of the sectors, although instruments for early warning are in place at EU (EU Civil Protection) and national level (disaster and emergency management), that could play a major role in preventing this uneven burden to take place. Policies to mitigate heat impact are currently most advanced in the scope of climate related health impacts.

The monitoring need is therefore to track just resilience related to health and working conditions of outdoor workers in these three sectors. The Lancet Countdown has already an indicator in place that would fit to this purpose, measured at NUTS 2 level. The indicator combines NUTS 2 labour supply data with temperature and precipitation data from the ERA5-Land to track the impact of temperature on labour supply (number of working hours) for highly exposed occupations (agriculture, forestry, mining and quarrying, and construction). However, this indicator is only available for heat events. To fit with all relevant extreme events, the development of comparable indicators for flooding, drought and wildfire would be instrumental, with a focus should agriculture, forestry and fisheries sector respectively.

6.1.3 Monitoring risk to poverty due to rising energy costs in the buildings, energy and transport sectors

Evidence on the uneven burden and adaptation action in the buildings, energy and transport sectors show that the low-income households stand at risk to be further pushed into poverty due to climate change and even due to mitigation and adaptation actions such as fuel taxes. Due to poor building performance and rising energy demands in combination with rising energy prices, climate change and policy interventions might result in severely decreased energy affordability and access for these groups. This can in turn increase poverty and have health impacts. To action just resilience in these sectors, low-income households should be financially supported to improve building performance or provide for market-based adaptation measures that take into account their financial situation.

These measures to increase just resilience are part of mitigation policy, as well as EU poverty policy, oriented to support the poor households. There is a willingness within the EU to make sure financial instruments are not aggravating the inequalities between low- and high-income households.

To monitor risk to poverty in this context, an indicator would measure risk to energy poverty with the help of composed index that combines exposure and vulnerability to high summer temperatures like urban heat intensity, housing stock energy efficiency, in combination with vulnerability indicators like household income, population over 65 years, amongst others. This indicator set would be aggregated at local or regional level and would rely on statistical data to track progress on just resilience.

6.1.4 Monitoring the recognition, distributive and procedural justice of people in relation to biodiversity and nature-based solutions, as part of the biodiversity, urban, coastal areas sectors.

There are several sectors that strongly promote biodiversity measures and nature-based solutions to improve the resilience to climate change, such as in the biodiversity, urban and coastal areas sectors. Evidence has indicated that these green measures may have adverse impacts if the true relationship between people and nature is not considered. Some people heavily depend on nature for their livelihood or others may be affected by higher rents due to better quality of the living environment. Findings from Chapter 4 clearly indicate that in the perspective of just resilience, peoples' values and cultures regarding nature needs to be recognised and considered in the design and implementation of biodiversity measures and nature-based solutions. Stakeholders should be engaged properly during all stages of the decision-making process and the distributive effects of the nature-based measures on the different social groups should be assessed. Policy on nature-based adaptation is not yet instrumental on how to improve just resilience in these sectors.

A suitable indicator to monitor just resilience in this scope could be the Adaptation Justice Index, as this index combines statistical data and data from surveys on recognition (acknowledge different adaptation needs across groups; impact on social structures), distributive (division of costs and benefits among groups) and procedural justice (who participates, allocation of responsibilities). This indicator should be measured at local or regional level.

6.1.5 Monitoring the risk to increased living costs and difficulties to recover in disaster risk reduction, financial, water management and coastal areas and cross-cutting sectors

Based on the evidence in Chapter 4, there are several sectors that demonstrate an uneven burden of climate change to vulnerable groups due to unequal damage and due to rising living costs as for instance increased insurance fees, costs for protection, and increased prices of water. When it comes to unequal burdens, these vulnerable groups often struggle to recover from impacts as well. The existing inequalities in society interact with the mechanisms triggered by climate change impacts, making certain groups more vulnerable to climate risk than others and less prone to benefit from adaptation action. The most prominent vulnerable groups across sectors are poor and low-income groups that lack financial resources; ethnic minorities, indigenous people and migrants including people that do not speak the local language; people that are not sufficiently mobile such as children and the elderly; people with disabilities and in poor health; and people with limited social networks.

These just resilience aspects are largely found in disaster risk reduction, financial, water management, coastal areas and cross-cutting sectors. Policies are aware of the disproportionate distribution of impacts among social groups but only a few policy instruments are currently working towards changing the underlying inequalities between people. To monitor just resilience with regard to this aspect, it is important that the indicators assess the proportion of vulnerable people at local or regional level. Several vulnerability indices are mentioned in Chapter 5, including the INFORM climate change index. Furthermore, the EU has several indicators to monitor inequality

and poverty at national level as there is the EU multidimensional inequality monitoring framework and the EU integrated poverty and living conditions indicators, supported by quantitative data sets as well. It is important that there is a good understanding of who the vulnerable groups are that may risk increased living costs, in order to adjust the vulnerability index. Furthermore, the best level to monitor vulnerability is at regional or local level, as aggregation to the national level would result in loss of information. **Table 12** below provides an overview of the key monitoring needs for the different cross-cutting sectors, and potential approaches for monitoring them.

Table 12: Overview of monitoring needs on just resilience for policy sectors

Monitoring needs	Sectors	Justice dimension	Potential approach for monitoring	Type of indicator	Potential data sources	Scale
Income changes	Agriculture, forestry, fisheries	Distributive	Regional socio-economic vulnerability index with focus on the productivity and income loss	I, R, RP	Modelling and statistical data	Regional, local
Health impact of workers and labour impact	Agriculture, forestry fisheries	Distributive	The Lancet Countdown on health and climate change	I, R	Statistical data on labour supply and ERA5 Land data	Local
Risk to poverty due to energy poverty	Buildings, energy and transport	Distributive	Energy poverty indices	R	Modelling, statistical data	Regional /local
Loss of livelihood and values	Biodiversity, urban, coastal sectors	Recognition, distributive, procedural	Adaptation justice index	R	statistical data, geospatial analysis, quantitative policy analysis	Local
Risk to increased living costs and recovery difficulties	Disaster risk reduction, financial, water management and coastal areas	Distributive	EU integrated poverty and living conditions indicators	V	Surveys, statistical data	National, regional, local

6.2 Evidence base to develop a monitoring framework for just resilience at European level

The evidence in Chapter 3 and 4 can also inform which governance indicators are suitable to include in the monitoring framework for just resilience at European level. European policy analysis in Chapter 3 identifies the following monitoring needs based on policy priorities in Europe:

- Monitoring the justice dimensions that relate to the transboundary impacts of climate change in European trade, migration and stability: this would refer in particular to the distributive aspects of justice and can be monitored for example by changes in national/regional economic productivity, by using climate impact assessments or scenario analysis looking at for example import and export dependencies and response mechanisms.
- Monitoring the justice dimensions of the impact of climate change and adaptation measures on employment and workers' rights and the related labour mobility: this indicator also assesses the distributive dimension of justice and would refer to aspects like employment and labour market changes, job loss/growth, mobility and productivity changes.
- Monitoring the justice dimensions of European adaptation policies and action for people living outside the EU: This indicator could assess for example adaptation finance flows and impact on wellbeing. This data could be collected by participatory survey and statistical data.
- Monitoring the justice dimensions related to allocation of funding between EU Member States: for example by data on the distribution of funding and the ease to access funding.
- Monitoring to what extent just resilience is mainstreamed in different European sector policies: the assessment of mainstreaming of just resilience in policy sectors could take place in line with ongoing EEA adaptation score board approaches with specific attention to the distributive and procedural aspects of justice.

Table 13 connects these monitoring needs from European level with the steps in the adaptation cycle, to indicate when results are relevant for policymaking. The table also illustrates potential monitoring approaches and indicators that could be of use, based on the collection of existing indicators. However, as these proposed monitoring approaches and indicators were initially developed for other contexts or purposes, there is a need to modify them to fit into the context of monitoring just resilience at European level. Where possible, potential data sources to collect data for the proposed indicator is highlighted in the table. From the table it can be concluded that monitoring just resilience at European level has a current focus on distributive dimensions of justice and to a certain extent is also referring to procedural dimensions, echoing the EU policy priorities . The proposed monitoring approaches are mainly impact indicators.

Table 13 Monitoring needs of just resilience at European level

Step in the adaptation cycle	What should be measured/monitoring needs	Justice dimension	Potential approach for monitoring	Type of indicator	Potential data sources	Examples/references
Step 2	Justice dimensions with regards to the transboundary/cascading/ spill over impacts of climate change on European trade and productivity	Distributive	Climate impact assessment and scenario modelling/analysis that indicate changes in import and export dependencies, response mechanisms and changes in national/regional economic productivity (GDP)	Impact indicator	Imports and export, GDP, historical data	Barnett et al. 2013; JRC PESETA project (EC and Joint Research Cemtre (JRC), 2023)
Step 2, 3 and 4	The justice dimensions of climate change and adaptation on changes on the labour market, working conditions and employment	Distributive	Employment and labour market monitoring: job loss/growth; labour market mobility; productivity changes	Impact indicator/respons e indicator	National labour market data; modelling of labour productivity with WGTB method and climate change projections	Kjellstrom et al., 2009; EC et al., 2018, 2021
Step 3-4	The justice dimensions of European adaptation policies and measures on people living outside the European Union	Distributive	Transboundary impact assessment by assessing adaptation finance flow of the EU to developing countries; increase level of risks; impact on wellbeing	Impact indicator, vulnerability indicator	Participatory survey, statistical data	Schipper et al. 2015
Step 5	The justice dimensions regarding the scope of allocating funding between EU Member States	Distributive and procedural	European budget in according to just distribution principles and the ease to access funding in accordance with vulnerability	Response indicator	Public budgets European research and regional funding	UNEP 2022
all steps	The level of mainstreaming of just resilience into different European sector policies	Distributive and procedural	Policy document check	Response indicator	National adaptation strategies and plans	EEA Adaptation scoreboard

6.3 Evidence base to develop a monitoring framework for just resilience at national level

The policy review in Chapter 3 also indicated the monitoring needs for just resilience monitoring frameworks at **national level** in Europe. Each of these monitoring needs is connected to related steps in the adaptation cycle. These needs include:

- The uneven burden of climate change within and between countries, in particular in terms of health impact, economic impacts and employment.
- The distribution of impacts of climate change and of adaptation actions across social groups: Which groups bear an uneven burden? Who benefits the most?
- The access to finance to implement adaptation measures.
- The extent and quality of involvement of vulnerable groups in the adaptation decision-making and development.
- Monitor if people's values, and in particular vulnerable people, are equally included in adaptation processes and avoid maladaptation.
- Monitor if people have received compensation when harm has taken place as the result of adaptation measures.

Table 14: Monitoring needs and approaches for just resilience at national level.

Step in the adaptation cycle	What should be measured/monitoring needs	Justice dimension	Potential approach for monitoring	Type of indicator	Data sources	Examples/references
Step 1-2	Impact of climate change on health, economy, employment	Distributive	Impact assessment studies	Impact	Population data, economic data, labour market data	The Lancet countdown on impact of climate change on health; Eurostat Quality of Life framework
Step 2	The impact of climate change on social groups that are unevenly affected by climate change	Distributive	Social vulnerability assessment	Vulnerability	DG Regio Eurostat Database, SILC	-
Step 3 - 4	The impact of adaptation on people's vulnerability	Distributive	Ex-ante assessment of adaptation measures – composite index changes	Response	Survey and statistical data on vulnerability characteristics	Social justice index; Resilience dashboards, Assessment of Scottish climate policy; an adaptation justice index; human wellbeing index
Step 5	Equal access to finance to implement adaptation measures	Distributive and procedural	Assess where adaptation funding is allocated to and if it matches with vulnerability and high impact areas	Vulnerability	Adaptation budget data Insurance data	Access to insurance via insurance penetration rate
All steps	Monitor the quality of involvement of vulnerable people in developing adaptation policies and decision-making	Procedural	Assess the way people are involved via scale rating	Response	Policy documents	Monitoring participation and involvement in NBS solutions (European Commission, 2021)
All steps	Monitor if people's values, and in particular vulnerable people are included in adaptation process, in order to avoid maladaptation	Recognition	Assess the extent to acknowledge plurality in needs and values with regards to adaptation process and measures	Response	Policy documents	Assessing acknowledgement of plurality in adaptation policy documents with help of scale rating - Juhola et al. 2022
Step 6	Monitor if people have received compensation when harm is taking place as a result of adaptation measures	Restorative	n/a	Impact	n/a	The loss damage debate on the irreversible damage and loss to most vulnerable parts of the society (Boyd et al. 2017)

6.4 Conclusions on the joint analysis of policy, evidence and indicator screening:

This chapter provides a synthesis of screened evidence, policy needs, and existing indicators, datasets and frameworks, to inform the development of a framework of just resilience indicators. The evidence base can provide a first set of indicators that can be used for monitoring just resilience. Several conclusions derive from the analysis:

- The evidence base makes it possible to elaborate indicators for each of the policy sectors, but also for governance indicators at EU and at national level.
- Several monitoring goals have been identified in the policy sectors and at EU and national level. A key observation is that specific and differentiated monitoring goals can be connected to the different steps in the adaptation cycle, which is of particular relevance to the governance-related indicators.
- Monitoring approaches for several sectors have shown to be comparable, however, it might be expected that the collected data will focus on different subsectors, social groups or regions.
- Existing indicators can inform the framework to monitor just resilience. However, it needs to be specified what dimension of justice is to be measured as well as the monitoring need to identify the appropriate monitoring approach and data source. Therefore, users of the indicators are recommended to assess the specific justice dimension that they aim to monitor as well as the goal of just resilience.
- Many indicators are not ready for use and would require modifications to fit the just resilience context. For justice relevant impact indicators, many impact assessment studies were found that would fit as data source. These studies should be interpreted from the just resilience perspective to increase their relevance for monitoring purposes.
- It is also observed that almost none of the indicators refers to changes in power dynamics, while this is assumed to be required to change the underlying social structures that result in social inequality.

