ISSN 1831-9424

European Commission

JRC TECHNICAL REPORT

Exploring an approach for monitoring the implementation of the European Union's disaster resilience goals

An options paper on the architecture and monitoring of the European Union's disaster resilience goals

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2023

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JRC133161

EUR 31467 EN

PDF ISBN 978-92-68-01624-4 ISSN 1831-9424 doi:10.2760/037239 KJ-NA-31-467-EN-N

Luxembourg: Publications Office of the European Union, 2023

How to cite this report: Eklund, G., Poljansek, K., Corbane, C., Marzi, S., Antofie, T., Salvi, A., Sibilia, A., Santini, M. and Gyenes, Z., *Exploring an approach for monitoring the implementation of the European Union's disaster resilience goals*, Publications Office of the European Union, Luxembourg, 2023, doi:10.2760/037239, JRC133161.

Contents

Abstract

Decision No 1313/2013/EU, amended in March 2019 by Decision (EU) 2019/420, reinforces and enhances the Union Civil Protection Mechanism (UCPM) and, as a consequence, results in the need for the Emergency Response Coordination Centre (ERCC) to increase its monitoring, early-warning and analytical capacity. The close collaboration between the Directorate-General for European Civil Protection and Humanitarian Aid Operations and the Directorate-General Joint Research Centre has been recognised as a strategic pillar on which to build a bridge between research and operations and to translate the results of research projects into an improvement in the services provided by the ERCC in the context of civil protection and humanitarian aid operations.

This report aims to explore potential concepts and architectures for the monitoring of the European Union's disaster resilience goals. The report focuses on three main areas: (1) the use of the composite indicators approach for monitoring and review, (2) an exploration of potentially relevant indicators of resilience within the context of the disaster resilience goals and (3) demonstration of the Disaster Risk Management Knowledge Centre Risk Data Hub as a repository for the data reported and collected to facilitate its interpretation via maps and dashboards.

The main concept running through the three points above is the exploration of a monitoring framework based on two indicative parts: self-assessment indicators and independent indicators. Self-assessment indicators could be developed from the reports submitted by EU Member States and other participating states under Article 6 of the UCPM but also from other reporting mechanisms such as the national reports submitted on the implementation of national adaptation actions or surveys (e.g. Eurobarometer). Independent indicators could be provided from a range of credible publicly available sources or calculated from independent loss data. They would fit into existing theoretical frameworks of vulnerability and disaster resilience.

This report was written during the drafting of the European Union's disaster resilience goals in 2021 and 2022. The Commission adopted the Commission recommendation of 8 February 2023 on Union disaster resilience goals.

Acknowledgements

The authors thank Elisabeth Krausmann, of the European Commission's Joint Research Centre, for the careful review of this guidance and the useful comments.

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1. Introduction

On 2 June 2020, the European Commission adopted a legislative proposal to upgrade the Union Civil Protection Mechanism (UCPM), in view of the initial lessons emerging from the COVID-19 pandemic. The revised UCPM legislation was adopted on 20 May 2021 ([1]). One of the new ideas introduced in the UCPM is that the Commission is to work with EU Member States to define the Union disaster resilience goals (DRGs) in the area of civil protection – a common baseline for supporting prevention and preparedness actions in the event of disasters that cause or are capable of causing multi-country transboundary effects (Art. 6.5). The revised legislation also includes disaster risk management planning at EU level for specific large-scale transboundary disaster scenarios (Art. 10). The approach to the DRGs and the planning required are not pre-defined and will have to be developed in cooperation with Member States and ultimately issued in the form of Commission recommendations.

The European Commission Joint Research Centre (JRC) has, throughout the process of the drafting of the DRGs, explored various options for the goals, resilience and vulnerability indicators and their monitoring, methodological and data support for selected disaster scenario building, and the like. The final result is this report, which is an options paper on the architecture and monitoring of the DRGs.

It is also important to understand that the work in preparing this report was done in parallel with the work within the Expert Group for Disaster Prevention and Risk Management (DPEG) and the Directorate-General for European Civil Protection and Humanitarian Aid Operations (DG ECHO) to develop the framework for the DRGs. Therefore, this report is considered a living document, and regular updates should be required to adapt to changing circumstances and subsequently align it with the Union disaster resilience goals adopted by the Commission.

1.1. Background – resilience and conceptual framework

Resilience as a cross-disciplinary concept is defined in different ways among different communities. In general terms, it refers to the behaviour of a dynamic system exposed to external disturbances. Such behaviour can be explained in terms of how the system is able to respond to an external shock while maintaining its essential function, identity and structure (bounce-back concept) and its capacity for adaptation learning and transformation (Brand and Jax, 2006; Fletcher and Sarkar, 2013; IPCC, 2014; Marzi et al., 2019).

Resilience in the context of the UCPM ([2]) can be understood as a measure of how well civil protection authorities and communities plan to improve their capabilities and adapt to withstand potential future adverse events. Resilience building is a journey that needs investment. The resilience goals define the direction of fit-for purpose-resilience building.

Therefore, resilience planning requires the definition of unique targets as well as specific targets related to different scenarios and relevant capacities to be developed. In response to such needs, the Commission has taken the development of a coherent risk management policy to the next level and now provides a legal framework to:

- establish and develop the Union disaster resilience goals in the area of civil protection, and adopt recommendations to define them as a non-binding common baseline to support prevention and preparedness actions in the event of disasters that cause or are capable of causing multi-country transboundary effects (Art. 6.5);
- engage in disaster risk management planning and scenario-building at EU level (Art. 10);

([1]) Regulation (EU) 2021/836 of the European Parliament and of the Council, 20 May 2021, amending Decision No 1313/2013/EU on a Union Civil Protection Mechanism (OJ L 185, 26.5.2021, p. 1) (https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R0836&from=EN).

([2]) According to ISO 22300:2021 resilience is the 'ability to absorb and adapt in a changing environment'. The term 'resilience' is often used to encompass a broad range of characteristics, especially in regard to individuals and communities, resulting in its wide application. Resilience is something all parts of societies strive for. It is a fluid and ever-moving state and should therefore be considered on a continuum, rather than as a final destination that any system can attain, as its very nature requires that systems continually improve and adapt.

- use the results of this work to define response capacity goals (Art. 11.2) and rescEU capacities[3] (Art. 12.2).

1.2. Concept for developing the framework

In an effort to explore a robust and holistic approach to monitoring the implementation of the DRGs, we present a pragmatic methodological approach. In essence, the monitoring and subsequent evaluation would comprise two work streams: (1) an indicator-based approach with collection of qualitative and quantitative data; and (2) a self-assessment approach, based on national reporting (e.g. reports under Article 6 of the UCPM), and potentially reporting on the implementation of national adaptation strategies (NASs) and plans (NAPs) ([4]). The methodology envisages using existing information from national reporting and independent sources. Self-assessment indicators are seen as complementary and could be used where other, more appropriate, indicators are not available, in addition to encouraging shared ownership, as the information is provided directly by the EU Member States and other participating states.

In the following section we explore a concept and methodology for monitoring the implementation of the DRGs, working from a composite indicator approach. The focus is currently on using existing information and developing a methodology to measure it. The Member State / participating state (MS/PS) summary reports submitted under Article 6 of the UCPM are a good example of existing, and reproducible (reporting requirement every 3 years) sources of information in the context of monitoring the DRGs.

We will briefly address other indicators in terms of how they could be developed and scored, could fit into the composite indicator approach and could be presented as a scoreboard. However, indicators should be explored and proposed by expert groups within the framework of the DPEG and the Union Civil Protection Knowledge Network. The examples presented in this report are intended to explore pathways to a framework, but it is important to understand that, as with any framework, the contents will be under constant review and will need to be updated on regular basis to align them with the resilience goals once they are adopted.

The summary reports submitted under Article 6 of the UPCM, to a certain extent, contain relevant information for most of the proposed DRGs. Additional indicators based on other reports, surveys, objective risk analysis and/or loss data are mainly relevant for specific goals. This makes it even more important to have a solid theoretical framework and an adaptable platform in place.

([3]) The European Commission upgraded the EU Civil Protection Mechanism and created rescEU to protect citizens from disasters and manage emerging risks.

([4]) See the European Climate Adaptation Platform Climate-ADAPT – country profiles (https://climate-adapt.eea.europa.eu/en/countries-regions/countries).

2. Composite indicator approach for monitoring and review

Composite indicators have several advantages with regard to the objective of monitoring the implementation of DRGs as an essential part of European resilience building. A good example in this sense is the Index For Risk Management (INFORM) which is a composite indicator developed by the JRC (De Groeve et.al., 2014) as a multi-hazard tool for understanding the risk of humanitarian crises and disasters.