7 Conclusions and the way forward

This paper presents the current trends and developments in the framing, understanding and current practices to inform ways of measuring justice in adaptation for Europe. The task of operationalising 'Just Resilience' for Europe and developing indicators to measure, monitor, report and evaluate progress towards this goal is ongoing. This chapter distils the insights from the analysis for the potential to measure and monitor justice and equity in European climate change adaptation and makes suggestions on future priorities for the development of just adaptation procedures and indicators to match. The chapter is based on the combined information provided through stakeholder consultations and the analysis of European policies and EU Member States reporting, scientific evidence and indicator screening. It presents the core conclusions and reflections from the analysis followed by suggestions for concrete opportunities and priorities for policy, practice and further research for the operationalisation of just resilience in Europe ahead.

7.1 Conclusion and reflections

Harvesting low hanging fruit: a lot can already be done

The integration of just resilience concerns and the application of justice dimensions into the adaptation process, national monitoring systems and vulnerability assessments can already be started using the current knowledge base and available indicators. Such assessments can be encouraged to consider not only distributive effects from climate impacts and from adaptation, but also procedural justice dimensions as well as people's and groups' different capacities and capabilities.

The reporting from EU Member States and Türkiye and the indicator screening show that such a development is already in motion in several areas and states, such as the development of sub-national indicators for the Metropolitan area of Helsinki to understand adaptation needs and evaluate the effectiveness of measures. Data for vulnerability assessment at a national and sometimes regional level for information on such as gender, age, income and wealth are readily available through European organisations such as Eurostat as well as frameworks targeting heath, wellbeing and quality of life aspects (a full overview is provided in Chapter 5).

While increasing attention is given by EU Member States to the social justice dimension of adaptation and to the social and cultural values at risk from climate change, most countries do not yet have monitoring frameworks in place to measure just resilience. Where statistical or survey data is lacking, one way forward could be to encourage EEA member countries to provide qualitative information where available and to develop quantitative monitoring. Examples of good practice can inform countries that do not have monitoring frameworks for social justice in place to guide their understanding of the reporting of Art. 19 on national adaptation actions for the EU GovReg[23]. Including monitoring of justice aspects in monitoring requirements can be a strategy to attract attention to these aspects of adaptation policy. It could also provide opportunities for peer-to-peer learning between sectors and EU Member States as new tools and frameworks are being developed, thus improving the collective understanding on indicators, providing comparable data and enable the measurement of policy progress.

While using existing datasets, frameworks and tools is a starting point, there are several actions that can contribute to clarity and accuracy both for the operationalisation of just resilience in Europe, and for the development of indicators. The consideration of recognition justice and the potential

[23] Currently the guidelines for reporting is limited to the consideration of gender perspective as well as description of activities for involvement of those stakeholders who are particularly vulnerable to climate change impacts (Annex I, 3.3 and 3.6, EC, 2020a, p. 18).

risk of maladaptation are two core knowledge gaps. The need to understand, consider and monitor these aspects in the adaptation process have been identified in and by European policy, EU Member States and from sector-level evidence. However, tools and indicators for such assessments are currently considerably lacking. To address these gaps, five key steps that have been identified in this study that can improve the development of indicators for just resilience are listed below.

Five key action points: to improve the operationalisation and monitoring, reporting and evaluation of just resilience in Europe

1. Define justice and adaptation goals

While advances are being made at both European and EU Member State level, this study has shown that adaptation goals related to justice in Europe are often broad and, in some cases, entirely lacking. A clear articulation of goals can enable a more targeted, transparent and effective monitoring and evaluating processes, with the possibility to strengthen justice outcomes. A first step in operationalising and developing a monitoring framework for just resilience in Europe would be to clearly define the goal(s) of adaptation, including justice goals, throughout the adaptation process. This could also help to ensure policy coherence within Europe. An example of current incoherence in policy goelas is the first reference to just resilience in the EU Adaptation Strategy, relating to justice in international dimensions, transboundary and cascading impacts of climate change and between Member States. This aspect of justice in adaptation is absent from EU Member State and sector-based priorities.

Goal formulation can be particularly important for a topic as complex and with such different potential interpretations and applications as "just resilience", as this study has shown. Such a definition of goals at the beginning of an adaptation process would provide an opportunity to discuss and agree on minimum qualitative goals (and where possible made quantifiable) to guide policy action and their monitoring and reporting throughout the adaptation process. Additional guidance and exchange of experiences among EU Member States, regional and local actors, practitioners and those responsible for sectoral policies could help developing such improvements of adaptation practices and increase the applicability of indicator development and data.

2. Measure justice throughout the adaptation process/cycle:

Just resilience is an umbrella term that includes the different lenses through which justice can be approached in climate adaptation. These include the core concepts of procedural, distributive and recognition justice and are complemented by further dimensions identified as key for understanding, advancing and developing indicators for just resilience, in particular capacities and capabilities approaches and intergenerational and intersectional dimensions of justice. Currently, distributive justice is the most used and implemented, followed by procedural justice.

Ways of including a wider justice framing, and more qualitative monitoring systems can be furthered analysed, to ensure a nuanced understanding of outcomes that are difficult to be measured quantitatively or can be understood only in their specific context. This is specifically important in monitoring procedural justice, recognition justice (especially during steps 1-2 in the adaptation cycle), adaptation options and outcomes (step 4 and 6 in the adaptation cycle) and understanding, anticipating and monitoring potential maladaptive outcomes (steps 3, 4 and 6).

3. Moving from sectors to systems: adopting holistic approaches

In this paper, the policy sectors level of analysis was adopted as a practical approach providing ready input to existing processes in current European institutions to inform, where possible, the development of indicators at a sector level. However, there are several inherent flaws in a sector-oriented approach, as well as the design of the current sector division. This includes missing, mismatching and overlapping sectors (as discussed in Chapter 4) that can create artificial barriers

and inhibit the effective operationalization of just resilience and the development of indicators. For both global and European policies, to overcome such barriers, a more holistic approach can be beneficial, working towards integrated principles as well as adopting a systems lens.

Integrating just adaptation policy and monitoring into existing policies and practises could result in a more efficient implementation. Some work is already underway in the direction of integration and policy mainstreaming, as for instance in the application of a whole-of-government approach used, for example for the work on the EU Adaptation Strategy. However, more focus on horizontal policy integration is welcome, for example in relation to just resilience policies within employment and worker protection, gender issues, adaptation finance, trade policies and development practices, not generally practiced in EU Member States. Such horizontal considerations would entail dialogues on policy goals and strategies for ensuring justice in adaptation-relevant policies, including relevant actors and stakeholders. Better integration and information-sharing could also be instrumental in setting priorities for indicator frameworks for both the impacts of climate change on vulnerable groups and progress of just resilience policies practices. This is strongly related to the goal-setting process.

There are also potential benefits with using a systems view to address and assess just resilience. Such a development would be in line with recent policy developments in Europe and globally, on the back of the acknowledgement of the need for new frameworks to support circular systems and transitions. A practical example of such an approach could be the focus on just resilience solutions and indicators for 'urban food systems', rather than focusing on "agriculture", "health" and "urban" sectors separately and broadly. A systems approach can help to provide clearer definition and a more coherent analysis of goals and indicators for just resilience, and better reflect action' and processes 'on the ground'. Furthermore, economic sectors with similar justice and adaptation traits (albeit belonging to different policy sectors) could benefit from coordination and mutual learning. Such is the examples of the agriculture and fishing and marine sectors in Europe, facing similar challenges for the development of indicators for just resilience.

4. Anchoring indicator development with people and contexts, for local and sector-level indicator developments

The development of indicators related to just resilience developed **for a specific sector or geographical context** can benefit from a close connection to the **context** in which they are applied, such as through collaborative developments of definitions, priorities and indicator frameworks with the **people of most concern.** The development of indicator frameworks can benefit from the involvement not only of targeted groups (including identified vulnerable and marginalised groups and those typically excluded from such processes) but also of practitioners within relevant fields and at different levels of governance. Questions such as "do these indicators reflect your experience/work?", "does this collection method make sense to you/in your work?" and open questions asking "what and how would you describe/measure your experience/work (quantitively or qualitatively)" could form part of such an anchoring process. This could help avoid data-driven biases and faulty conclusions, resulting from mismatches between existing statistical data and generic assumptions about the people on the one side and processes that are meant to be safeguarded on the other, thus help in avoiding maladaptation.

This paper, as an example, has been produced by academics and policy officers based in Europe, the majority of whom are white women from Western European countries, and is based on desk research. Therefore, anchoring, trialing and testing the outcomes from such an approach on the ground will be crucial in the future development of indicators for just resilience. Such work is time-consuming and could thus benefit from a stepwise approach as well as from the use of ongoing efforts in EU Member States to collect information and understand core drivers.

5. Improve and learn through looking beyond current lenses

The awareness and development of policies as well as indicators monitoring just resilience is currently in rapid development, and a lot can be learnt from the experiences and trial-and-error expected in the coming years. The development of indicators for just resilience for Europe could benefit from drawing on experiences, approaches and expertise beyond the scope of this paper. Crucially, such approaches include:

(i) Learning from countries outside of Europe (in particular recent developments in e.g. Canada and Australia are of high interest/relevance but also developments in Latin America (Colombia and Chile in particular), Africa and Asia[24].

(ii) Focusing on practices that are already happening but might not (yet) be well documented. Certain areas and in particular cities (such as Barcelona, Berlin) are well advanced in their understanding, mapping and integration of vulnerable and marginalised groups and justice consideration in planning and implementation. Other cities and sectors/systems could greatly benefit from knowledge exchange in the process and approach improving the capacity to identify the vulnerable groups, locate them, to address their needs, and know how to involve them in the planning process.

(iii) Eastern Europe is not well researched or represented: this is a serious gap to be bridged, particularly considering a generally lower level of adaptive capacity in Eastern European countries compared to Western Europe, increasing the risk of countries and people being left behind.

(iv) Synergies with mitigation policies: adaptation and mitigation efforts are closely connected and could greatly benefit from the experiences and learning of the indicator development currently ongoing for both fields.

Structural and systems change: justice and power, transformation and adaptation

This paper has had a deliberate focus on the questions of "what is just resilience", "how it is implemented in practice" and "how can indicators be developed to measure that implementation", to provide actionable knowledge for the operationalization of just resilience in Europe. There is however a broader question underpinning them, namely 'how *should* it be implemented in practice'.

Structural and systems change lies at the core of both the justice and resilience concepts (as well as the transition equivalent for mitigation). Evidence support that pre-existing inequalities interact with adaptation feasibility and effectiveness (including limits to adaptation) and drive climate related vulnerabilities, as the IPCC concludes in its lates adaptation report stating that adaptation solutions should not only recognise but also address existing inequities (IPCC, 2022b Section B). Such structural elements are clearly echoed in the existing framework designs and indicators, many of which focus on capacities and capabilities by targeting 'quality of life'/'wellness' aspects, including elements such as social cohesion, sense of community, trust in institutions and active citizen participation as core elements. The connection to broader structural and systemic prerequisites and policy objectives becomes even more salient when it comes to the policy aim to avoid maladaptation. According to the IPCC: "maladaptive responses to climate change can create lock-ins of vulnerability, exposure and risks that are difficult and expensive to change and exacerbate existing inequalities. Maladaptation can be avoided by flexible, multi-sectoral, inclusive and long-term planning and implementation of adaptation actions with benefits to many sectors and systems." (IPCC, 2022b Section C4).

[24] See for examples the global review of scientific literature by Araos et al.(2021)

To effectively avoid maladaptation, assessing justice implications and outcomes of adaptation would thus need to become a common practice by assessing, measuring and monitoring plans, processes and implementation (the entire process of adaptation from design to implementation) to assess progress towards addressing these underlying structural drivers of inequities. But doing so does not happen in a technical or practical vacuum and would need to become part of a holistic agenda to transition towards a resilient society, which would include uprooting and confronting structural elements of injustice. Striving to strengthen such goals is perhaps not the most common interpretation of adaptation action but is intrinsically part of transformative approaches. Inherently, the issue becomes a political question, while adaptation is seen as a "technical" task.

7.2 Ways forward

Adaptation Policy

- **Adaptation processes**: **operational goals of adaptation**, including justice goals, can be clearly defined from the outset and continuously monitored throughout the adaptation process. This is important considering the diversity of approaches and conceptualisations of justice dimensions that can form the baseline of such practices. Clarity of goals and definitions would support operationalisation and approaches to measure process as well as progress.
- EU policies: a coherent framework on how to **mainstream justice** into different policy sectors could serve as a basis for creating specific guidance on justice issues into the guidelines for national adaptation strategies. The absence of specific EU policies on just resilience is currently a barrier for implementation at national level.
- The success of the just transition funding programme (EC, 2022c) shows that a **dedicated funding stream** for just resilience can support action on the ground providing not only economic support but also flagging justice in adaptation as a relevant policy goal. The current discussions on dedicated funding, underway under the financial framework policy and its priority setting (following up on the 2021-2027 EU Multiannual Financial Framework) (XI.1, 2022) could be place for such a decision. Such a financial stream would benefit greatly from a clear goal formulation and operationalisation of the concept of just resilience.

Adaptation Practice

- Starting with what is already there: **available datasets, tools and frameworks for justice monitoring and reporting** can be used to proceed in a gradual and stepwise learning experience, improving processes and tools underway. This can happen alongside the progression of indicators for measuring adaptation in general. As the goals and definitions of just resilience in Europe become more developed, the next step would be to develop a framework for indicators to measure justice in Europe.
- Availability of overarching guidelines for **detecting and engaging vulnerable groups** in adaptation planning would help EU Member States in advancing the special consideration and inclusion of vulnerable and underrepresented groups and communities in national and sectorial adaptation planning at an early stage. Progress towards participation in adaptation planning could then be measured in relation to the usage and effective implementation of such tools.

- Go beyond the no-harm principle and approach **climate adaptation as an opportunity to substantially reduce systemic and underlying inequalities and injustices** that have led to increased vulnerabilities. This includes recognising these underlying inequalities, promoting resilience building and enabling practices including the strengthening of social networks and enhancing political capabilities for underrepresented groups.
- Enable opportunities for **sharing good practices and lessons learnt** between sectors and EU Member States and ensure the particular involvement of those with the greatest needs or those often underrepresented. Integrate experiences and approaches from countries outside of the EU. This could greatly support the improvement of national and local measures, monitoring systems and co-learning.

8 List of abbreviations

Abbreviation	Name
CAP	Common Agricultural Policy
CCVIA	Climate Change Vulnerability Impact Assessment
DG AGRI	The Commission's Directorate-General for Agriculture and Rural Development
DG CLIMA	The Directorate-General for Climate Action
DPSIR	Driving force, pressure, state, impact, and response
DRR	Disaster Risk reduction
EC	European Commission
EUCRA	European Climate Risk Assessment
GHG	Greenhouse gas
I, V, R and RP	Impact, Vulnerability, Response and Response Proxy Indicators
LDC	Least Developed Countries
MS	European Member States
NAP	National Adaptation Plan
NBS	Nature-based solutions
SDG	Sustainable Development Goals

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Annex Ia: Evidence matrix: Climate change impacts and risk with uneven outcomes ('uneven burdens')

Key Types	Sub-type	Clarification (Impacts of climate change or climate change risk on …)	Impact/risk type	Description		Governance level	Key sector(s)	Justice dimension(s) identified in literature	Source
				Identified impact or risk	Justice implication				
A: Governance and institutional	A1: Policy instruments and regulation								
	A2: Management and planning								
	A3: Coordination, cooperation and networks								
B: Economic and Finance	B1: Financing and incentive instruments	*… unequal **access to financial or other resources***	Drought, reduced water resources (forest fires)	**B1.1: Loss of economic assets and income** Climate impacts can have a physical impact on property values and trigger losses of economic assets (place based) and/or income revenues: examples are impacts on agriculture or tourism or due to increasing flood risk along coasts and rivers, extreme precipitation events or fire risk. *Links to A2 (physical planning), A3 (networks) , C1 and C2 (grey l infrastructure) and e (knowledge and behavioural change).	**Unequal distribution of assets' value losses and income losses:** Certain populations disproportionately affected: place based (e.g. coastal areas and along rivers; farmers in Southern Europe due to international trade market.) and socio-economic groups). Women are disproportionately affected, due to unequal access to resources, education, job opportunities and land rights, aggravated by social and cultural norms and their diverse intersectional experiences. Small scale forest owners may risk to lose larger proportion of their income	National, local	Water management, Agriculture, Forestry	Distributive	Country Reporting Bulgaria, Austria, Latvia, Romania and Slovenia. And: European Parliament 2018, EEA, 2019, Reidsma et al. 2010; Reidsma et al. 2009a; Reidsma et al. 2009b; Mostegl et al., 2019.
	B2: Insurance and risk sharing instruments	*…unequal access to **insurance and contingency funds/services for emergencies***	Flooding	**B2.1: Increased insurance prices and needs** Increased climate risk affect insurance needs and prices. *Links to C1: physical infrastructure.	**Insurance affordability (and eligibility)** Unequal access to insurance - aggravates the inequal access of retribution of damage to assets and social security. Example Romania: Farmers, and SMEs, which represent a significant percentage of the Romanian population, cannot afford to pay insurance premiums related to mandatory disaster protection policies.	National, local	Finance, disaster risk reduction, Water management	Distributive	Country Reporting Romania and: Davoudi and Brooks, 2012; Luttenberger and Luttenberger, 2018
C: Physical and Technological	C1: Physical infrastructure		Heatwaves, Prolonged cold fronts	**C1.1: Extreme temperatures** Heatwaves and extreme cold: impacts people's health and cause fatalities. (*See also C.2.1 Extreme temperatures and cooling/heating needs).	**Highly vulnerable groups** The most vulnerable groups affected by heatwaves are older people, infants, people in poor health and people with poor social networks (e.g. homeless, people who are substance abusers, ethnic minorities, men in single households etc.) and people living in high-rise dense areas and areas with low density of green spaces and people working in weather-exposed occupations. The health of people with certain diseases (e.g. cardiovascular and respiratory diseases or diabetes) is also affected more by heat than those in the general population, and these people are often at higher risk of heat-related death. Pregnant women may be more susceptible to heat stress, and overheating and dehydration may trigger labour. Furthermore, mental health illnesses have been found to increase the risk of death and hospital admission related to high temperatures (European Climate and Health Observatory, 2022). Adaptive capacity towards heat stress depends on both tangible (physical and financial) as well as intangible (social or human) assets.	National, local	Health, Urban, Energy, Buildings, Cross-cutting	Distributive	De Cian, 2019; Ludden et al. 2021; Oliveras et al. 2021; Scottish Government, 2020; Cabrita et al. 2021; Sánchez-Guevara Sánchez et al. 2017; Sánchez-Guevara Sánchez et al. 2019; Climate Change Committee Scotland, 2022b; López-Bueno et al.,2020; Ellena et al. 2020a and b; Martínez-Solanas et al. 2018; Navas-Martín et al. 2022; EEA, 2018, 2022; WHO Europe, 2021; European Climate and Health Observatory, 2022; EEA 2022.
			Flooding and landslides	**C1.2 Flooding and landslides** From heavy rainfall damaging private and public resources, including infrastructure and property, inhibiting movement (short or long term) and has impacts on land-base management practices (see D). *Also links to land use planning and management (A2 and A3).	**Unequal losses and health effects** Documented 'worse' impacts on vulnerable groups compared to less vulnerable groups. Resources include a wide spectrum of assets, including the capacity of being able to voice ones needs. ** Identified knowledge gap: Aggravates pre-existing inequalities related to access to private and public transport systems (gender, age, socio-economic groups). May aggravate health conditions due to power outage.	National, local	Buildings, Cross-cutting, Water management, Energy, Transport, Coastal areas, Health, Urban, Disaster	Distributive, Procedural	Expert group consultations and: Lindley 2011; Foudi et al., 2017; Rey-Valette et al., 2015; Corfe, 2017, cited by Buser, 2020; Szewrański et al., 2018; D'Alisa and Kallis, 2016; EEA/ETC, 2018. Climate Change Committee Scotland, 2022b; Jessel et al. 2019.
			Sea level rise	**C1.3: Sea-level rise** Exposure to sea-level rise, storms and flooding in coastal communities. *Links to A2 (Integrated Coastal Management) and D1 and D2 (green and blue infrastructure)	**Unequal risk/impacts and losses** Different groups of population are at risk, but with very varying abilities and willingness to deal with this risk. One vulnerable group with regard to flooding is the growing number of old people living in cities. The typology of coastal population may differ significantly across Europe. Example from Sweden where wealthy populations are especially affected because of their ownership of property in flood-prone areas (with a risk of directing disproportionate support to affluent citizens). Almost 50 million people are living in low elevation zones in Europe. And over 70% of these people live in countries like Netherlands, Germany, UK, Italy, Spain and Russia.	National, local	Coastal areas, water management, urban, buildings	Distributive	Country Reporting Sweden and Romania. And Rey-Valette et al., 2015; Corfe 2017, cited by Buser, 2020; Schmidt et al., 2018; Jones et al., 2014; Karrasch et al., 2014; Garmestani et al., 2019; Rulleau et al., 2017; Buser, 2020; Vousdoukas et al. 2020; McEvoy S., et al. 2021; Climate Change Committee Scotland, 2022a and b;
			Multiple risk	**C1.4: Cities/Urban exposure and vulnerabilities** Heightened vulnerability to climate change impacts in cities: urban areas with higher density, intensive traffic, reduced green and open spaces, and old infrastructure with limited capacity to absorb increasing climate impacts. The effects of climate change (such as heat waves, drought, increased air pollution, and heavy rainfall) will represent an additional burden and could affect the health of the population.	**Unequal impacts and losses** Extreme weather events will more significantly affect vulnerable groups including those living below the poverty line, in poor quality housing, the homeless, the elderly, and the sick. In cities, poor people and those at risk of poverty often live in areas exposed to heavy traffic noise and high levels of particulate pollution, and generally have little access to green spaces or recreation areas .	National, local	**Urban**, health	Distributive	Country Reporting Bulgaria, Austria, Romania and Germany. And Szewrański et al., 2018; Keeler et al., 2019; EEA, 2018
			Multiple risk, flood and droughs	**C1.5: Rural exposure and vulnerabilities** Rural areas are exposed to in particular floods and droughts with impact on rural livelihoods. *see also D1.1	**Few options for alternative rural livelihoods leads to increased vulnerability** In those areas where there is scarce economic diversification extreme events can leave people without resources. With regards to the Western Balkans, DG Agri observes that climate change, may result in water scarcity and extreme climate events, such as floods. In case of drought in rural area, women leave rural areas and move to cities	National, regiona	DRR, water management, Urban	distributive	DG AGRI, 2020, p. 24; Charveriat, et al., 2019; Gisbert Velasco et al., 2020
	C2: Technological infrastructure		Increased temperatures and heat waves	**C2.1: Extreme temperatures and cooling/heating needs** Increasing temperatures and heatwaves, poorly designed buildings and lack of cooling systems (*see also C1.1). Poorly insulated homes and increased energy demand (cooling and heating) and transition risk (energy access and increased prices) and can increase occupational injuries - also related to C2 Technological infrastructure. *Links to A1, A2, A3 (Governance and institutional)	**Inequality in housing conditions and affordability** Access to cooling options inside the dwelling (good insulation of homes and availability/use of cooling devices) as well as outside (cooling centres, parks) are key elements in effectively adapting against extreme heat for the elderly population. Uneven burdens due to energy poverty (specifically mentioned by Hungary and Spain) and low-income groups, the elderly and the homeless. Furthermore, the monitoring of heating is often included in the context of energy poverty policies, whereas the capacity to keep temperatures cool are rarely measured. Cooling needs are more prominent in Southern Europe and heating needs in Northern Europe, leading to a risk bias to northern geographical areas if cooling needs are not adequately monitored in the context of energy poverty.	National, local	Health, Buildings, Urban	Distributive	Sánchez-Guevara et al., 2019; Benmarhnia et al., 2014; Nunes, 2018. Country reporting Hungary and Spain. Thomson et al. 2019, EU-SILC ad-hoc modules 2007 and 2012, EEA, 2018, WHO, 2018, 2021; Eurofund, 2020.
	D1: Green		Multiple risk	**D1.1: Impact on regional livelihood and rural viability** The agricultural sector in Europe experiences increasing challenges to sustain its own livelihoods and contribute to the broader sustainability of rural communities with increased variability in weather patterns and extreme events, and land use changes such as desertification and erosion. Exposure exacerbated due to potential conflicts with other sectors (e.g. water).	**Unequal distribution of risks, losses and adaptive capacities among regions and farmer groups** Uneven distribution over regions and groups. Highlighting the disproportionate vulnerability of farmers (vulnerability, coping capacity, social capital, adaptative capacity). Small farms and businesses with limited resources, options or capability to diversify production more vulnerable. More knowledge on social vulnerability of farmers needed. The agricultural sector was specifically identified as disproportionately vulnerable by several NRC's, including Ireland, Italy, Spain, Turkey, Romania and Latvia. Linked to B1.1-2 and C1.1-3	EU and country level	**Agriculture,** Water management, Cross cutting	Distributive	Country Reporting Ireland, Italy, Spain, Hungary and Turkey. And Griffiths and Evans, 2015; Marshall et al., 2014; Pedersen et al., 2020; Reidsma et al., 2015; Escriva-Bou et al., 2017; Iglesias et al., 2017; Bernabé-Crespo et al. 2021; Zagaria et al. 2021. EEA. 2015; CCC Scotland 2022b
			Multiple risk	**D1.2: Loss in natural capital** And land-use change (driven by climate change) pose a risk to livelihoods and cultures closely linked to ecosystem services/natural land-use and cause loss of intrinsic natural values, memories and benefits from biodiversity. *Links to A1 to A3 (Policy and coordination, cooperation and networks) and E2 (empowering and lifestyle choices) It also relate to potential loss of social values that are connected to health, feeling of safety, belongingness, self-esteem, self actualisation.	**Nature-based livelihoods and historical injustice** Social groups that are at risk of losing their livelihoods due to the changing environmental conditions, including their culture, social networks, well-being, health and income basis, example is the Saami population and Basque example of losses of memories and mental health as a result of flooding. Most affected are indigenous groups and groups with strong cultural and livelihood-based ties to natural systems. Communities who contributed the least to climate change are suffering most from the consequences. Inter-generational loss of indigenous cultural heritage.	National, local	Cross-cutting, Eco-system based approaches, Coastal areas	Distributive, Procedural, Recognition, Intrinsic values, Historical justice	Foudi et al., 2017; Guillaume and Neuteleers, 2015; Graham et al. 2013; Marzeion & Levermann, 2014; Fatoric and Seekamp, 2017, Karlsson et al. 2015; IPCC AR6 2021.