In this chapter we discuss the advantages and limitations of the composite indicator approach and of existing resilience indices in the context of disaster risk management. Following this, relevant indicators are explored, and in Section 4.2 we provide an example of how to use indicators from a selected source to begin to develop a framework for the monitoring of the DRGs using the composite indicator approach.

2.1. The advantages of the composite indicator approach

This approach is useful for describing **complex problems**, presenting them as **multidimensional phenomena**. It is the only method that allows holistic assessments of phenomena to be made when their aspects are so many and different that it would be difficult to find a model that would allow so many different metrics as inputs. For example, all social, behavioural, economic, environmental, etc., issues relevant for resilience building are often described with a mixture of qualitative, semi-quantitative and, in the best cases, quantitative metrics.

It is important to develop a **theoretical framework** that would serve as the basis for the selection and combination of single indicators into a meaningful composite indicator following the fitness-for-purpose principle (OECD, 2018). In this case, the theoretical framework for monitoring the implementation of the resilience goals should present the **consensus among various stakeholders** (in this case Member States) that are often also the users of or data providers for the composite indicator. Their involvement in the model design and their influence in defining the relationship among the different aspect and components leads to a **common and objective understanding** of phenomena that can be perceived differently by different partners, for example the resilience building. Furthermore, such collaborative design results in **greater acceptance of the results** and **reduced potential for their misuse**.

The composite indicator model simplifies a lot of information about the phenomena. It is a multilayer structure that provides an insight into the **drivers of the phenomena**. For example, in the case of monitoring the implementation of the resilience goals, we can use the model to see which actions have been accomplished and then identify areas that the countries need to work on. Therefore, it can easily be used for decision-making and prioritisation, and it can facilitate developing a **transparent narrative** to justify the decisions. Furthermore, such composite indicators can become an efficient **communication tool** to explain the concepts adopted to new users, the public and policymakers.

Scientifically, the raw indicators are collected at a particular spatial level, for instance administrative unit. These indicators are then processed (standardised, normalised, etc.) and reclassified within a chosen range. The resulting indices are relative. This allows comparability of scores across different levels of the model and across different dimensions (e.g. resilience goals) in time and among different spatial units. It is therefore possible to **rank countries**, or sub-national administrative units within countries, and **monitor their progress** in an aggregated way or with respect to specific resilience goals.

2.2. Limitations of the composite indicator approach

The composite indicator approach is a very useful framework, but, at the same time, it has its limitations. The following section will explore these shortcomings.

2.2.1. Limitations in data

It can be challenging to find indicators/information with sufficient geospatial coverage (and resolution) and frequency of updating to cover all aspects defined in the theoretical framework. Therefore, it is often the case that:

- The theoretical framework is a balance of data-driven vs user-driven approaches to achieve useful outcomes.
- Information from self-assessment reports is used where some aspects cannot be completely covered by indicators collected from independent sources, or in cases when the self-assessment information is not to be fully trusted, it is complemented with best proxy indicators. Such combined approaches are not rare and are often used for monitoring and evaluating policy implementation (e.g. the methodology for monitoring and evaluation of measures implemented, as defined in the national adaptation strategy and plan in Austria ([5])).

However, a robust and solid theoretical framework allows changes to be made at the indicator level when better data become available.

2.2.2. Methodological limitations

The composite indicator methodology requires a lot of processing of raw indicators in the form of normalisation. During this step, **the connection with the absolute baseline is lost**. For example, it is not possible to quantitatively assess how many emergency hospital beds (as part of its response capacity) the country needs if it is to reach its goal/target. Furthermore, it is not possible to consider **interactions among the dimensions**/aspects. However, in the case of composite indicators used as a monitoring tool, this feature can be missed. Since composite indicators aggregate results into one score value, they **cannot** produce or encompass other information such as the **uncertainties related to the quality of the data**.

2.2.3. Scale dependency

Indices developed at higher administrative or statistical levels (e.g. national) do not consider the inherent variability at lower levels (e.g. provincial), which may result in having suboptimal and misleading policies in place. Using multiple-scale assessments from the local/municipal level up to a regional/national level can improve the consistency of indices across geographical scales (Marzi et al., 2018; O'Brien et al., 2004).

'Fit-for-purpose' and policy-relevant indices have to be scientifically sound, robust and transparent. Considerable attention must be given to the creation of an index and its communication to avoid problems arising from misleading information or misinterpretation. Index developers are usually faced with a spectrum of plausible alternatives associated with various stages during the index development. This involves a considerable degree of subjectivity, which may result in misleading policy messages. This issue can be tackled by implementing a sensitivity and robustness analysis. By doing so, several analytical methods can be examined to explore to what extent the index is influenced by methodological choices (Tate, 2012). The issue of misinterpretation can be alleviated by transparent methodology and indicator selection (Angeon and Bates, 2015). This step is most important for the interpretation and use of indices but also for anticipating the risk of subjective influence (Nardo et al., 2005).

([5]) See Climate ADAPT country profile: Austria – National circumstances relevant to adaptation actions (https://climate-adapt.eea.europa.eu/en/countries-regions/countries/austria).

2.3. Existing resilience indices in the context of disaster risk management

There have been several attempts to develop comprehensive resilience indices for decision-making and for monitoring, reporting and evaluation purposes. Existing indices are either hazard and/or sector specific or hazard independent and are designed at different scales, ranging from national to community level.

Examples of hazard- and/or sector-specific indices include a flood resilience index (Leandro et al., 2020), the Resilience to Emergencies and Disasters Index – Hurricanes (Kontokosta and Malik, 2018), an agriculture resilience index (Ciani, 2013) and resilience index measurement and analysis (RIMA) (FAO, 2016). Such studies characterise resilience based on indicators that can measure to what extent the targeted society and/or sector is able to 'bounce back' while exposed to a specific shock in the future.

Among these, the FAO's RIMA has been used for operational purposes in more than 10 countries in the Near East and sub-Saharan Africa. The index enables monitoring and evaluation of households' capacity to cope with shocks and stressors in the context of a food security crisis.

In contrast, hazard-independent indices assess the overall capacity of the society under consideration to absorb, adapt and 'build back better' when exposed to various types of unprecedented shocks or disturbances. Examples of hazard-independent indices are a cumulative resilience screening index (CSRI) (Summers et al., 2020), a city resilience index (ARUP, 2014) and a comprehensive disaster resilience index (Marzi et al., 2019). The CRSI is operational and has been used to support disaster resilience planning at community level. The index was developed by the United States Environmental Protection Agency at the request of counties and communities seeking assistance to measure their resilience readiness to withstand amplified natural hazards. The city resilience index developed by ARUP is a composite indicator that enables cities to measure and monitor their resilience to natural and anthropogenic hazards. The index has been piloted in several cities around the world since 2015, including Arusha, Concepción, Hong Kong, Liverpool and Shimla.

3. Exploring new indicators and data sources

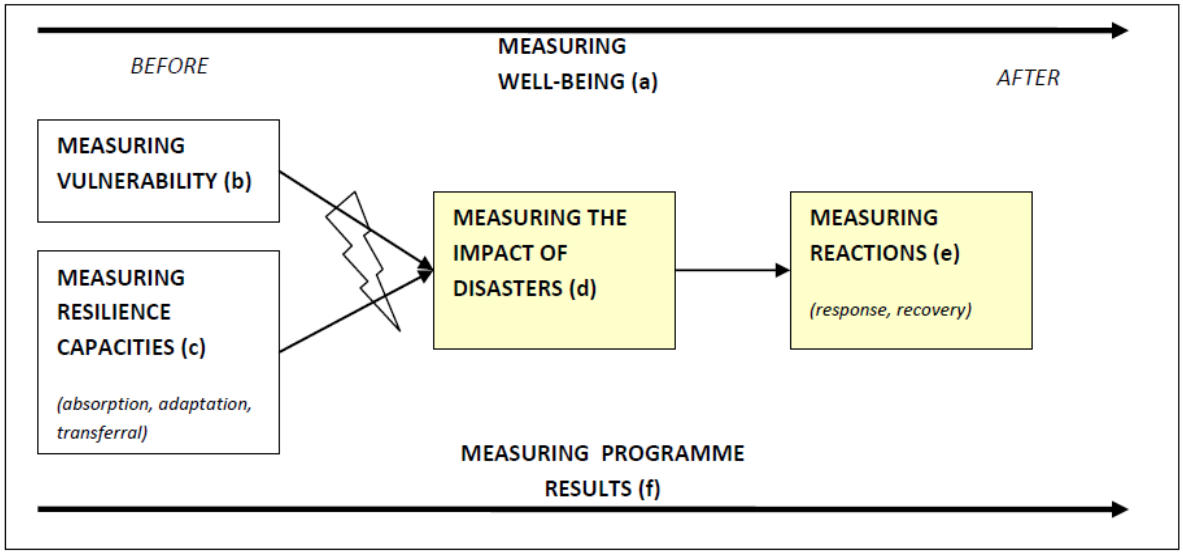
Identifying metrics and standards for measuring resilience is a challenge. In this chapter we explore the potential for developing a new indicator framework for conceptualising and measuring resilience that could benefit from existing sources of information and reporting on countries' disaster risk reduction status and climate adaptation plans. We also consider the potential for quantifying and measuring the impact of disasters in order to assess resilience, following the approach proposed by the United Nations Development Programme (UNDP) (Winderl, 2014) and conceptualised in **Figure 1**. While the UNDP approach recognises that data on all dimensions of disaster resilience are required to obtain a complete picture of resilience and how it changes over time (especially in the case of a disaster), it addresses the measurement of resilience through vulnerability, coping capacity, and the damage and losses caused by disaster.