Annex Ia: Evidence matrix: Climate change impacts and risk with uneven outcomes ('uneven burdens')

Key Types	Sub-type	Clarification (Impacts of climate change or climate change risk on …)	Impact/risk type	Description		Governance level	Key sector(s)	Justice dimension(s) identified in literature	Source
				Identified impact or risk	Justice implication				
D: Nature-based solutions and ecosystem based-approaches	D1: Green 'infrastructure' (including ecosystem services), natural and semi-natural land-use		Multiple risk	**D1.3: Low environmental qualities exacerbates vulnerabilities** Enhanced risk to impact-prone areas or places with low environmental qualities that exacerbate the impacts of climate change (e.g., in areas with a lack of green space and/or poor air quality, living in poorly drained areas affected by frequent flooding or living in housing of poor quality not adapted to protect from heat or withstand flooding, severe storms or increased fire risk). *See also C1.5.	**Unequal impacts and losses:** Socially vulnerable groups suffering from enhanced exposure can include, for instance, individuals or groups living in such areas and the homeless.	National, local	Buildings, Coastal areas, cross-cutting, water management, urban, health, working conditions	distributive	EEA 2018, 2021 (add urban literature, double check sources) Expert interview 1;
			Multiple risk	**D1.4: Disruptions of international supply chains (goods)** Climate change may exacerbate vulnerabilities in a complex global system such as food prices, energy, trade and ultimately livelihoods (virtual trade in green 'infrastructure'). The EU is increasingly affected by climate impacts outside Europe through cascading and spillover effects (also related to A, B and C).	**Unequal access and affordability of supplies on the global market** In countries with high climate risk, low adaptative capacity, poor governance and safety-net programmes, cascading effects of climate change impacts may dangerously escalate tensions and increase vulnerabilities. Adaptation measures aimed at mitigation cascading (transboundary) climate risk may in turn exacerbate the situation in already vulnerable groups or places. In Europe, Low-income consumers are extra vulnerable at times of price spikes.	International to local	Cross-cutting, (Finance, Agriculture, Transport, Fisheries)	Distributive, Procedural, Historical,	Lager et al. 2021; UN, 2015 (for agriculture: EEA, 2019; Barnett et al. 201, FAO, 2016; Climate Change Committee Scotland, 2022b; Birkmann et al. 2021; Adams et al. 2021
			Multiple risk	**D1.5: Disruptions of crucial supplies to Urban areas** Threatened security of supply in cities of key provisions such as water and energy. See also D1.4	**Unequal access and affordability** Urban areas highly reliant on inputs, impacts occurring far outside of a city can affect systems (e.g., water or energy supply) essential to life within the city, disproportionately affecting low-income groups.	National, local	Urban	Distributive	Country Reporting Romania
			Multiple risk, heat	**D1.6 Uneven exposure for European cities** Urban morphology (size and form), and in particular the lack of urban green infrastructure makes some cities more prone to urban heat island effect, compared to other cities or rural areas	**Unequal risk and access to intervention** Justice implication is that some cities might require more systemic interventions in their morphology, compared to others. In addition, research has demonstrated that not all people have equally access to urban green infrastructure that is available in European cities - resulting in unjust circumstances (see C1.4). However, there is not yet a conclusion whether northern European cities' morphology is more vulnerable to urban heat island, compared to southern European cities. The density in southern European cities seems to create shade that is cooling the city, while surrounding areas suffer more from heat due to the fact that these are arid zones and heating up quite fast as well during hot and dry summer, therefore impacting the UHI estimation.	National, local	urban, ecosystem	Distributive	Zhou, et al. 2017
			Multiple risk	**D1.7: Climate risk in energy production and navigation** The energy and navigation sectors are affected by long-term drought. Regions that are expected to be more frequently dry, are expected to have issues with energy production and navigation problems. This is expected to disproportionally affect the people in these regions, as they might be confronted with issues in energy provision and potentially also more expensive energy. Navigation may mean that certain commodities might not be available. The impact on energy and navigation may cascade into issues with regard to food availability and food affordability.	**Energy affordability and energy poverty** Energy prices are expected to go up during periods of drought. Increasing energy prices aggravated energy poverty, which was already estimated at 6.6% of the European population that were not able to pay utility bills. While it cannot be stated that there is full overlap between energy poverty and income poverty, research has indicated that tenants are more vulnerable to become energy poor.		energy sector	distributive	Byers et al. 2020; Bouzarovski et al. 2020; Middelkoop et al. 2001
	D2: Blue 'infrastructure', natural and semi-natural water and marine areas		Drought	**D2.1 Drought, water access** Increased risk of droughts, leading to water scarcity (or quality decline)	**Unequal risk/impact and access** Documented exacerbated impacts on vulnerable groups compared to less vulnerable groups. If access to water of good quality is severely impacted, options to pay for water severely affects low-income groups, families with children and the elderly.	National, local	Water management, health	Distributive	Country Reporting Romania. And Duinen et al., 2015; Bernabé-Crespo et al., 2021; Zagaria et al., 2021; Alcamo et al. 2018
			Flooding	**D2.2. Flooding and impact on water quality.** During flooding, water can get polluted by human-made waste	**Geographical hotspots** People living in flood risk areas are more prone to experience poor water quality, which may affect their health	local	water management, health	distributive	Howard et al. 2016
	E1: Information and awareness								
			Multiple risk	**E2.1 Workers and employment** The effects of climate change on workers and employment, working conditions, health and safety and livelihoods.	**Unequal distribution of losses of livelihood/income and productivity** Those who work in certain occupations are disproportionately exposed to high temperatures, for example those who perform physical work, use protective equipment or clothing, work outdoors exposed to the sun or work indoors with machinery that generates heat (WHO Europe, 2021). Emergency workers, such as firefighters, are particularly likely to be exposed to flooding and wildfires at work, putting them at risk of injury and death (European Climate and Health Observatory, 2022c, d). Labour supply will increase in northern European countries, due to climate change. Effective labour is expected to decrease in Southern Europe In addition, the risk for loss of livelihood are disproportionate in sectors that depend on a high quality, healthy environment. Such as farming and fishing, coastal and marine tourism,	National, local	Health, Agriculture, Marine and fisheries, Cross-cutting	Distributive	Country Reporting Latvia. Dasgupta S. et al. 2021: WHO Europe 2021; EEA, 2022.; Susova L., Mailleux F 2020

Annex Ib: Evidence matrix: Adaptation action with justice outcomes ('leaving no one behind')

Key Types Measure	Sub-type	Clarification (Adaptation measure aimed at …)	Description: Identified response, adaptation measure or adaptation outcome	Description: Justice dimension or implication	Governance level	Key sector(s)	Justice dimension(s) identified in literature	Adaptive/mal-adaptive outcomes (positive/negative/both)	Source(s)
A: Governance and institutional	A1: Policy instruments and regulation	… ***policy and regulation*** *with justice outcomes/implications*	**A1.1 Gender mainstreaming adaptation:** Promoting the integration of gender-relevant issues in climate policy programs and gender mainstreaming of NAPs (Spain) and climate policy implementation and resource allocation (Sweden).	**Promoting gender equality** Can fundamentally promote gender equality by including it in various decision-making processes. Climate policies can perpetuate or reinforce gender inequalities and existing power relations. These inequalities and power relations must therefore be made visible in policy design so that efforts toward gender equity can be integrated into climate policy strategy development and policy design. A consistent implementation of the Gender Impact Assessments (GIA) can help to improve (Germany) gender equality. The Swedish EPA defines five main thematic areas where strategic interventions are deemed to have the greatest potential to contribute to gender equality and women's rights; capacity building, equal representation, coherence, gender mainstreaming and monitoring and reporting.	EU and country level	Cross-cutting	Distributive, Procedural, Intersectional	Positive & Negative	European Parliament, 2018; Spitzner et a. 2020; Naturvårdsverket 2021; MITECO 2020; Interview and country reporting Sweden
			A1.2 Trade policies and agreements Acknowledging the cross-border and international dimension of just resilience in climate policy and stepping up international action for global climate resilience.	**International justice and global resilience** Actively addressing resilience on a global scale, targeting the most vulnerable with the least capacity to adapt. Also, in order to avoid that adaptation policies and measures in one country or region lead to reinforced or redistributed risks and vulnerabilities in other countries (i.e., maladaptation), adaptation measures need to take into account systemic and cascading cross-border effects.	International, EU, national, local	Cross-cutting, (Finance, Agriculture, Fisheries)	Distributive, procedural	Positive & Negative	Lager et al. 2021; EC, 2021a
			A1.3: Agricultural policies including the EU Common Agrigultural Policy (CAP) Policy and adaptation planning in agriculture often critiqued for favouring the preservation of status-quo over more transformational changes that involve a significant re-structuring of the agricultural system. Best practice include adaptive capacity assessment/impact assessment at farm level to avoid unjust policy measures. Strategies can also specifically result in shifting farm practices, such as the rise in popularity, materially or discursively, of flex crops and climate resilient commodities; affecting land use and agricultural practices.	**Risk exacerbate inequalities due to power dynamics, pre-existing vulnerabilities and poor representation** Power inequalities between large agricultural business and small- and medium scale farmers related to influence, as well as intra- and extra EU power dynamics. Measures might increase vulnerability or might risk to leave certain farmers behind because assessment at regional level does not reveal underlying vulnerabilities. shifting practices can undermine small-scale, traditional and nature-based practices (and benefits large scale producers and monocultures.	International, EU, national and regional level	Agriculture	Distributive, procedural,	Positive or negative (to be determined with the new CAP)	EEA 2018, 2021; Zagaria et al. 2021; Reidsma et al. 2010; EEA, 2019; European Commission, 2022
	A2: Management and planning	… ***creation or revision of technical rules, codes and standards*** *, with justice outcomes/implications*	**A2.1 Just resilience in National Adaptation plans** Several EU Member States have integrated considerations calling for the respect of principles of justice or consideration of specific social vulnerability aspects in their national adaptation plans or strategies as cross-cutting, strategic goals.	**Actively targeting vulnerable groups** Targeting: vulnerable groups in human settlements (Czech); human life, health, and well-being regardless of gender, age and social background; social adaptation (Hungary); favour no-regret and win-win options and minimize risks to democracy, health, security, and social justice (Austria); address adaptation capacities in different societal groups (low-income and high-income households, gender, age, etc. (Germany); principles to guarantee sustainability and inter-generational equity (Italy); assessment of social vulnerability, development of adaptive responses that are appropriate to the levels of vulnerability and socially just and 'territorial vulnerability', gender and social vulnerability as a cross cutting issue (Spain). Broad and inclusive participation in the adaptation process is also promoted	EU and country level	Cross-cutting	Distributive, procedural, intersectional	Positive	National Adaptation plans of Austria, England, Sweden, Finland, Greece, Wales, Germany, Italy, Spain, Czech Republic, Latvia and Hungary; Boeckmann and Zeeb, 2014; Juhola et al. f.c
			A2.2 Urban adaptation planning Guidance documents to support cities in key steps for addressing social vulnerability (identifying, locating, and involving vulnerable groups).	**Tracking and inclusion of vulnerable groups** Guidance documents not comprehensive and, in most cases, lack specific methods for the identification of vulnerable groups and for their involvement in adaptation decision-making. They also do not provide suggestions for indicators for monitoring the social outcomes of adaptation actions over time. Best practice example from Glasgow (Scotland) involving organisations, community groups and businesses in adaptation planning.	national, local	**Urban**	Distributive, procedural,	Positive & Negative	EEA, 2018; Climate Change Committee Scotland, 2022a; Borras et al. 2018
			A2.3 Cooperation on disaster risk reduction: the EU Civil Protection Mechanism Includes a provision for the EU to work together with Member States and develop Union disaster resilience goals.	**Special attention to vulnerable groups** The provision shall take into account the immediate social consequences of disasters, make sure to ensure the preservation of critical societal functions and shall give special attention to the consequences of disaster for vulnerable groups.	EU and country level	Disaster risk reduction	Distributive, procedural,	Positive	EC, 2021b
			A2.4 Platform for implementation of the EU Green Deal in physical planning and living spaces: The New European Bauhaus initiative: Integrates spatial, social and environment/climate objectives, amongst others, aiming to foster living space design, which considers sustainability, quality of experience and inclusion	**Social inclusion and affordability**: Aim to develop affordable, inclusive and attractive solutions to climate challenges in the living spaces connecting to the goals of the European Green Deal.	Local	Buildings, Urban	Distributive, procedural,	Positive	EU, 2022
			A2.5 Flood resilience management procedures to include social and environmental vulnerability assessments to achieve inclusive procedures.	**Participation** Suggested measure to deal with unequal outcomes and burdens in flooding management: taking into account poverty and ageing populations, as well as the distribution of the areas vulnerable to floods. Scottish example also include businesses in regional/local resilience partnerships.	national, local	**Coastal areas**, Urban, Water management	Procedural	Positive	D'Alisa and Kallis, 2016; Bozza et al. 2016; Climate Change Committee Scotland, 2022a
			A2.6 National heat wave planning (heat protection plans are examples of early warning systems, cost-effective and efficient adaptation measures)	**Special attention to vulnerable groups** A good example of interaction between different governance levels see (C2.1) and sectors to address social forms of vulnerability among older people, babies, people in poor health and people with poor social networks (e.g. homeless, people who are substance abusers, ethnic minorities, etc.). Examples include France, Italy, Germany, Sweden, Portugal, Austria and the UK and local approaches (Kassel (Germany), Botkyrka (Sweden) and Košice and Trnava (Slovakia).	Country and local level	**Health, Urban,** Disaster risk reduction	Distributive, procedural,	Positive	Country reporting France, Italy, Germany, Sweden and Austria and: Climate-ADAPT 2022b; EEA, 2018; Kazmierczak et al., 2020; Robine et al., 2008; Hémon and Jougla, 2003; Vandentorren et al., 2004; Salagnac, 2007; Michelozzi et al., 2009; Morabito et al., 2017
			A2.7 Managed retreat (including expropriation), 'decommission' and realignment practices, especially in coastal zones.	**Underrepresented groups and top-down planning** Can create uneven impacts depending on implementation. Halting maintenance of existing flood protection measures and to relocate the settlement but without proper preparation and planning affects local residents and result in decline in property values, and a decline in health and welfare Example form the UK where coastal communities are among the most vulnerable in the country. Has frequently been implemented through top-down models of planning. A coproduction approach can provide a means to help address key planning challenges in this field, i.a. through collecting local knowledge of the risks (climate hazards and/or retreat),provide institutional support and mechanisms for supported relocation and facilitating community-led processes of retreat and redevelopment.	National, local	Coastal areas, Buildings, Water management, cross-cutting	Distributive, procedural,	Positive & Negative	Buser, 2020; Zografos, 2017; Jones et al., 2014; Garmestani et al., 2019; Rulleau et al., 2017; Rey-Valette et al., 2015; Tubridy et al., 2022.
			A.2.8: Mandatory elevation of buildings (flood risk management). *Links to B1 (financial instruments) and C1 (physical infrastructure)	**Affordability and gentrification** Regulations to manage flood risks without including provisions for affordable housing can mean exclusion of low-income groups from neighbourhoods and the entrance of new social groups (medium-high income households) able to bear the high costs of the new developments (gentrification), especially in coastal and river-front areas. Compliance with regulations leads to unavoidable budgetary surcharges, which entail high building costs. Examples from LeHavre, France and the Netherlands.	National, local	Urban, Coastal areas, Water management, Buildings, biodiversity	Distributive	Negative	Orillard et al., 2018
			A2.9 Inadequate preparation/planning/rules for sea level rise The use of different sea level rise and different protection levels among coastal areas in Europe	**Intra-European/regional differences in standards** Coastal areas with high population but planning with low SLR and low protection levels may result in certain European regions being left behind. It is not clear why low protection levels are chosen, but if this is related to the length of coastline and low available national budgets to protect coastline, this might indeed indicate justice implications	National, local	Coastal	Distributive	Negative	McEvoy et al. 2021
			A2.10: Economic assessment tools for assesing flood protection measures favours the wealthy	**Affordability, representation and gentrification** Favouring of wealthy - ordering relocation for minority groups and therefore harming them too - they will also lose their voice.	National, local	Coastal, water management, urban	Distributive, Procedural, Recognition	Negative	Siders 2019; Nussbaum, 2000, Shi 2016
			A2.11 Land use planning and practice in rural areas Land use and land use planning ineract with climate change and can result in social-ecological tipping points.	**Sami recognition, representation, and unequal power dynamics** Indigenous communities (Sami) in the Arctic/sub-Arctic regions engaged in nature-based livelihoods, such as small-scale forestry and agriculture, hunting, traditional fishing, and gathering are practiced are highly impacted changes in land use planning, but power inequalities, poor recognition and participation, and uncertainty land use rights for European indigenous groups abide.	EU, national and regional level	Agriculture, nature-based solutions, urban, cross-cutting	Distributive, Procedural, Recognition, Historical	Negative	Landauer et al. 2021
	A3: Coordination, cooperation and networks	… ***institutionalised coordination or stakeholder networks*** *, with justice outcomes/implications*	**A3.1: Stakeholder networks** Measures to enhance/improve local level engagement and participation in planning and managing climate hazards: Education and champions, collaboration of different departments, agencies, and vulnerable groups to participate in the design of adaptation policies and actions; another example is innovative funding mechanisms (local taxes and crowdfunding).	**Stakeholder practices and power inequalities** Stakeholder engagement does not automatically guarantee effective and fair adaption outcomes. The explicit recognition of climate change as matter of social justice could help address power inequalities in communities. Stakeholder involvement processes often fail to consider diversity and power issues within communities, nor do they investigate how these diversities affect the possibility of people to engage in participatory spaces in egalitarian forms.	Cross-cutting	Cross-cutting	Distributive, Procedural, Recognition, Historical	Negative	Climate-ADAPT, 2022a; Breil et al. 2021 p. 54-56.
			B1.1 Subsidies and financial incentives (green energy) directed at energy efficiency and regulations such as carbon taxes which aim at incentivising energy efficiency via market mechanisms.***strong link to mitigation	**Affordability** Owners vs. tenants. Energy price increase create disproportional burdens for low-income households and tend to further enhance inequalities including energy poverty (C1.1) and the vulnerability of farmers (D1.1)	EU and country level	Energy, Buildings, Transport, Cross-cutting	Distributive	Negative	De Cian et al., 2019; Ludden, et al., 2021; Oliveras et al., 2021; Scottish Government, 2020; Eurofound and EEA, 2021; Cabrita et al., 2021; Sharifi, 2021; Sánchez-Guevara Sánchez et al. 2017; Sánchez-Guevara Sánchez et al. 2018
			B1.2: Farmland expropriation Proactive expropriations of farmland prone to salinization and erosion protecting the economic assets of farmers	**Pro-active engagement with vulnerable groups** Presented as a means of managing coastal realignment without causing economic stress to residents. Participation and recognition important for fair and due processes.	national, local	Agriculture, Coastal areas	Distributive, procedural, recognition	Positive	Zografos, 2017

Key Types Measure	Sub-type	Clarification (Adaptation measure aimed at …)	Description: Identified response, adaptation measure or adaptation outcome	Description: Justice dimension or implication	Governance level	Key sector(s)	Justice dimension(s) identified in literature	Adaptive/mal-adaptive outcomes (positive/negative/both)	Source(s)
B: Economic and Finance	B1: Financing and incentive instruments	*… unequal access to financial or other resources*	**B1.3: Innovative funding mechanisms** Including local taxes and crowdfunding schemes.	**Targeting low-income groups** with limited access to resources and financial instruments - ease access to funding	local	Finance; Fisheries	Distributive	Positive	Expert consultation and Climate-ADAPT, 2022a; Finance Watch 2020
			B1.4 International adaptation finance mechanisms: including border carbon cost and border tax adjustments to raise adaptation finance.	**Remediating historical inequalities** Although many poor people have contributed very little to climate change, they are especially vulnerable to its impacts and often lack the means to adapt accordingly. This has been referred to as a "double inequity". There is considerable agreement among justice scholars that the very poor ought not to bear the burdens of climate change.	International	Finance, cross-cutting	Distributive, historical, restorative	Positive	Baatz 2018
			B1.5 Market based adaptation options Insurance and water pricing for effective water management	**Disproportionately affects low-income groups** while a potentially effective measure to reduce water usage, low income actors eventually cannot afford water prices or need to put different priorities and discard insurances	national	agriculture, water management, insurance	Distributive		Eionet country feedback Turkey
			B1.6 International development assistance The possibility of focuing development assistance assistance on climate proofing and assistance for adaptation (set aside national funding).	**Support the poorest and redusing global inequalities** Examples from Finland ad Ireland include the provision of financial resources through development assistance for the health sector, eradicating poverty, reduction of inequalities	national/international	finance,, development assistance, health	Distributive, historical, restorative	positive	country reporting Finland, Ireland
	B2: Insurance and risk sharing instruments	*…unequal access to **insurance and contingency funds/services for emergencies***							
C: Physical and Technological	C1: Physical infrastructure		**C1.1 Housing energy savings** Improving building insulation, using passive heating/cooling solutions, improving energy efficiency of heating and cooling devices, high-performance windows, shading and ventilation. Adaptation and health-effects.	**Dedicated policies to endure affordability** Particularly relevant for vulnerable populations at-risk from extreme temperatures. Requires dedicated policy packages, which frequently rely on incentives to the private sector. High risk of inequities (example Scotland), as the necessary investments to be incentivized by public policies are generally reserved to home owners and tend to exclude tenants. Energy poverty is increasing among both owner occupiers and tenants creating further limits to private investments in particular among poor households. MB Tenant households normally are not able to improve energy efficiency of their buildings, while landlords do not have an economic stake (energy bills being paid by tenants) Dedicated measures to improve affordability of renovation and higher energy efficiency will have the co-benefit that the health of the most vulnerable people is expected to improve as well.	Involve private actors MB support low income home owners, tenants	Energy, Buildings, Urban, Health	Distributive	Positive & Negative	De Cian et al., 2019; Ludden, et al., 2021; Oliveras et al., 2021; Scottish Government, 2020; Eurofound and EEA, 2021; Cabrita et al., 2021; Sharifi, 2021. EEA 2021
			C1.2 Urban greening and green infrastructure	**Affordability of housing, risk of gentrification** Risk of increasing inequalities due to action increasing increase housing prices – making the area unavailable to lower income households. Would need adequate policy measures for reducing this effect. Despite engagement processes, vulnerable groups can be worse off, due to the adaptation measures, as in the context of greening policies (e.g. Amsterdam)	City-scale, National-level	**Urban,** Health, Buildings	Distributive, procedural	Positive & Negative	Country reporting Sweden and Sharifi, 2021; Climate-ADAPT 2022a; (Anguelovski and Corbera, 2023).
			C1.3 Adaptation in the social housing sector Targets socially disadvantaged parts of the population. *Links to A1 (Policy	**Affordability of housing, risk of gentrification** Ensure a fair access to housing for low income groups during adaptation measures in the building sector/urban area through setting up just participation processes. Limited awareness and financial and regulatory constraints can result in a lack of anticipatory and deliberate adaptation actions (e.g., Netherlands). Among the financial barriers, there is also the fact that investments in adaptation would increase costs for social housing, making it less affordable to low-income groups. Best practices include: participative work with the residents in the planning and implementation is a good practice leading to procedural justice (e.g. Malmo, Sweden), retrofitting of public spaces strategically located around social housing areas (Paris, France), policy and regulatory measures to limit the gentrification resulting from increased attractiveness after the adaptation measures (e.g., Barcelona)	Local scale, city scale	**Buildings** Urban	Distributive, procedural	Positive & Negative	Boezeman and de Vries, 2019; Breil et al. 2021 (p. 51-53)
			C1.4 Post-disaster reconstruction (housing)	**Techno-managerial approaches** A case in Italy where participation has enforced a techno-managerial approach to post-disaster rebuilding to reconstruction using heavy grey protection measures for one settlement rather than a wider approach based on relocation and holistic risk prevention approaches. Example of how participatory processes may prevent the implementation of efficient measures and transformative approaches.	Disaster risk reduction, buildings, cross-cutting	**Disaster risk reduction,** Buildings, Cross-cutting	Distributive, procedural	Negative	D'Alisa and Kallis, 2016
	C2: Technological infrastructure		**C2.1 Heat wave protection measures at the local level**	**Targeting vulnerable groups** In some countries/cities, special efforts are made to reach out and care for vulnerable groups through registers with regular phone check-ups (Paris) and hotlines, cool rooms and physical assistance (Paris, Bologna, Kassel).	Local scale, city scale	**Urban** Disaster risk reduction, Health	Distributive, procedural	Positive	Breil et al, 2018; Kazmierczak et al., 2020
D: Nature-based solutions and ecosystem based-approaches	D1: Green 'infrastructure' (including ecosystem services), natural and semi-natural land-use		**D1.1 Adaptation measures through relocation**	**Leading to loss of intrinsic natural values** and benefits from biodiversity: (see also climate impacts: disruptive events).	Local and regional	Buildings, Disaster risk reduction, Ecosystem-based	Intrinsic values	Negative	Foudi et al., 2017
			D.1.2 Regenerative practices and nature-based solutions: are offered as examples of good adaptation practices for urban transformation (increasing tree canopy to enhance shading and reduce solar radiation, biophilic design, improving water management and quality). MB: in cities, enhancing green areas leads to increases in real estate prices, contributing "green gentrification" with low income households being expelled to urban areas with less environmental qualities	**Co-benefits and historical values** Providing co-benefits and reconnecting people with nature and the history. Potential to especially target urban areas with especially vulnerable groups such as low income citizens and the elderly. Examples from Heidelberg, Germany and Albufeira, Portugal. MB: low income households might not be able to benefit from improvement because or mechanisms of real estate markets	Local scale, city scale	Urban, Ecosystem-based approaches	Distributive, procedural,	Positive & Negative	Luttenberger and Luttenberger, 2018; Blau et al., 2018; Foshag et al., 2020 MB: Anguelovski et al., 2019
			D1.3 Nature-based solutions for long-term coastal-zone adaptation management such as afforestation, careful land use and less impermeable surfaces.	**Targeting vulnerable groups** Addresses potential loss of assets and livelihoods for vulnerable groups (coastal zones: the elderly, fisheries etc.). Example Croatia.	Local/national	Ecosystem-based approaches, Coastal areas, Buildings	Distributive, procedural,	Positive	Luttenberger and Luttenberger, 2018
	D2: Blue 'infrastructure', natural and semi-natural water and marine areas								
E: Knowledge and behavioural change	E1: Information and awareness	*… information and awareness raising, alt. unequal pre-requisites related to access to information, education etc. - capacities and capabilities ,*	**E1.1: Outreach and design for altering attitudes, perception and concerns** Actors' preferences, risk perceptions, concerns, perception of self-efficacy and 'controllability' of the adaptation problem have an influence on their attitude towards climate risk and their actions.	**Engaging vulnerable groups** Ensuring appropriate outreach and design of awareness raising and enabling measures towards vulnerable groups to improve their risk perception and adequate participation in adaptation planning and implementation. Examples from Austria and Bulgaria.	Local	Cross-cutting, Agriculture	Distributive, procedural	Positive	Country reporting Austria, Bulgaria and Rendón et al., 2016; Adger et al.,2009; Grothmann and Patt, 2005; Woods et al., 2017; Simón Pérez, 1998; Patt and Zeckhauser, 2002; Tversky and Kahnemann, 1974; OECD, 2012; Akter and Khanal, 2020; Duinen et al.,2015; Jones et al., 2014; Karrasch et al., 2014; Schmidt et al., 2014
	E2: Capacity building, empowering and lifestyle practices		**E2.1: Education, training and reskilling** Just transition action: focus on increased need for education, training and reskilling leading to new green jobs and economic diversification. * Links to A1 and A2. ***strong link to mitigation	**Targeting vulnerable groups** Enables labour force mobility to green growth sectors (from fossil-dependent sectors, identified as vulnerable groups - especially in low-income segments).	National, Local	Cross-cutting	Distributive, procedural	Positive	EC, 2021a
			E2.2: Gender mainstreaming adaptation education and information etc. Gender mainstreaming of adaptation measures associated with education and training, information and awareness raising, and promotion of sustainable lifestyles. Women will be considered as active agents of change, by promoting their access to leadership positions.	**Targeting gendered differences/women** Consider gender differences in terms of access to information and training, risk perception, environmental behaviours and lifestyles. Consider women's resilience and decision-making capacities, their full, equal, and meaningful participation in key adaptation decision-making fora and the consideration of their input on solutions that take into account the different gender gaps that still exist and the roles they play in society.	EU and country level	Cross-cutting	Distributive, procedural	Positive	MITECO, 2020; Naturvårdsverket, 2021
			E2.3: Citizen involvement Adaptation measures used for directly involving inhabitants, creating, inter alia, apprenticeship and employment programmes for residents (example Groundworks, London). MB: requested also for actions enhancing biodiversity	**Targeting vulnerable groups** Can target e.g. low-level income-groups and people with low political capability	National and local	Urban, Cross-cutting MB: biodiversity restoration, NbS	Distributive, capabilities	Positive	Climate-ADAPT, 2022a; Breil et al. 2021, p. 41-42; IUCN 2020