We attempt to follow a similar approach by addressing the measurement of resilience by building on:

- assessments of countries' capabilities, tackled in their national reports under Article 6 of the UCPM;
- reports on climate adaptation actions;
- disaster loss and damage indicators;
- the vulnerability framework developed in the context of the Risk Data Hub;
- recently developed resilience indicators covering several dimensions developed by the JRC to allow a holistic assessment of resilience in the EU and its Member States;
- survey-based indicators building on Eurobarometer or similar surveys.

The options explored in this report give only a partial understanding of all the dimensions of resilience. In **Annex 1** we provide a table summarising a basket of efforts to measure disaster resilience at different scales and covering different dimensions.

Figure 1. Elements of measuring disaster resilience



Source: Winderl, 2014.

3.1. Reports under Article 6 of the Union Civil Protection Mechanism

Under Decision No 1313/2013/EU on the UCPM, as amended by Decision (EU) 2019/420, Member States have an obligation to develop risk assessments and assessments of risk management capabilities at national or

appropriate sub-national level (Box 1). To facilitate and guide this reporting, in 2019 the Commission developed, in cooperation with Member States, the new reporting guidelines ([6]). The first deadline to submit the aforementioned information to the Commission under the revised legislation was 31 December 2020. The reporting guidelines and the Member States' reports pre-date the revision of the UCPM legislation in May 2021 that introduced the Union disaster resilience goals ([7]). On receipt of the reports from Member States, the Commission will undertake the analysis of national submissions with a view to:

- identifying developments in the disaster risk landscape and capabilities to manage those risks, in particular as compared with the previous reporting cycle in 2018;
- taking stock of priority prevention and preparedness measures put in place by Member States for key risks with cross-border impacts and for low-probability risks with a high impact;
- extracting lessons from the first reporting exercise carried out under the revised UCPM legislation and the new reporting guidelines;
- identifying good practices and putting forward recommendations to improve disaster risk assessment and management in Europe.

Box 1. Disaster risk management and reporting under Article 6 of Decision No 1313/2013 on the Union Civil Protection Mechanism, as amended by Decision (EU) 2019/420 (amendments introduced by Regulation (EU) 2021/836 are in *italics*)

In order to promote an effective and coherent approach to the prevention of and preparedness for disasters by sharing non-sensitive information, namely information disclosure of which would not be contrary to the essential interests of Member States' security, and to promote the exchange of best practices within the Union Mechanism, Member States shall:

a) further develop risk assessments at national or appropriate sub-national level;

b) further develop the assessment of risk management capability at national or appropriate sub-national level;

c) further develop and refine disaster risk management planning at national or appropriate sub-national level, *including as regards cross-border collaboration, taking into account the Union disaster resilience goals referred to in paragraph 5, when established, and the risks related to disasters which cause or are capable of causing multi-country transboundary effects*;

d) make available to the Commission a summary of the relevant elements of the assessments referred to in points (a) and (b), focusing on key risks. For key risks having cross-border impacts, *and risks related to disasters which cause or are capable of causing multi-country transboundary effects*, as well as, where appropriate, for low probability risks with a high impact, Member States shall describe priority prevention and preparedness measures. The summary shall be provided to the Commission by 31 December 2020 and every three years thereafter and whenever there are important changes;

e) *participate, on a voluntary basis, in peer reviews on the assessment of risk management capability*;

f) *in line with international commitments, improve the collection of disaster loss data at national or the appropriate sub-national level to ensure evidence-based scenario building as referred to in Article 10(1) and the identification of gaps in disaster response capacities*.

The reporting guidelines on disaster risk management, based on the UCPM legislation as amended up to 2019, contain a list of 24 questions, split into three sections (**Table 1**):

- risk assessments,
- risk management capability assessments (RMCAs),
- priority prevention and preparedness measures.

([6]) Commission Notice 2019/C 428/07, Reporting Guidelines on Disaster Risk Management, Art. 6(1)d of Decision No 1313/2013/EU (OJ C 428, 20.12.2019, p. 8).

([7]) Regulation (EU) 2021/836 of the European Parliament and of the Council, 20 May 2021, amending Decision No 1313/2013/EU on a Union Civil Protection Mechanism (OJ L 185, 26.5.2021, p. 1) (https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R0836&from=EN).

Table 1. Questions in the reporting guidelines on disaster risk management (Commission Notice 2019/C 428/07) addressing risk assessments, risk management capability assessments and priority prevention and preparedness measures

Risk assessments	Risk management capability assessment	Priority prevention and preparedness measures
1. Risk assessment process 2. Consultation with relevant authorities and stakeholders 3. Identifying the key risks at national or sub-national level 4. Identifying climate change impacts 5. Risk analysis 6. Risk mapping 7. Monitoring and reviewing risk assessment 8. Communicating risk assessment results	9. Legislative, procedural and/or institutional framework 10. Roles and responsibilities of the competent authorities 11. Roles of relevant stakeholders 12. Procedures and measures at national, sub-national and local levels 13. Procedures and measures at cross-border, inter-regional and international level 14. Focus on climate change adaptation measures 15. Focus on critical infrastructure protection measures 16. Source(s) of financing 17. Infrastructure, assets and equipment 18. Focus on disaster loss data collection and procedures 19. Focus on early warning systems equipment and procedures 20. Risk information and communication to raise public awareness	21. Key risks with cross-border impacts 22. Priority prevention and preparedness measures 23. Low-probability risks with a high impact 24. Priority prevention and preparedness measures

Source: Commission Notice 2019/C 428/07.

The rationale for the new reporting guidelines and the need for further periodic reporting include the following:

- risk needs to be regularly addressed because of its dynamic features; this means that the disaster risk landscape is continually developing, and therefore the capacity to manage those risks must also develop over time;
- risk assessment is at the heart of the policy cycle for implementing integrated disaster risk management; therefore, it has become a limitation to focus on national risk assessments (NRAs) only without considering (1) how to fit the entire process into the national risk governance structure and (2) how the improved capacities change the outcome of the risk assessment;
- every risk assessment should capitalise on the experience gained from previous NRAs (e.g. the exchange of good practices and lessons learned through the Commission's series of publications 'Overview of risks that the EU may face', based on the outcomes of the reporting process), the increased availability and better quality of risk and loss data, the better understanding of risk drivers, and the continuous improvements of risk assessment methodology;
- EU policies on different risks should be improved to support the formation of an EU prevention policy framework that would complement and enhance national policies and promote better national risk governance with a legal framework and integrated approach to disaster risk management;
- it is important to obtain a more comprehensive picture of EU-wide needs **to build resilience**.

Reporting outcomes are only a summary of the real activities related to NRA and RMCA in a country. NRA and RMCA processes are very comprehensive and tailored to the national context. However, the reporting exercise fosters a shared understanding of the aspects that NRA and RMCA have at EU level, such as activities at **cross-border, inter-regional and international level, climate change adaptation, critical**

infrastructure protection and disaster loss data collection. It paves the way for the next steps already addressed in the latest revision of the UCPM (Regulation (EU) 2021/836): cross-sectoral, all-hazard approaches to transboundary disaster risk management, based on scenario **planning** at EU level and implementing the **Union disaster resilience goals**. The extensive work on the main analysis of the reports submitted under Article 6 of Decision No 1313/2013/EU on the UCPM is a valuable source of information and will be exploited in the ongoing work to develop the Union disaster resilience goals.

The reporting questionnaire, especially if well designed, can facilitate a common understanding of the elements that need to be in place to set up an efficient, flexible and systematic process for the implementation of integrated disaster risk management.

The resilience concept places pre-disaster and post-disaster risk management actions within a common framework that we refer to as integrated disaster risk management. Implementing integrated disaster risk management is a result of a risk governance process comprising a three-step policy cycle: risk assessment, risk management planning, and implementing risk prevention and preparedness measures.

The reporting questionnaire offers an opportunity to stress the need for learning, constant improvement and planning capability development. It assesses where the country is, in which direction the it should go and what is the very next step to reach the goals that are aligned with its development strategies.

3.2. Reports on national climate adaptation actions

Disaster risk assessment for disaster risk reduction and climate change adaptation are central dimensions of all spheres of government and society and target resilience as a precondition and an outcome of risk-informed development. As the majority of disaster events are related to climate extremes, both agendas have often been politically and operationally intertwined. Both policies seek to prevent new and reduce existing disaster risks. The objective is to build adaptive capacity and reduce vulnerability to the unavoidable adverse impacts of disasters.

This section gives an overview of the reporting by the European Environment Agency (EEA) on the MS/PS national adaptation actions available on the Climate-ADAPT platform ([8]). Apart from being a potential source of indicators, the platform is also an interesting example of how data and information can be presented in a systematic way.

EEA member countries are at different stages of preparing, developing and implementing NASs and NAPs. The EEA provides country pages and maps showing the information reported per country under the national adaptation actions of Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action ([9]). Additional details of the reporting are specified in an implementing act ([10]). By 15 March 2021, and every 2 years thereafter, Member States are required to report to the Commission information on their national adaptation actions. A selection of the information reported for each country is available, along with a link to the public submission of the reporting, where all information and additional files submitted are available. To provide a consistent overview of the reporting, information is structured in the same way on each country page.

The country pages consist of the following:

- **summary** (an overview of key items, their status and links);
- **assessment** (climate modelling, projections, scenarios, methods and tools, observed and future impacts and key sectors affected);
- **legal and policy framework** (institutional frameworks and governance at the national and sub-national scales along the adaptation policy cycle, integration into sectoral policies, networks and collaboration);

([8]) The European Climate Adaptation Platform Climate-ADAPT – country profiles (https://climate-adapt.eea.europa.eu/en/countries-regions/countries).
([9]) https://eur-lex.europa.eu/eli/reg/2018/1999.
([10]) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32020R1208.

- **strategies, plans and goals** (priorities, challenges, gaps, barriers and overview of national and sub-national strategies, integration in sectoral policies, plans and programmes and stakeholder engagement);
- **monitoring and evaluation** (methodology, state of play of implementation, spending on climate adaptation, progress towards reducing climate risks, increasing adaptive capacity, meeting adaptation priorities, addressing barriers to adaptation, steps to review climate change impact and vulnerability assessments and national adaptation policy, and good practice on reviewing sub-national adaptation policies);
- **good practice, cooperation and synergies** (synergies of adaptation actions with international frameworks, cooperation in science and policy) and
- **contacts** (organisation in charge, relevant websites and social media).

3.3. Indicators based on past events and losses

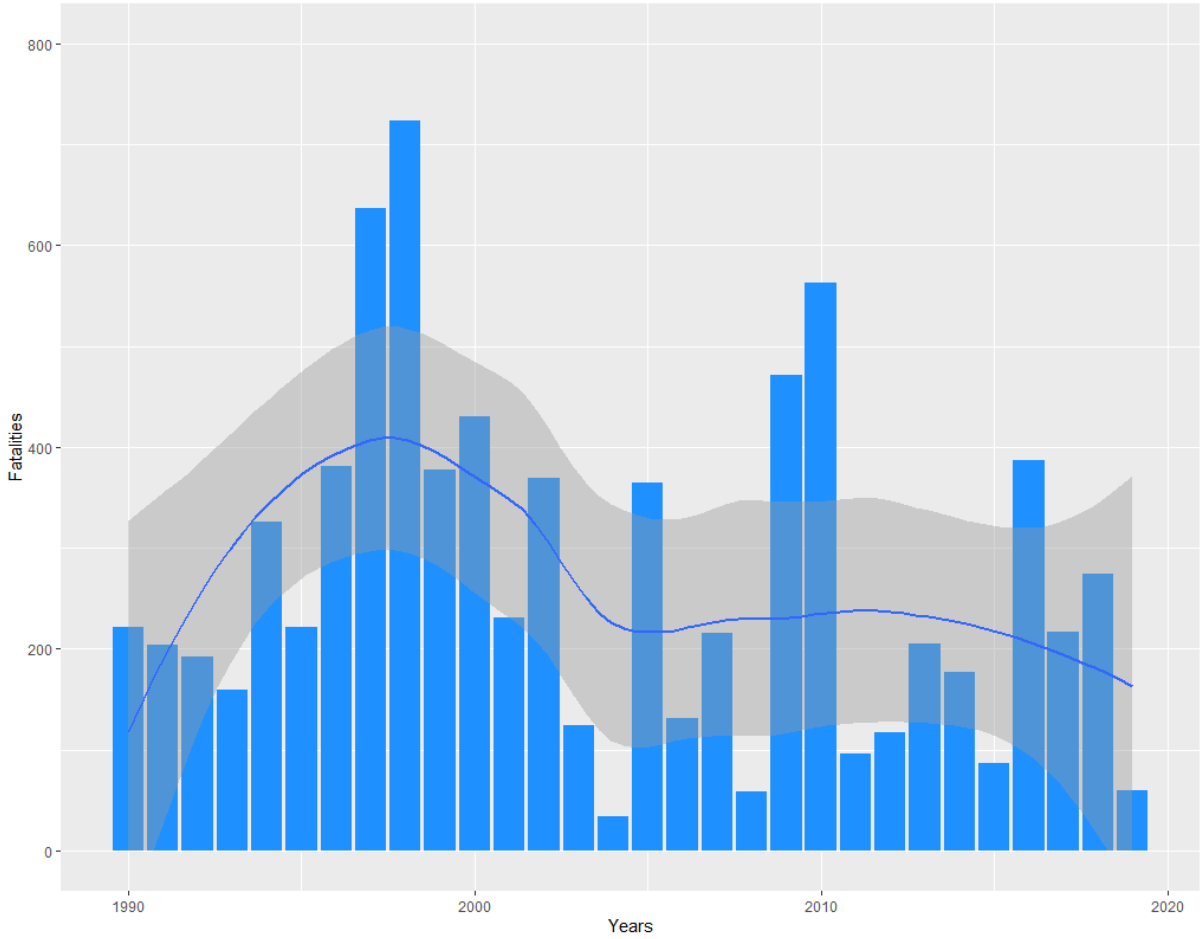
Effective and efficient management of post-disaster damage and loss data is a key component of disaster risk reduction and climate change adaptation policies to fulfil the requirements of the Sendai framework for disaster risk reduction, sustainable development goals and, more recently, the European climate law (Faiella et al., 2022).

Loss accounting can provide input for some components of the monitoring of the DRGs, depending on the context. In particular, it would be good practice to understand the connection between survey results and information in the summary reports submitted under Article 6 in more detail, and to check those against the independent loss data available on the Risk Data Hub ([11]) (RDH) platform. The RDH covers several dimensions of disaster risk management: from understanding the impacts of disaster events to the calibration and validation of risk models and up to the evaluation of progress in implementing disaster risk reduction measures. Through better collection, curation and sharing of disaster risk and loss data, the mission of the RDH is to support the collective effort towards a more resilient future at an EU level.

Figure 2 shows the overall trend in fatalities for all risks over the last 30 years in Europe. It is important to note that the selection of loss data for all risks is made consciously in order to take account of the different risk landscapes in different countries.

([11]) https://drmkc.jrc.ec.europa.eu/risk-data-hub.