Key Types Measure	Sub-type	Clarification (Adaptation measure aimed at …)	Description		Governance level	Key sector(s)	Justice dimension(s) identified in literature	Adaptive/mal-adaptive outcomes (positive/negative/both)	Source(s)
			Identified response, adaptation measure or adaptation outcome	Justice dimension or implication					
			E2.4: Participatory planning Using citizen participation to choose adaptation options and education and champions, collaboration of different departments, agencies, and vulnerable groups to participate in the design of adaptation policies and actions;	**Recognising and involving vulnerable groups** Ensuring a just set-up of participation processes for adaptation planning and managing hazards though focusing on recognition and active participation and address power inequalities within communities. Stakeholder involvement processes often fail to consider diversity and power issues within communities, or investigate how these diversities affect the possibility of people to engage in participatory spaces in egalitarian forms. Examples: Urban greening project in Gent (the Netherlands) and re-designing coastal protection measures in Timmerdorfer strand (Germany)	Cross-cutting	Urban, Cross-cutting	Procedural	Positive & Negative	Lioubimtseva and da Cunha, 2020; Loh and Kim, 2021; Shi et al., 2016; Brunner, 2008; Innes and Booher, 2004; Climate-ADAPT, 2022a; Breil et al. 2021, p. 41-42; Cattino and Reckien, 2021; D'Alisa and Kallis, 2016; Fernandes-Jesus et al., 2017, p. 1557; D'Alisa and Kallis, 2016; Planas Carbonell, 2021; NAS Kosovo, 2018; Therville et al., 2019; Krebs et al., 2013; Burnside Lawry & Carvalho 2016.

Annex II: Indicator screening results

* Impact (I), Vulnerability (V), Response (R), Response Proxy (RP) * Impact (I), Vulnerability (V), Response (R), Response Proxy (RP)

Included in Chapter 5 as selected example

Available datasets and frameworks

ID	KTM	Indicator type*	Climate impact/ risk	Indicator focus	Name/Title	Description (general)	Indicator samples (what is measured/monitored)	Justice dimension(s)	Collection method	Scale and granularity	Sector(s)	Source and URL
I1	n/a	V	n/a	General	**DG Regio Eurostat Database**	DG Regio collect sub-national disaggregated data on a number of classifications of potential relevance for assessing vulnerability in relation to Just Resilience in Europe.	Sub-national (NUTS3) European data within the categories: Agriculture, demographics, economic accounts, education, science and technology business statistics and demography, health, tourism, transport, labour markers, digital economy and society, environmental and energy, poverty and social exclusion, crime statistics.	Distributive justice, capacities and capabilities	Statistical data	Europe, National, Local	Cross-cutting	Eurostat 2023: https://ec.europa.eu/eurostat/web/regions/data/database
I2	n/a	V, RP	n/a	Poverty and living conditions	**EU Integrated Poverty and Living Conditions Indicator System**	Framework aim to improve monitoring, analysis and interpretation of the quality of life of vulnerable groups in Europe, across countries and over time. Specific focus on age (children, youth, the elderly, migrants and disabled persons). Collects a total of 50 indicators.	- Material living conditions (at-risk of poverty rate, material and educational deprivation, overcrowding, housing cost and deprivation rate etc.) - Labour market and work-life balance: (work intensity, formal child care etc.) - Education and training: (education, educational literacy rate etc.) ,- Health and risk behaviour: (birth weight, infant mortality, alcohol consumption, illicit drug use, attempted suicide etc.) - Social connectedness and civic participation: (participation in civic activities, noise from Neighbours, pollution and other environmental problems, crime and violence, etc.) - Policy and context: (un/employment rate, fertility rate, women's age at childbirth, Gini coefficient, gender pay gap, life satisfaction, social protection expenditure etc.	Capacities and capabilities, intersectional, Intergenerational, historical and temporal justice	Surveys, statistical data	Europe, National	Cross-cutting	InGRID, 2019: https://ipolis.tarki.hu/
I3	n/a	V, RP	n/a	Quality of life	**EU Multidimensional Inequality Monitoring Framework**	The framework includes 346 country level inequality indicators to measure inequality between inhabitants in the EU. Published 2021. A first, but comprehensive, attempt to establish a 'common language' and a common framework for monitoring and analysing inequalities in the EU.	Structured into 10 domains: (1) knowledge and skills, (2) health, (3) material living conditions, (4) natural and environmental conditions, (5) working life, (6) cultural life and recreation, (7) political participation and voice, (8) social and family life, (9) bodily integrity and safety and (10) overall life experience. The framework encompasses five analytical approaches: (1) vertical inequality measures (inequality between individuals, e.g. wealth or health distribution), (2) horizontal inequality (inequality between social groups such as ethnicity, gender, age etc.), (3) equality of opportunity approach (compensation and reward in relation to degree of effort), (4) capabilities measurement approach and (5) social mobility (inter- and intragenerational socio-economic mobility).	Capacities and capabilities, distributional justice, Intersectional, intergenerational	Statistical data, surveys	Europe, National	Cross-cutting	European Commission, 2023
I4	n/a	V, RP	n/a	Wellbeing and opportunity	**European Social Progress Index (SPI)**	The SPI aims to serve as a policy tool tracking changes in social progress over time and across countries. Social progress is defined as the capacity of a society to: (i) meet the basic human needs of its citizens; (ii) establish the building blocks that allow citizens and communities to enhance and sustain the quality of their lives; and (iii) create the conditions for all individuals to reach their full potential.	- Basic human needs: Nutrition & basic medical care, water and sanitation, shelter, personal safety - Foundation of wellbeing: Access to basic knowledge, access to information and communications, health and wellness, environmental quality - Opportunity: personal rights, personal freedom and choice, inclusiveness, access to advanced education	Capacities and capabilities, intersectional	Statistical data	Europe, National	Cross-cutting	EC, 2022: https://ec.europa.eu/regional_policy/information-sources/maps/social-progress_en
I5	n/a	V, RP	n/a	Human development and wellbeing	**EUROSTAT Quality of Life framework**	Measure human development and wellbeing beyond GDP including measured and perceived wellbeing such as life satisfaction, emotions and sense of purpose in life. Collection of 45 indicators.	-Material living conditions: income, consumption, material conditions (material deprivation, housing conditions) - Productive or other main activity: quantity of employment (employment and un- and underemployment), quality of employment (income and benefits, health and safety at work, work/life balance, temporary work, quality of employment) - Health: outcomes (life expectancy, morbidity and health status), drivers (behaviours), access to healthcare - Education: competences and skills (education, self-reported skills, assessed skills), lifelong learning, opportunities for education. - Leisure and social interactions: Leisure (quantity, quality, access), social interactions (with and for people, supportive relationships, social cohesion) - Economic and physical safety: wealth, dept, income security, crime, perception of physical safety - Governance and basic rights: trust and/or satisfaction in institutions and public service - Natural and living environment: Pollution, access to green and recreational spaces, landscape and built environment - Overall experience of life: life satisfaction, affects, meaning and purpose	Distributive, Capacities and capabilities	Statistical data and surveys	Europe, National	Cross-cutting	Eurostat, 2023: https://ec.europa.eu/eurostat/web/quality-of-life/
I6	A1, A2, B2, C2	I,V	General	Coping capacity	**INFORM Climate Change Index**	The INFORM Climate Change Index is a future projection of the INFORM Risk Index – a composite index that measures the risk of humanitarian crises and disasters globally. The index incorporates climate and socioeconomic projections to analyse how risk will evolve as a result of climate change under different emission and socio-economic scenarios.	-Hazard and exposure: natural (earthquake, tsunami, river flood, coastal flood, tropical cyclone and wind, drought, epidemics), human (conflict intensity and probability) - Vulnerability: socio-economic (development and deprivation, inequality, aid dependency), vulnerable groups (unprotected people, other vulnerable groups) - Lack of coping capacity: institutional (DRR, governance), infrastructure (communication, physical infrastructure, access to health system)	Distributive, Capacities and capabilities	Statistical data, Geospatial analysis and scenario analysis	Global, national	Disaster Risk Management, Cross-cutting	European Commission 2023: https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Climate-Change
I7	n/a	V, RP	n/a	Human development (poverty, services, gender)	**Leave-No-One-behind Index**	Summarising indicators related to four dimensions: a) extreme poverty and material deprivation; b) income inequality; c) access to and quality of services; d) gender inequality. Disaggregation of some indicators per gender, socio-economic background, rural/urban, income and age	- Extreme poverty and material deprivation: population unable to keep home adequately warm, population living in a dwelling with a leaking roof, damp walls, floors or foundation etc. , people at risk of income poverty after social transfers, etc... -Income inequality: protection of fundamental labour rights, Gini Coefficient, Palma ratio - Access to and quality of services: Gap in life expectance, gap in self-reported health, by income, gap in self-reported unmet need for medical examination and care, by income, variation in science performance explained by students' socio-economic status, youth not in employment, education or training, gap in internet access, individuals aged 55 to 74 years old who have basic or above basic digital skills, urban population without access to green urban areas in their neighbourhood, access to justice - Gender equality: unadjusted gender pay gap, gender employment gap, population inactive due to caring responsibility, seats held by women in national parliaments, positions held by women in senior management positions, proportion of ICT specialists that are women	Distributive, Intersectional	Statistical data and surveys	Europe, National	Cross-cutting	Europe Sustainable Development Report 2022: https://eu-dashboards.sdgindex.org/map/leave-no-one-behind
I8	n/a	I, V, RP	General	Social and economic equity, including health and education.	**Resilience Dashboards**	The dataset covers four dimensions (Social-Economic, Digital and Geopolitical) with more than 100 indicators from different public sources (Eurostat, OECD, World Bank, etc.). Indicators are categorised as: Capacities - enablers and/or opportunities to navigate the transitions and face future shocks; and Vulnerabilities - obstacles or aspects that can worsen the negative impact of the challenges related to the green, digital, and fair transitions.	- Social and economic: Inequalities and social impact of the transition such as: risk of poverty or social exclusion rate, employment in energy intensive sectors, government expenditures on education, health and social protection - Health, Educaton, work: reported unmet need for medical care, gender employment gap, long-term unemployment rate - Economic and financial stability and sustainability: government debt Indices directly related to climate change adaptation: fatalities from climate extremes, insured losses from climate extremes, farm income variability, soil erosion by water	Distributive, capacities and capabilities, Intersectional	Statistical data, surveys.	Europe, National	Cross-cutting	European Commission, 2021a
I9	n/a	V	n/a	Human development and environmental sustainability	**SDG Indicators**	The global indicator framework includes 231 unique indicators to cover the 17 SDG's including no poverty, gender equality, reduced inequalities, sustainable cities etc.	Indicator examples: - Inequality (income shares, income share by the richest) - Gender equality (women's right to vote, legal right to equal pay and paid maternity leave, criminalisation of marital rape, rights to property and land, self-ownership, equal right of testimony under law)	Capacities and capabilities	Statistical data	Global, National	Cross-cutting	United Nations, 2021; https://sdg-tracker.org/
I10	n/a	V	n/a	Broad justice focus	**Social Justice Index (SJI)**	Composite indicator that aims to measure changes in areas related to social justice and provide cross country ranking. The overall aim is to facilitate improvements in national and European policymaking on inclusive growth, social justice and social conditions through information, analysis and the evaluation of policies. The latest edition comprises 46 indicators (38 quantitative and 8 qualitative) associated with six dimensions of social justice	- Poverty prevention (poverty risk, disaggregated age groups) - Equitable education (education policy, performance (PISA) and participation) - Labour market access (employment, disaggregated age groups, foreign/native born) -Social cohesion and non-discrimination (policy, political participation, gender and foreign/native born disaggregated) - Intergenerational justice (environmental, pension and family policy, R&D spending, GHG emissions, footprint consumption etc.) - Health (life expectancy, health policy, infant mortality etc.)	Capacities and capabilities, intersectional justice, Intergenerational	Statistical data and qualitative policy analysis	Europe, national	Cross-cutting	Hellmann et al., 2019; https://www.bertelsmann-stiftung.de/en/publications/publication/did/social-justice-in-the-eu-and-oecd
I11	n/a	V	n/a	Labour markets and welfare systems	**Social Scoreboard for the European Pillar of Social Rights**	The Social Pillar identifies 20 fundamental principles and rights that are deemed essential for fair and smoothly functioning labour markets and welfare systems	- Equal opportunities: participation in learning, education and training, digital skills, unemployment, gender employment gap, income shares. - Fair working conditions: employment/unemployment rate, disposable income of households, activity rate, activation measure, permanency of employment, poverty risk - Social protection and inclusion: poverty or social exclusion at-risk rate and material and social deprivation rate, disability employment gap, housing cost overburden, unmet needs for medical care, government expenditure on social protection, healthcare and education, pensions, health at age 65.	Distributive, Capacities and capabilities	Statistical data, surveys	Europe, national	Cross-cutting	European Commission, 2021b: https://ec.europa.eu/eurostat/web/european-pillar-of-social-rights/
I12	n/a	V, RP	n/a	Wellbeing	**Sustainable Society Index (SSI)**	Monitors progress on human, environmental and social wellbeing globally (in 213 countries). Collection of 21 indicators. Updated every 2 years (latest data from 2018)	**- Human wellbeing:** Basic needs (sufficient food, sufficient drinking water, safe sanitation), Personal development and health (education, healthy life, gender equality), Well-balanced society (income distribution, population growth, good governance) **- Environmental wellbeing:** Natural resources (biodiversity, renewable water resources, consumption), Climate and energy (energy use, energy savings, GGH, renewable energy) - **Economic wellbeing:** Transition (organic farming, genuine savings), Economy (GDP, employment, public debt).	Capacities and capabilities	Statistical data	Global, national	Cross-cutting	Technische Hochschule Köln, 2016; https://ssi.wi.th-koeln.de/index.html

ID	KTM	Indicator type*	Climate impact/ risk	Indicator focus	Name/Title	Description (general)	Indicator samples (what is measured/monitored)	Justice dimension(s)	Collection method	Scale and granularity	Sector(s)	Source and URL
I13	n/a	RP	n/a	Gender equality	**The Gender statistics database**	Collects data for EU Member States on women's involvement in climate change decision-making.	**Gender-disaggregated data**, e.g. collection of women's representation in environment decision-making bodies in EU institutions, national governments and public administration, and in United Nations Framework Convention on Climate Change.	Procedural, intersectional	Statistical data	Europe, national, local	Cross-cutting	EIGE (European Institute for Gender Equality), 2022: https://eige.europa.eu/gender-statistics/
I14	n/a	V	n/a	Economic, social, environmental and governance	**Transitions performance index 2021**	The indicators focus on mitigation rather than adaptation, but the social economic and governance and environmental factors can be used as proxy for measuring social vulnerability for adaptation as well. Composite index made of 28 quantitative indicators to measure sustainable transitions in countries (globally). Based on SDG's and country ranking taking in to account 4 dimensions; Economic, Social, Enviromental and Governance.	- Economic: education (gov expenditure in education, internet users, proportion of people with ICT skills), wealth (GDP per capita), labour productivity and R&D intensity, industrial base) - Social: health (life expectancy at birth) , work & inclusion (employment rate, including gender gap), free or non- remunerated time, equality (Gini coefficient disposable income, income share held by the poorest quintile), - Environmental (greenhouse gas emissions reductions, biodiversity, resource productivity, energy productivity), and - Governance (fundamental rights, security, transparency, sound public finances).	Distributive, intersectional	Statistical data	Europe, national	Cross-cutting	European Commission, 2022: https://research-and-innovation.ec.europa.eu/strategy/support-policy-making/support-national-research-and-innovation-policy-making/transitions-performance-index-tpi_en
I15	n/a	V	n/a	Economic progress	**WEF Inclusive Development Index**	Annual assessment of the economic progress of countries beyond GPD collecting 12 indicators through three focus areas: (1) growth and development, (2) inclusion, and (3) intergenerational equity and sustainability. Latest update 2018.	- Growth and development: GDP(per capita), employment, labor productivity, healthy life expectancy - Inclusion: Median household income, income Gini, poverty rate, wealth Gini. - Intergenerational Equity and sustainability: Adjusted net savings, public debt (share of GDP), dependency ration, carbon intensity of GDP	Distributive, capacities and capabilities, intergenerational	Statistical data	Global, national	Cross-cutting	World Economic Forum, 2018: https://www.weforum.org/reports/the-inclusive-development-index-2018/
I16	n/a	V, RP	n/a	Environmental justice	**The Environmental Atlas for Berlin (Germany)**	The atlas specifies the current environmental quality of the metropolitan area, including the location and evaluation of environmental pressures, their causes and effects, potentials and qualities, sensitivities, and hazards, land use and building densities. The approximately eighty topics and hundreds of maps are organized under the topics of soil, water, air, climate, biotopes, land use, traffic, noise, energy, human and environment.	**Example indicator:** "Human": Noise burden, Air pollution, Green space supply, Bioclimate / thermal burden, Social disadvantage / status index	Distributive	Statistical data	Regional, Local	Cross-cutting, Urban	State of Berlin, 2023: https://www.berlin.de/umweltatlas/en/
I17	n/a	I, V, RP	multiple risks	Monitoring Nature-based solutions	**Evaluating the impact of nature-based solutions: A handbook for practitioners**	NBS impact assessment framework including set of indicators and methodologies to assess impacts of nature-based solutions across 12 "societal challenge areas" including indicator sets to monitor natural and climate Hazards, participatory planning and governance, social capacity building and social justice and social cohesion. the indicators are classified as structural, process-based or outcome-oriented.	Sample indicators: - Participatory planning and governance: Openness of participatory processes, Proportion of citizens involved in participatory processes, Sense of empowerment: perceived control and influence over decision-making, Adoption of new forms of participatory governance, Policy learning for mainstreaming NBS: Number of new policies instituted, Trust in decision-making procedure and decision-makers - Social justice and social cohesion: Bridging– quality of interactions within and between social groups, Bonding – quality of interactions within and between social groups, Inclusion of different social groups in NBS co-processes, Trust within the community, Solidarity among neighbours, Tolerance and respect, Availability and equitable distribution of blue-green space	Procedural, Capacities and capabilities, Distributive	Geospatial analysis (I), statistical data (V) and surveys and project based and participatory data collection (quantitative and qualitative) (R, RP)	Local	Urban, Nature-based solutions, Cross-cutting	European Commission,2021 Directorate-General for Research and Innovation, Evaluating the impact of nature-based solutions : a handbook for practitioners, Publications Office of the European Union, 2021, https://data.europa.eu/doi/10.2777/244577
I18	n/a	I, V, RP	Extreme temperatures, drought	Health	**The Lancet Countdown on health and climate change: towards a climate resilient future**	The Lancet Countdown in Europe is a collaboration of 44 leading researchers, established to monitor the links between health and climate change in Europe and to support a robust, evidence-informed response to protect human health. Mirroring the Global Lancet Countdown, the report monitors the health effects of climate change and the health co-benefits of climate action in Europe. The indicators are included into the European Climate and Health Observatory	**Examples:** -**Climate change impacts, exposures, and vulnerabilities**: Health and heat (vulnerability to heat exposure, exposure of vulnerable populations to heatwaves, heat stress risk related to physical activity, heat-related mortality), Extreme events and health (wildfire smoke, drought) - **Adaptation, planning, and resilience for health**: Adaptation planning and assessment (National assessments of climate change impacts, vulnerability, and adaptation for health, National adaptation plans for health, City-level climate change risk assessments, Adaptation delivery and implementation, Climate information for health, Exposure to green space, Air conditioning benefits and harms	Distributive, procedural (?)	Statistical data, Geospatial analysis, quantitative policy analysis	Global, National, local (municipality)	Health, cross-cutting	

Case studies: methodological developments and novel approaches in peer scientific papers

ID	KTM	Indicator type*	Climate impact/risk	Indicator focus	Name/Title	Description (general)	Indicator samples (what is measured/monitored)	Justice dimension(s)	Collection method	Scale	Sector(s)	Source and URL
CS1	C1, A1, A2	I, V	Extreme temperatures	Heat and energy poverty considering income and age.	**Population vulnerability to summer energy poverty: Case studies of Madrid and London**	Heat and energy poverty indices: exposure and vulnerability to high summer temperatures by exploring the geospatial connection between the urban heat island intensity, housing energy efficiency and overheating risk, and social vulnerability indicators.	Impact: urban heat intensity, housing stock energy efficiency Vulnerability: household income, population over the age of 65 Context specific proxies for each indicator and location.	Distributive	Modelling, statistical data	Local	Buildings; Urban	Sánchez-Guevara, C., et al., 2019
CS2	A1, A2, C2, B2	V, RP	Extreme events	Quality of life for people at risk, enhancement of societal preparedness and restoration	**Constructing a comprehensive disaster resilience index: The case of Italy**	Municipality-level disaster resilience indices that include indicators on social vulnerability and on adaptive/coping capacity. Three sub-levels are included: individual, household and community over 7 categories and time-series data.	- Access to services and quality of institutions: distance and travel time to service centers, distance and travel time to fire brigades, election participation - Housing conditions: quality rate of dwellings, rate of empty dwellings over total, index of overcrowded residences - Cohesion: Index of single parent families/large families/small families, index of elderly dependence, old age, participation in the labor market female, commuting rate for study/work - Education: illiteracy, low education index, high education index Environment: share of ecological corridors, share of the protected lands - Economic resources: income, GINI index, unemployment rate, share of the families with potential economic hardship - Response Proxy: "Indicator-based assessment using panel (time-series) data may reveal how resilience changes over time in response to major investments in disaster risk reduction"	Distributive, capacities and capabilities, Intersectional	Statistical data	Local	Disaster risk reduction	Marzi, S., et al., 2019
CS3	A1, A2	I,V	Extreme temperatures and altered rainfall patterns	Health, regional vulnerbility	**Geographical analysis of climate vulnerability at a regional scale: the case of the Southern Great Plain in Hungary**	The socio-economic climate vulnerability index: combines the physical, economic and social sensitivity, adaptation and exposure indices and relate to different climate impacts. Builds on the application on international indices at the local/regional level.	- Environmental vulnerability: groundwater level of main rivers, biomass production of forests and arable lands - Economic vulnerability: ratio of the agricultural sector in employment, labour income share of the small-scale agricultural sector, ratio of industry in employment. - Social vulnerability: Patients of respiratory and cardiac distress, number of visits to a general practitioner, proportion of people aged over 65 among permanent residents - Adaptation capacity: per capita income, proportion of graduates within the 25+ population, number of scientific, technical-technological enterprises (proxy for the intellectual, scientific and technical potential which can be used in the adaptation process) - Exposure: change of the number of heatwaves, change of rainwater quantity, volume of urban land, quantity of communal water supplied d in settlements.	Distributive	Statistical data	National, Regional	Cross-cutting, Agriculture	Zsolt Farkas, J., et al., 2017
CS4	A1	V	n/a	Wellbeing/quality of life	**Quality of Life Indicators for Vulnerability Assessment: Municipality Trajectories in Southwest France from 1999 to 2009**	Present a conceptual multidimensional ''human wellbeing'' framework to analyse vulnerability. The paper proposes a method to define indicators suitable to measuring quality of life through time, as the social political and economic situation of the studied population evolves and the criteria defining high quality of life change.	**40 variables across 8 life domains:** 1. Housing characteristics and the quantity of affordable and available housing for low-income households 2. Employment conditions and job opportunities 3. Financial conditions 4. Better access to educational facilities 5. Better access to health facilities 6. Better accessibility and quality of services 7. The social environment including family, friends, and neighbours 8. Natural environmental conditions measured by land-use and land-cover change	Distributive, capacities and capabilities, Intersectional, intergenerational	Statistical data	Regional, local	Cross-cutting	Kuentz-Simonet et al., 2017
CS5	A1	V	n/a	Quality of life	**Multidimensional Inequality Framework**	Aims to provide a robust framework for measuring inequality in individual well-being, acknowledging the multiplicity of dimensions within which the quality of individuals' lives should be monitored.	Indicators across 7 Domains: 1. Inequality in the capability to be alive and to live a healthy life 2. Inequality in the capability to live in physical safety and legal security 3. Inequality in the capability to be knowledgeable, to understand and reason, and to have the skills to participate in society 4. Inequality in the capability to achieve financial independence and security, enjoy dignified and fair work, and recognition of unpaid work and care 5. Inequality in the capability to enjoy comfortable, independent and secure living conditions 6. Inequality in the capability to participate in decision- making, have a voice and influence 7. Inequality in the capability to enjoy individual, family and social life, to express yourself and to have self-respect	Distributive, capacities and capabilities	Statistical data, surveys	National	Cross-cutting	Atlantic Fellows for Social and Economic Equity, 2019. https://sticerd.lse.ac.uk/inequality/the-framework/media/mif-framework.pdf
CS6	A1, A2, C1, D2	I,V,RP	Altered rainfall patterns	Unequal distribution of loss of economic assets and income	**Economic Value of Climate Change Adaptation Strategies for Water Management in Spain's Jucar Basin**	Economic losses indices: assess the potential economic loss related to water scarcity under different patterns of allocation of water within a river basin and provides a monetary measure of equity between farmers. They measure the relation between losses in the demand over the potential maximum loss.	- Economic loss (equity of the system, assesses the relation between the losses in the demand over the potential maximum loss) - Demand satisfaction (volumetric water supply reliability of the system) -Demand reliability (total water delivery provided to the demand with acceptable reliability or under condition of no failure divided by the topical water demand of the system) -Withdrawal (percentage of water resources abstracted from the system) - Withdrawal use (percentage of water resources withdrawn from the system to supply the demand with respect to natural yield)	Distributive	Statistical data, modelling	Regional, Local	Water management, Agriculture	Escriva-Bou et al., 2017