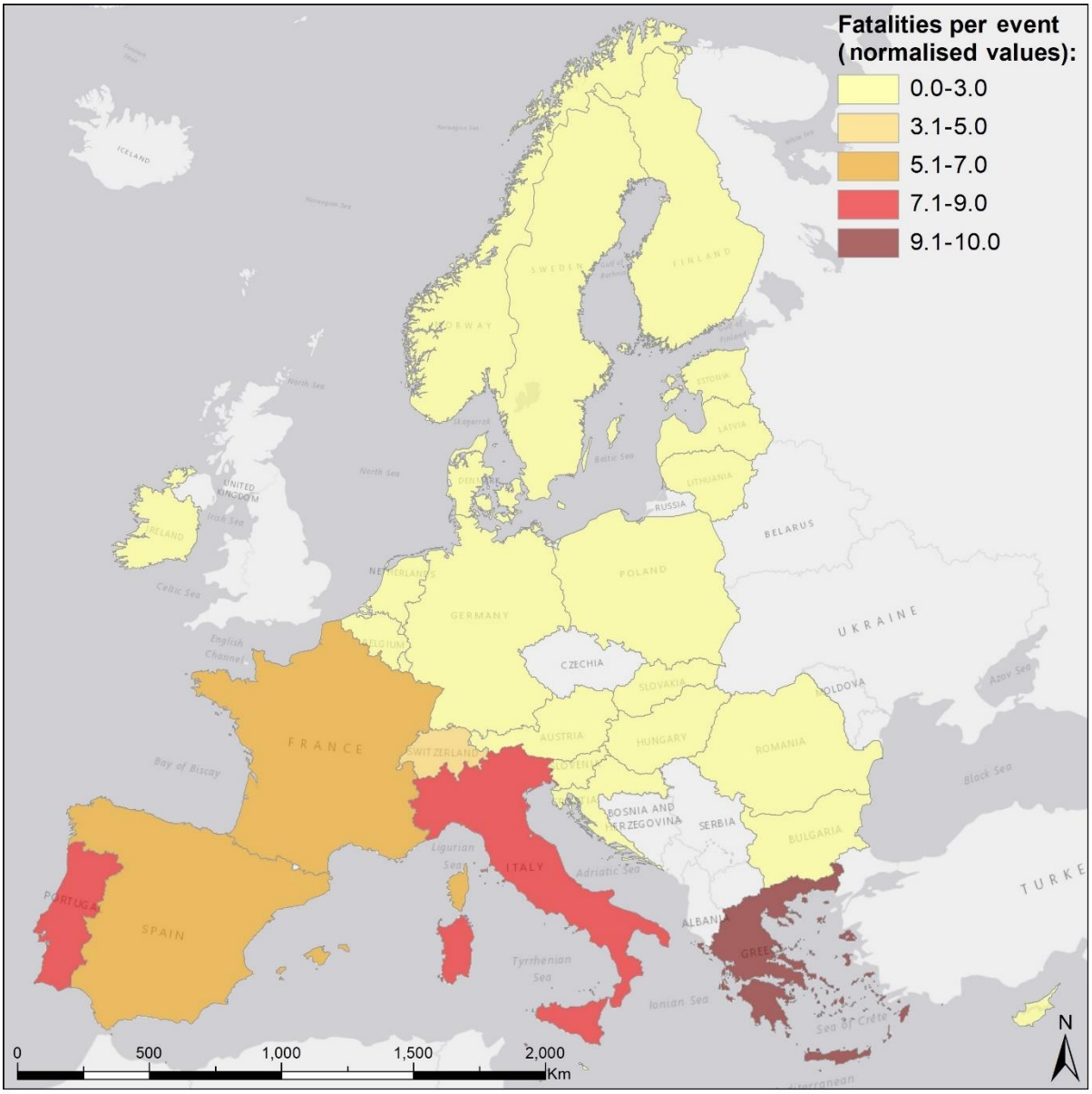
Figure 2. Fatalities in Europe for all types of hazard, 1990–2019



Source: Risk Data Hub, 2022.

Breaking it down by country over the last 3 years, it is possible to create a damage history indicator, which would be a relevant component to monitor in the context of the DRGs. The total losses (in this case fatalities) are counted over the last 3 years and then divided by the number of events. The resulting indicator is mapped in **Figure 3** and represents the number of fatalities per event by country.

Figure 3 Fatalities from all types of hazards per event (2020-2022)



Source: Risk Data Hub, 2022.

3.4. Risk Data Hub vulnerability framework

The purpose of developing the RDH vulnerability framework ([12]) is to obtain a fit-for-purpose vulnerability component to be used in the estimation of risk, which is defined as a function of hazard, exposure and vulnerability. Furthermore, and in order to function in the RDH structure, it is essential that the RDH vulnerability index can be assessed at different geographical levels (national, NUTS2, NUTS3)[13] and over various scales (Europe-wide, national, sub-national).

For the purpose of the RDH, the vulnerability index comprises four dimensions:

- The **social** dimension explains the condition and processes of individuals and of the entire population. Here, the conditions refer to health aspects, access/mobility, population distribution and demography and, to an extent, dwellings. Social participation and information play a crucial role in reducing inequalities and climate-resilient pathways (Marzi et al., 2019).
- The second component describes the **economic** situations of individuals, the population and the government. Post-disaster property loss and the effects of business disruption have been stated as the main contributors to the economic component, revealing the operational roles of businesses and organisational and institutional entities. Economic resources play an important role in boosting resilience and adaptive capacity.
- The **political** component deals with the quality of government and its actions. High levels of institutional quality and governance can ensure effective implementation of emergency planning, as well as climate change adaptation and resilience policies. Accountability of and trust in institutions and officials is an important element of organisational resilience and business continuity.
- The vulnerability of **ecological** systems can be associated with various factors related to biodiversity, redundancies, diversity of responses, governance and management policies. The environmental and ecosystem aspects of vulnerability have been embedded in the ecological/ecosystem dimension in previous studies. The expansion and conservation of protected areas and ecological corridors leads to preserving ecosystem services and ecological resilience, which are the core elements of green infrastructure planning in Europe (Marzi et al., 2019).

Under each dimension above is a set of sub-dimensions, ideally cross-level (Europe-, national-, sub-national-level). Some of these are of particular relevance to resilience: access and health (social dimension), financial resources and inequality (economic dimension), government and political situation (political component).

The concept of vulnerability is particularly relevant to building resilience. We define resilience as 'the ability of a system, community or society exposed to hazards to resist, absorb, accommodate [to] and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions' (UNISDR, 2016). By obtaining an efficient measure of vulnerability, we seek to identify structural features that are deeply intertwined with the concept of resilience. That is, by addressing vulnerable components of a system, we expect to witness a twofold positive effect. On the one hand, the estimated risk will be reduced. On the other hand, a lower level of vulnerability enables a more efficient and faster rebound from unanticipated disasters. It is worth noting that in this paper we concentrate on the hazard-independent nature of vulnerability, which is commonly captured through systemic indicators that describe the features of a given system.

([12]) https://drmkc.jrc.ec.europa.eu/risk-data-hub/#/vulnerability-in-europe.

([13]) Nomenclature of Territorial Units for Statistics or NUTS is a geocode standard for referencing the administrative divisions of countries for statistical purposes.

It is important to highlight that, by disaggregating further to specific indicators selected for the vulnerability framework, the importance in the context of the DRGs can be better understood. A small selection of indicators and their rationales are presented in **Table 2**.

Table 2. Selection of indicators in the RDH vulnerability framework that are relevant for resilience in the context of the DRGs

Indicator	Rationale
Projected population change	'Urbanisation opportunities for disaster risk management. Many high-income countries demonstrate how urban density can be utilised for increasing the efficiency and effectiveness of measures such as disaster response units, hydraulic infrastructure or risk-sensitive land-use zoning. On the other hand, negative urbanisation can bring forth tremendous challenges for designing and financing efficient adaptation strategies. Our analysis underscores that urbanisation can have different implications on overall vulnerability, with high levels of economic growth, offering prospects to enhance adaptive capacity at the national level.'.[14]
Disabled people with need for assistance (16–64 years)	'People with need for assistance are more vulnerable because of their dependency. This indicator takes disabled people and people who reported the need for assistance into account since young and old dependency is covered by age-dependency it only covers the working age population (15–64 years). There is a need to address and include indicators for people with disabilities in order to plan and prepare an inclusive national disaster risk prevention and preparedness plan.'
Children at risk of poverty or social exclusion by age (less than 18 years old) and sex (both)	'Children at risk of poverty also indicate a future trend: for children already being at risk of poverty, the likelihood that they will be more vulnerable in terms of financial resources and/or social exclusion should be considered. This can further have an influence on political structures. Investing in vulnerable children is not only an investment in disadvantaged individuals, families and communities; it is an investment in more resilient societies and inclusive economies. Generating more resilience in children is the culmination of stronger support systems, better opportunities, secure child-parent attachment, high self-efficacy and optimism and adequate economic resources. Direct investments in low-income children's health and education generate the highest pay-offs.'

Source: JRC, 2022 data.