ID	KTM	Indicator type*	Climate impact/ risk	Indicator focus	Name/Title	Description (general)	Indicator samples (what is measured/monitored)	Justice dimension(s)	Collection method	Scale and granularity	Sector(s)	Source and URL
CS7	A1, A2	I,V	n/a	Intersectional analysis of social vulnerability	**What is in an index? Construction method, data metric, and weighting scheme determine the outcome of composite social vulnerability indices in New York City**	Illustrates a number of challenges for the construction of vulnerability indices that have been identified such as: (a) large differences between estimations of vulnerability based on different component construction methods (e.g., additive and reductionist models), (b) divergent results between different metrics (e.g. area-based vs population-based) and (c) absence of weighting vulnerability factors due to lack of quantitative empirical evidence and lack of verification (e.g. weighted and non-weighted additive models)	Examples: Total population [km2]; Female population [km2, %]; Population of black people or African American (one race) [km2, %]; Population of Asian people (one race) [km2, %]; Population of Hispanic people [km2, %]; Population of children < 10 years of age [km2, %];.Population of people aged 65 and higher [km2, %]; Population living in poverty [km2, %]; People without access to a car [km2, %]; One-person households [km2, %] Relies on a rich and basis of socio-economic data with high spatial detail (which is not always available in European cities, partly due to privacy rules).	Distributive, capacities and capabilities, Intersectional	Statistical data, surveys	Regional, Local	Urban	Reckien, D., 2018
CS8	A1, A2, B2, C1, C2	I,V	Flooding and coastal erosion	Social justice	**Dynamic Coast: Mapping Coastal Erosion Disadvantage in Scotland**	Map the overlap between social vulenrabilitya and exposure. Social Vulnerability Clasiffication Index adapted from Coastal Erosion Vulnerability Index (Fitton et al., 2018) social vulnerability mapping work related to flooding.	- **Population** :Total population, Number of children, Number of elderly people - **Physical and mental health and wellbeing**: physical health, mobility, mental health - **Cohesive and connected communities**: community engagement/social isolation, information use, social cohesion - **Skills, education and training**: Education, skills and lifeling learning - **Economic prosperity**: income/expenditure (long-term unemployed, dependent children households with no employed adults), employment deprrivation - **Sustainable communities**: Tenure (social rented, private rented, - Physical access (people working >30km from home), geographical access to services, remoteness - **Physical assets**: housing (mobile home, overcrowded houselholds)	Distributive, capacities and capabilities, Intersectional	Statistical data, surveys	Regional, Local	Coastal areas	Dunkley et al., 2021
CS9	B2	RP	Flooding	Inequal access and quality of insurance	**Flood insurance arrangements in the European Union: for future flood risk under climate and socioeconomic change**	Evaluate the ability of flood insurance arrangements in Europe to cope with trends in flood risk, including access to risk reduction measures and affordability. Combines models of insurance sectors, consumer behaviour, and flood risk.	- Insurance penetration rate: (The average percentage of households with high flood risk that buy sufficient insurance at the national level) - Incentivized risk reduction: (The total net present value (NPV) of incentivised risk reduction conducted by households at the national level) - Cost on low-risk households: (The NPV of the subsidy of high-risk households paid by low-risk households, aggregated to the national level) - Unaffordability of insurance: (The NPV of the magnitude of unaffordability, measured as the portion of premiums that cannot be paid from a poverty-adjusted disposable income at the national level)	Distributive	Statistical data	National	Water management, Buildings, Disaster risk reduction	Hudson et al., 2019
CS10	A1, A2, C2	V	n/a	Social vulnerability	**Social Vulnerability to Environmental Hazards**	Seminal paper identifying indicators for the Social Vulnerability Index (SoVI) for the US, based on 1990 data, using a factor analytic approach to reduce 42 variables to 11 independent factors	- Personal wealth (per capita income) - Age (median age) - Density of the built environment (no. commercial establishments/km^2) - Single-sector economic dependence (% employed in extractive industries) - Housing stock and tenancy (% housing units that are mobile homes) - Race/Ethnicity (%African American, Hispanic, native American, Asian) - Occupation (% employed in service occupations) infrastructure dependence (% employed in transportation, communication and public utilities)	Distributive, Intersectional	Statistical data	National, regional	Disaster risk reduction	Cutter et al., 2003
CS11	A1, A2, B2, C1, C2	V	Flooding	Social vulnerability	**Combining hazard, exposure and social vulnerability to provide lessons for flood risk management (Netherlands)**	Flood risk index with disaggregated data. Large heterogeneity in social vulnerability is found within population at risk. Combines physical and social vulnerability in flood risk assessments.	- Social vulnerability: Wealth (average monthly income), Age (% people under 14; % people above 65), Ethnicity and communication barriers (% on non-European immigrants), Single-parent households (%) - Structural/physical vulnerability: Construction year of the house	Distributive, Intersectional	Statistical data	National, Regional, Local	Water management, Disaster risk reduction	Koks et al., 2015
CS12	A1, A2	I, R	Flooding	Climate policy distributive effects	**A Novel Impact Assessment Methodology for Evaluating Distributive Impacts in Scottish Climate Change Adaptation Policy**	Present a climate justice toolkit (indicator set and guidance) that enables the consistent assessment of distributive impacts of climate policy, including broad suite of policies that comprise the national adaptation programme. Target groups are communities of living, working and place	**Example indicator set** **- Household aspects and indicators:** Occupant Profile (Working age adults—no children, couples with children, single parent families, pensioners), Equality Groups (Disability and long term illness, gender, sexuality, race and ethnicity, religion and belief), Household Income (low-medium-high), Level of Awareness, Mode of Transport (Reliance on private transport, reliance on public transport, cycling, walking), Dwelling Type, Tenure Type, , Urban–rural (Urban, small town, accessible rural, remote rural), Flood-Risk (Coastal areas, Islands, flood plains, other inland areas)	Distributive, procedural, capacities and capabilities, Intersectional	Surveys, statistical data	local, national	Cross-cutting	Dunk et al., 2016
CS13	A1, A2, A3, E1, E2	RP	General	Adaptation planning justice screening	**Connecting climate justice and adaptation measures: An Adaptation justice index**	Ex ante methods for assessing adaptation strategies and their planning processes. Indicator framework for four aspects of climate justice in the context of adaptation: recognition, distributive, restorative, and procedural justice. As adaptation planning is still a relatively new area of climate governance, the information produced offers valuable feedback for the development of analyses of climate justice in the planning phase. Framework rested in 5 European countries and their capitals	- Recognition justice: (the strategy acknowledges that adaptation needs are different across groups in society, the impact of existing societal structures on vulnerable groups in adapting to the impacts of climate change, adaptation as a way to secure basic rights) - Distributive justice: (a risk mapping/assessment is conducted, vulnerability assessment is conducted and there is a process for identifying vulnerable groups, - There is a process that assesses who benefits from adaptation, how costs of adaptation are divided, The strategy identifies the possibility of the distribution of negative impacts, i.e., maladaptation, of adaptation measures) - Procedural justice: (the strategy details who participate in the strategy process, involved participation during different phases of the process, allocates responsibilities related to adaptation, has a structured plan for participation in the implementation, has a plan for updating and evaluating the strategy - Restorative justice: (acknowledges the need to compensate for the diverging impacts of climate change, compensation measures to deal with maladaptation, The unequal distribution of resources for adaptation is compensated by redistribution	Distributive, procedural, recognition, restorative/historical justice	Qualitative content analysis	Local, national	Cross-cutting	Juhola et al., 2022.
CS14	n/a	V	n/a	Environmental justice	**Distributive Environmental Justice Indicators (DEJI) (Las Palmas de Gran Canaria)**	Evaluates social disadvantages (e.g., age, gender, ethnicity, income, disability, etc.) that make specific population groups more susceptible to environmental harm and less capable of enjoying and accessing urban green spaces.	Vulnerability indices: percentage of: population over 65 years, mortality risk excess of lung cancer, mortality risk by dementia, deposition capacity of vegetation types at different distances from pollution sources, the share of green permeable surfaces accounting for the directional slope, residential accessibility to community gardens at 600 m walking distance	Distributive	Statistical data	Local	Urban	Kato-Huerta and Geneletti 2022

Annex III: Detailed methodology

Policy review

Policies to be investigated were identified following up on the work by Breil et al, (2021) and was supported by experts from Academia, practice and national policy making. An expert group has been invited to reflect on the results achieved in 2021 and to support scoping of the report, in an on-line meeting held in January 2022. The same group has been consulted successively in written procedures asking for their comments on a first outline and definition of methodology sent in April and on a first draft of the report sent out in July 2022.

Table 15: Participants in the Expert meeting 22nd January 2022

Full Name	Organisation
Expert group	
Claire Dupont	Ghent University, EEA Scientific committee
Diana Reckien	University of Twente
Endre Gyorgy	DG EMPLOYMENT
Jaroslav Mysiak	CMCC/EEA Scientific committee
João Dinis	EMAC (Empresa Municipal de Ambiente de Cascais)
Marta Olazabal	Basque Centre for Climate Change (BC3)
Massimiliano Mascherini	Eurofound
Liviu Stirbat	DG CLIMA
Pavla Vidanova	DG CLIMA
Ruth Wolstenholme	Sniffer
Susanna Kankaanpää	City of Helsinki
Hanne vandenBerg	EEA
Stephane Quefelec	EEA
Kim VonDerHeide	EEA
Anders Branth Pedersen	Aarhus University
Frida Lager	Stockholm Environment Institute (SEI)
Kati Mattern	EEA
Kati Vierikko	Syke
Eugenio Giovanni Sini	CMCC
Margaretha Breil	CMCC
Richard Klein	Stockholm Environment Institute (SEI)

EU policies have been investigated using semi-structured interviews with five selected experts, to gain insight into EU policies and specific aspects on advanced national or local practice regarding indicator selection and monitoring. Information from these interviews was systematically coded and organized according to main thematic addressed.

A relevant part of information regarding practice in EEA Member countries and cooperating countries was represented in the country reports submitted by EU Member States as part of the Regulations on Governance of the Energy Union and Climate Action (EU, 2018, 2021e). Reports collected in this database were systematically analysed for information regarding:

- the role attributed to concerns about “just resilience” and ‘leaving no-one behind’ in policy documents;
- groups considered potentially at particular risk of being more vulnerable or left behind ,
- policies and actions implemented.
- good practices
- indicators used.

This information was integrated by an Eionet consultation made in in June 2022 which followed up on the consultation made in 2021, which yielded further information responding to three questions:

Analysis of policy needs: “Which adaptation policy interventions and - if any - in which specific policy sectors do you consider of particular importance in relation to social inequalities for measuring and reporting through indicators?”

Scientific evidence base: “Are there any knowledge developments that have happened since the last request for information in 2021 that you think we should consider towards measuring and reporting on justice in adaptation/just resilience?”

Potential indicators of interest “Do you have examples of existing indicators (or work in progress) that you think should be analysed for potential use towards measuring and reporting on just resilience?”

Responses to these questions were received from five EU Member States and from Türkiye, underlining specific concerns for achieving just resilience in the specific countries, indicating specific actions and projects and pointing to further sources of information and reports.

Table 16: Responses received from EEA Member countries.

Organization	Country
PBL	The Netherlands
ISPRA	Italy
Country officer	Spain
Country officer	Poland
UBA	Germany
DG Water Management	Türkiye

A relevant part of information regarding practice in EEA member countries and cooperating countries was represented in the **country reports** submitted by EU Member States as part of the Regulations on Governance of the Energy Union and Climate Action (EU, 2018, 2021e). Information collected in this database was systematically searched for statements regarding

the role of just resilience and ‘leaving no-one behind’ in policy documents and how specifically this has been addressed regarding,

- specific vulnerabilities and groups considered potentially at particular risk
- policies implemented.
- good practices
- The feedback received resulted in particular in a number of new reports to be considered for analysis.

Literature review forming the evidence base for just resilience in Europe

The literature screening included the literature collected through systematic review in Breil et al. 2021. This was complemented with a literature search containing literature published until September 2022, carried out according to Table 17 below. In addition to the below, we have included literature that has shown up as relevant during secondary search (referenced article in literature), informal suggestions from experts/interviewees and other such 'snowballing' exercises. A total of 145 items including scientific and grey literature, as well as commentary from Eionet consultation or the expert group has been included in the evidence-based analysis.

Table 17

Type	# total	# meet criteria	Search string	Source	Criteria for inclusion
Review articles 2021-2022	74	23	TITLE-ABS-KEY ("climate change" AND adaptation AND review AND justice OR equity OR *equality) AND PUBYEAR > 2020	Scopus search September 2022	Consider justice/equity/inequality (in some form) and climate adaptation as core elements of the study AND be relevant for the European region/countries.
Indicator review articles 2021-2022	24	1	TITLE-ABS-KEY ("climate change" AND adaptation AND indicator OR index AND justice OR equity OR *equality) AND PUBYEAR > 2020	Scopus search September 2022	Consider justice/equity/inequality (in some form) and climate adaptation as core elements of the study AND be relevant for the European region/countries AND not already be included in the search above (3 duplicates excluded)
EEA/ETC document scanning (and inputs from EEA colleagues)	15	7	Searched though EEA/ETC report database with anything related to "climate" since 2010. Scanned documents for: just*, *equal, equit*, vulnerable, group, social	https://www.eionet.europa.eu/etcs/all-etc-reports, September 2022	Consider justice/equity/inequality (in some form) and climate adaptation as core elements of the study
Review comments	16	12	n/a	Expert group and Eionet request for information April-May, 2022	Provide evidence-based material AND treat justice/equity/inequality (in some form) and climate adaptation as core elements of the study AND be relevant for the European region/countries AND be written in English

Indicator screening

A limited desktop analysis was carried out based on a document and literature review which was integrated by expert interviews, responses to a specific request in Eionet and an expert group consultation, focusing on indicators that have already been developed and are in use for measuring or monitoring social justice in climate adaptation.

We started by collecting resources that could inform our future work of investigating the opportunities, goals, pitfalls, and important nuances in measuring just resilience for Europe in the context of climate change adaptation. We collected four types of resources: databases and frameworks developed to monitor justice dimensions of potential relevance for climate adaptation, scientific papers on social justice indicators for climate adaptation, national and international adaptation strategies' monitoring developments with a specific justice or equity focus, and local level case studies and research papers on developing or using social justice indicators in climate adaptation actions. These sources were collected from 1) internet-based search, 2) the examples and references in the ETC/CCA 2021 Scoping paper (Breil et.al 2021), 3) indices identified as good examples during the initial Expert Group meeting and 4) a literature review.

For all these approaches, we have searched both for indicators on the unequal impacts and risk of climate change (Impacts and Vulnerabilities - –'I and 'V' indicators') and the benefits and burdens of adaptation responses (Response and Response proxy – 'R and RP-indicators'). However, our scope was not restricted to sources focusing explicitly on climate change - as adaptation to climate change needs to consider compounding and intersecting vulnerabilities of various social groups. We therefore extended our investigation on measurement of resilience to societal impacts from wider disasters, shocks and transformations. Similarly, our understanding of the notion of justice was kept broad for the scope of this exercise and included the notions of social vulnerability, sensitivity, exposure and coping capacity, social equity, inclusiveness and human well-being. We restricted our selection to sources that either focused on or could be applied to the context of the European Union but included scales ranging from the local level to the EU and international levels. Our desk-based research was complemented by expert interviews. A total of 32 frameworks, datasets and case studies have been included in the indicator screening.

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.

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