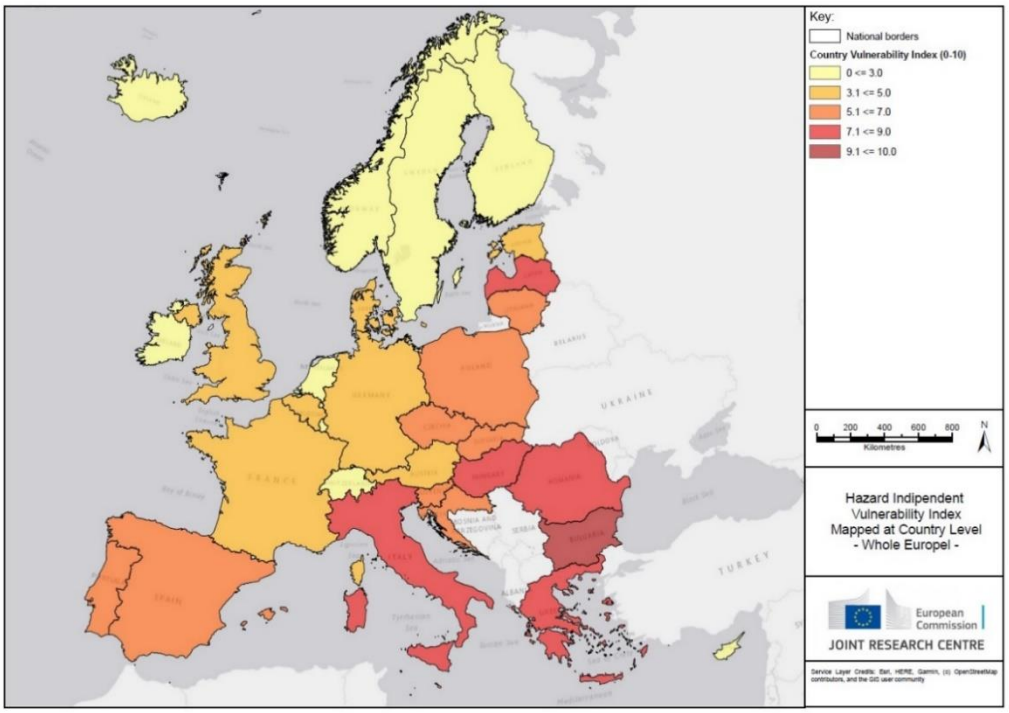
Within the context of the DRGs, components and indicators from the RDH vulnerability framework can be relevant to goals related to risk assessment and risk management planning and anticipation and for the strengthening of the crisis and emergency preparedness of civil protection.

Figure 4 and **Figure 5** show the RDH vulnerability index 2022, aggregated at country level.

Figure 6 illustrates a mapping of an indicator that we have developed using the trend of the vulnerability in time. The indicator is based on the last three years on record, and the projections of the vulnerability over the next three years. What is measure is the average yearly rate of change over the time period. The time period chosen is to avoid outliers (mainly in the past) and uncertainties (in projections).

[14] Garschangen and Romero-Lanken, 2013

Figure 4. RDH hazard-independent vulnerability index at the European scale, aggregated at country level and over the social, economic, political and environmental dimensions. In the context of resilience, the higher the value of the vulnerability index, the lower the resilience. The vulnerability index is taken from RDH 2022 data.



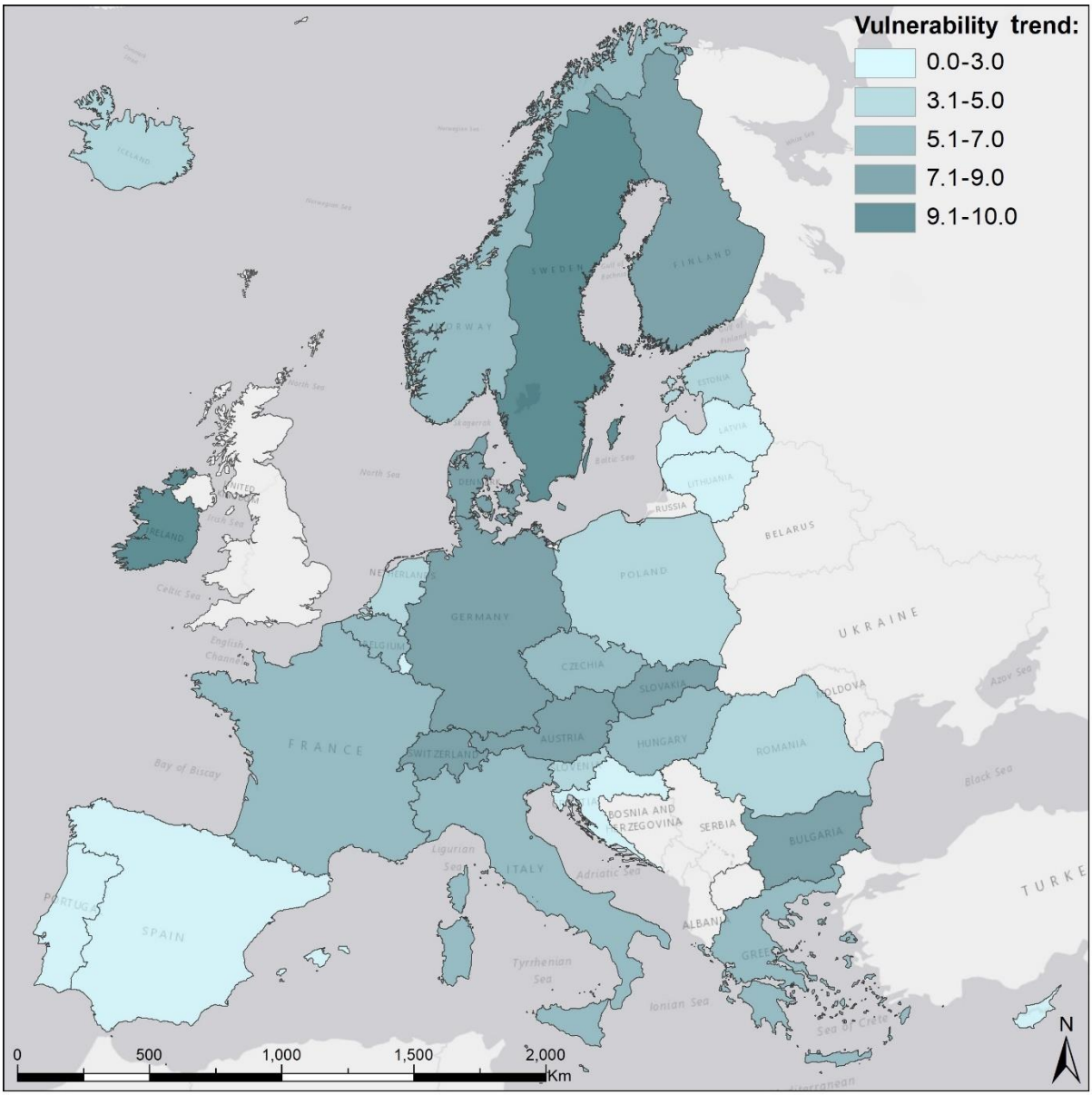
Source: Risk Data Hub, 2022.

Figure 5. RDH hazard-independent vulnerability index, as above but in tabular format

		Social											Economic								Political							Environmental					
		Population change	**Population**	Children at-risk-of-poverty	Disabled people with need for assistance	**Social participation**	Change in Age-dependency	**Dependency**	Self-reported unmet need for medical care	Perceived Good Health	**Health**		Gross National Saving	GDP per capita	**Financial resources**	Income Inequality	**Inequality**	Cultural heritage	**Cultural heritage**		Governmental efficiency	**Government**	Political Stability	**Political situation**	National Adaptation Strategies	**Strategy**		Environmental vulnerability index	Natura 2000 protected areas		Country Component	NUTS2 component	NUTS3 component	Country Vulnerability Index (0-10)
		0		1	1		1		1	0			0	0		1		1			0		0		0			1	0				
AT	Austria	5.3	5.3	3.6	1.9	2.8	8.6	8.6	2.1	2.8	2.5	4.8	6.6	6.1	6.3	3.1	3.1	1.1	1.1	3.5	3.1	3.1	3.5	3.5	0.0	0.0	2.2	8.5	7.9	8.2	4.7	3.1	5.9	3.6
BE	Belgium	5.5	5.5	3.7	6.3	5.0	3.8	3.8	5.1	1.7	3.4	4.4	7.5	6.4	7.0	1.6	1.6	1.6	1.6	3.4	4.7	4.7	7.3	7.3	0.0	0.0	4.0	10.0	8.6	9.3	5.3	2.8	5.5	3.6
BG	Bulgaria	9.0	9.0	8.3	0.5	4.4	4.6	4.6	4.9	4.0	4.5	5.6	8.2	10.0	9.1	10.0	10.0	6.6	6.6	8.6	10.0	10.0	7.3	7.3	10.0	10.0	9.1	4.8	0.7	2.7	6.5	9.1	6.3	10.0
CH	Switzerland	4.3	4.3	3.8	2.5	3.1	7.0	7.0	3.8	0.0	1.9	4.1	5.0	2.6	3.8	5.0	5.0	0.7	0.7	3.2	0.0	0.0	0.2	0.2	0.0	0.0	0.1	6.8		6.8	3.5	2.1	5.6	1.6
CY	Cyprus	3.1	3.1	2.7	1.2	1.9	7.0	7.0	3.3	0.9	2.1	3.5	9.0	8.2	8.6	6.3	6.3	0.5	0.5	5.1	6.2	6.2	6.3	6.3	0.0	0.0	4.2	5.2	2.9	4.1	4.2	4.2	4.0	2.7
CZ	Czechia	6.1	6.1	0.7	0.0	0.3	3.9	3.9	3.4	5.6	4.5	3.7	5.6	8.7	7.2	0.1	0.1	3.7	3.7	3.7	6.2	6.2	2.5	2.5	0.0	0.0	2.9	4.0	8.2	6.1	4.1	5.3	7.6	6.2
DE	Germany	6.2	6.2	4.6	3.0	3.8	10.0	10.0	2.1	4.4	3.3	5.8	6.8	6.4	6.6	6.3	6.3	6.0	6.0	6.3	2.1	2.1	5.8	5.8	0.0	0.0	2.7	7.5	7.9	7.7	5.6	2.6	7.2	4.9
DK	Denmark	5.5	5.5	0.9	4.3	2.6	6.2	6.2	5.3	3.3	4.3	4.6	6.5	5.1	5.8	3.1	3.1	0.9	0.9	3.3	0.7	0.7	3.2	3.2	0.0	0.0	1.3	6.6	10.0	8.3	4.4	2.1	6.7	3.2
EE	Estonia	6.8	6.8	2.1	1.3	1.7	2.6	2.6	10.0	7.2	8.6	4.9	6.1	8.7	7.4	5.7	5.7	0.4	0.4	4.5	4.6	4.6	5.9	5.9	0.0	0.0	3.5	1.2	6.8	4.0	4.2	5.3	5.6	4.7
EL	Greece	7.7	7.7	6.7	0.0	3.4	3.5	3.5	8.0	0.4	4.2	4.7	10.0	9.0	9.5	6.2	6.2	5.5	5.5	7.1	9.6	9.6	9.7	9.7	5.0	5.0	8.1	7.2	3.6	5.4	6.3	7.4	6.0	8.4
ES	Spain	5.1	5.1	6.8	4.3	5.6	3.0	3.0	3.3	1.6	2.5	4.0	8.1	8.0	8.1	7.9	7.9	10.0	10.0	8.7	5.7	5.7	8.5	8.5	0.0	0.0	4.7	7.1	3.6	5.4	5.7	4.2	7.0	6.1
FI	Finland	6.4	6.4	1.2	0.9	1.0	2.1	2.1	7.6	3.6	5.6	3.8	7.7	6.2	7.0	2.0	2.0	0.7	0.7	3.2	0.0	0.0	3.4	3.4	0.0	0.0	1.1	0.0	8.6	4.3	3.1	2.6	3.4	0.0
FR	France	5.5	5.5	3.8	3.3	3.5	4.3	4.3	6.0	3.9	4.9	4.6	8.2	7.0	7.6	4.0	4.0	6.8	6.8	6.2	2.9	2.9	9.6	9.6	0.0	0.0	4.2	7.9	8.6	8.2	5.8	4.4	5.1	4.9
HR	Croatia	8.4	8.4	2.5	1.0	1.7	7.4	7.4	5.1	5.9	5.5	5.8	8.3	9.5	8.9	4.7	4.7	4.2	4.2	5.9	8.9	8.9	4.6	4.6	10.0	10.0	7.8	0.0	0.0	0.0	4.9	6.9	3.6	5.0
HU	Hungary	6.9	6.9	2.7	0.9	1.8	5.2	5.2	4.0	6.5	5.3	4.8	5.8	9.4	7.6	3.6	3.6	3.0	3.0	4.7	8.7	8.7	4.7	4.7	5.0	5.0	6.1	8.0	5.7	6.9	5.6	7.2	5.3	7.1
IE	Ireland	2.3	2.3	3.7	10.0	6.9	0.0	0.0	5.8	0.0	2.9	3.0	0.0	3.5	1.8	4.3	4.3	0.0	0.0	2.0	3.3	3.3	2.6	2.6	0.0	0.0	2.0	4.3	8.6	6.5	3.4	3.5	3.0	0.6
IS	Iceland	0.8	0.8	0.4	3.2	1.8	3.0	3.0	6.5	1.1	3.8	2.4	7.4	4.6	6.0	1.1	1.1	0.1	0.1	2.4	3.0	3.0	0.0	0.0	10.0	10.0	4.4	2.7		2.7	3.0	0.5	6.2	0.4
IT	Italy	6.6	6.6	4.8	1.7	3.2	4.0	4.0	5.5	2.1	3.8	4.4	8.8	7.7	8.2	8.3	8.3	10.0	10.0	8.8	9.2	9.2	8.1	8.1	5.0	5.0	7.4	9.9	6.4	8.2	7.2	5.8	7.0	8.5
LT	Lithuania	9.0	9.0	4.0	2.6	3.3	9.9	9.9	5.3	10.0	7.6	7.5	8.5	9.1	8.8	10.0	10.0	1.2	1.2	6.7	5.3	5.3	4.7	4.7	0.0	0.0	3.3	4.0	8.6	6.3	5.9	6.7	4.2	6.1
LU	Luxembourg	2.1	2.1	4.5	4.7	4.6	4.7	4.7	2.1	3.6	2.9	3.6	0.0	0.0	0.0	8.1	8.1	0.0	0.0	2.7	1.2	1.2	0.0	0.0	5.0	5.0	2.1	5.1	3.6	4.3	3.2	1.6	6.9	2.0
LV	Latvia	10.0	10.0	2.0	0.8	1.4	7.5	7.5	7.6	10.0	8.8	6.9	8.1	9.2	8.6	9.8	9.8	0.6	0.6	6.3	5.5	5.5	7.2	7.2	10.0	10.0	7.6	0.4	8.9	4.7	6.4	7.1	5.3	7.6
MT	Malta	0.0	0.0	3.8	1.3	2.6	4.6	4.6	0.0	1.9	1.0	2.0	3.6	8.1	5.8	3.6	3.6	0.5	0.5	3.3	5.9	5.9	0.6	0.6	5.0	5.0	3.8	8.4	8.6	8.5	4.4	4.3	7.0	5.2

Source: Risk Data Hub, 2022.

Figure 6. Indicator based on the trend in hazard-independent vulnerability in Europe over the last 3 years (2019–2021, with available data) and projected over the next 3 years (2022–2024)



Source: Risk Data Hub, 2022.

3.5. European Commission resilience dashboards

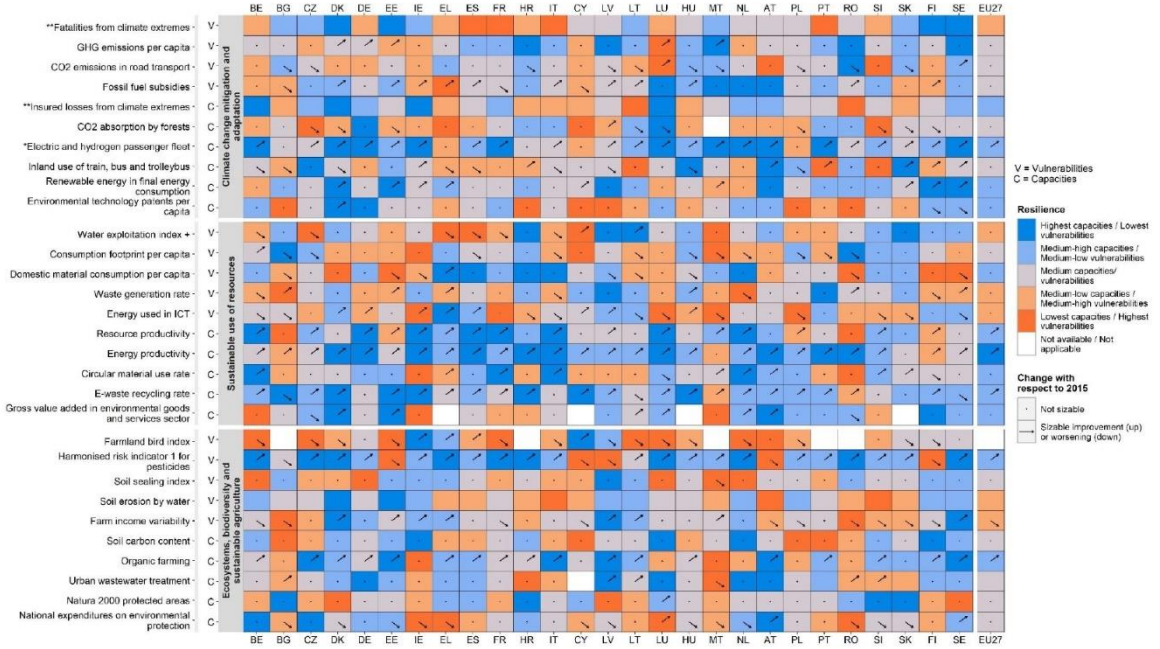
The resilience dashboards ([15]) developed by the European Commission represent the outcome of the process of collective intelligence gathering from Member States and other relevant stakeholders, as a follow-up to the 2020 strategic foresight report; they provide a holistic assessment of the ability to progress amid ongoing societal transformation and the challenges ahead, across four dimensions:

- social and economic,
- green (environmental),
- digital,
- geopolitical.

([15]) https://ec.europa.eu/info/strategy/strategic-planning/strategic-foresight/2020-strategic-foresight-report/resilience-dashboards_en.

They represent an innovative monitoring tool for the transition-led EU policy agenda and aim to help Member States identify areas for further analysis and potential policy actions. **Figure 7** is an example of the resilience dashboard for the 'green' dimension in 2021 for all EU Member States. The changes were calculated with respect to 2015.

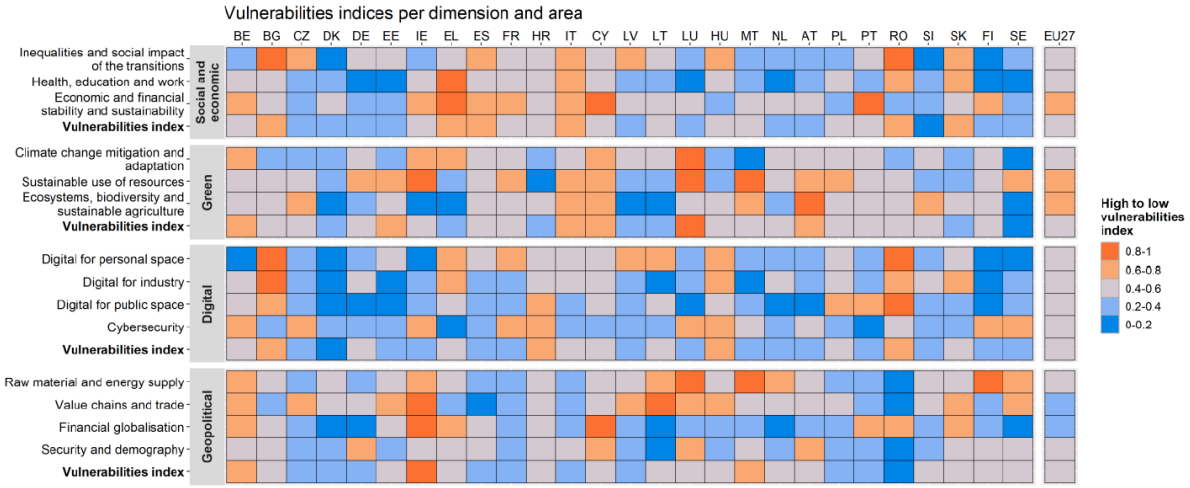
Figure 7. Green dashboard extracted from the resilience dashboard for November 2021



Source: JRC, 2021.

The synthetic indices aggregate the relative situation of the EU and its Member States across all indicators considered for the four dimensions (**Figure 8**). A higher capacity index indicates higher (relative) capacity, while a higher vulnerability index indicates higher (relative) vulnerability.

Figure 8. Synthetic indices across all areas and all dimensions



Source: JRC, 2021.

3.6. Survey-based indicators – Eurobarometer

Indicators based on surveys are important for several reasons: for example, they can provide decision-makers and policymakers with information essential for making informed policy choices. They also serve as baselines and are important for setting and understanding goals and targets for the future. Survey-based indicators can be used to obtain a measure of the perception of the general public or of specific target groups such as civil protection staff. Indicators created in this way are considered to be independent and qualitative. It is widely accepted that households engaging in preparedness activities are more resilient than those that are unprepared, due to their increased awareness and having made actual adjustments that contribute to the survivability of family members in the aftermath of disaster (Bodas et al., 2022).

Surveys need to be developed to be fit for purpose with respect to the specific goals for which they contribute to the measuring framework. In particular, one part of resilience and the DRGs is focused on the risk awareness of the population. For demonstration purposes, we have used an existing targeted survey that is partly relevant to risk awareness and created indicators using a selection of the questions from Eurobarometer survey 511 (

Table 3).

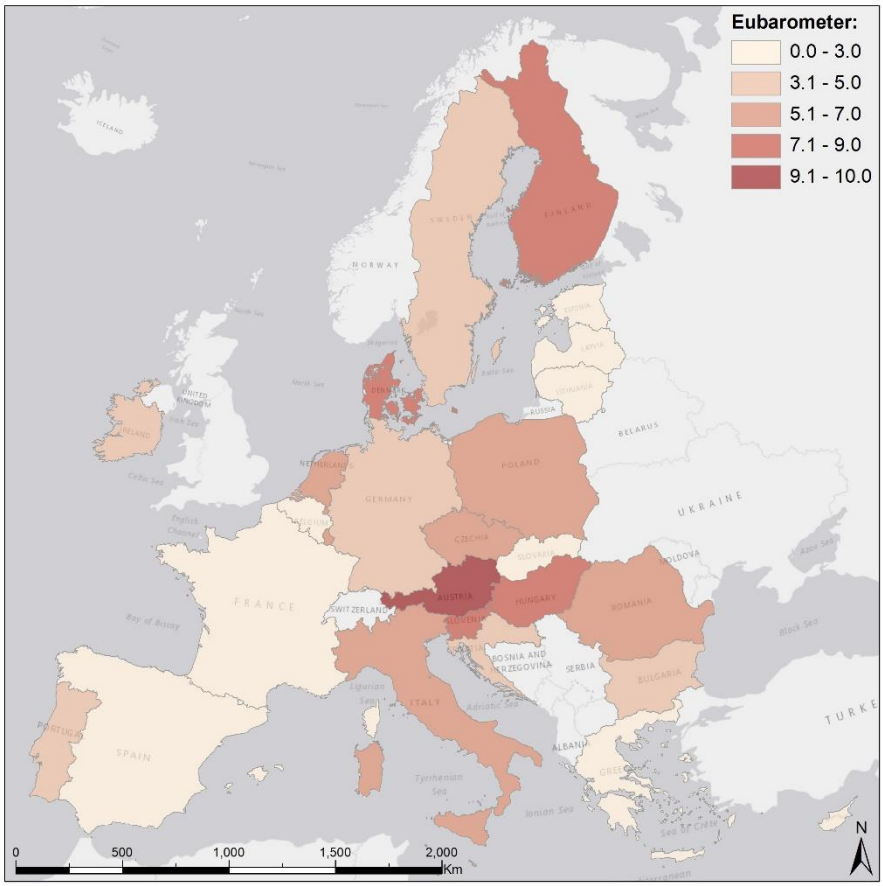
An indicator based on survey results is developed based on how the answers to each question are weighted. The answer options for the questions extracted from Eurobarometer survey 511 were generally split into five or seven options, ranging from 'Very well' or 'Agree fully' to 'Not at all' or 'Fully disagree'. The answers were given a weight based on these ranges, with positive answers given more weight. Using this method, we developed the indicator for each country answering the survey and then normalised it over all countries. The component created using the survey is shown in **Figure 9**. In the case of this sample survey, a higher score indicates a higher level of resilience.

Table 3. Survey questions used to create a survey-based indicator

Eurobarometer survey questions (somewhat) relevant to risk awareness
Climate change has resulted in a dramatic increase in natural hazards in Europe, such as wildfires, floods or droughts, often resulting in many victims and economic damage. In your view, how well prepared to respond or not are regional or local authorities?
Climate change has resulted in a dramatic increase in natural hazards in Europe, such as wildfires, floods or droughts, often resulting in many victims and economic damage. In your view, how well prepared to respond or not are the national authorities?
Climate change has resulted in a dramatic increase in natural hazards in Europe, such as wildfires, floods or droughts, often resulting in many victims and economic damage. In your view, how well prepared to respond or not are the European Union authorities?
To what extent are you aware or not of the risk of disaster in your region? (In this question, 'the risk of disaster' does not include pandemics)
When a disaster strikes in our country that is too big to deal with on our own, another EU country should provide help
When a disaster strikes in another EU country that is too big to deal with on their own, your country should provide help

Source: European Commission – Eurobarometer survey 511, 2021.

Figure 9. Eurobarometer component for the purpose of measuring risk awareness in Europe



NB: A higher score indicates more positive answers.

Source: JRC, 2022.

4. Disaster resilience goals: baseline for a possible indicator-based framework

The main scope of this report is to **explore an approach for monitoring the implementation of the DRGs**. The focus has remained on using existing information and developing a system and/or methodology to measure it. The existing information directly related to the context of the development of the DRGs is the recent analysis of the national reports submitted under Article 6 of Decision No 1313/2013/EU on the UCPM.

It is important to highlight that the reports submitted under Article 6 to a certain extent contain relevant information for all components of the DRGs**.** Additional indicators based on surveys, objective risk analysis and/or loss data are mainly relevant for specific goals but are in general not applicable to all.

In the following sections of this chapter we demonstrate how relevant information provided in the reports submitted under Article 6 of the UCPM can be used to develop indicators and then how to use those indicators to start constructing a composite indicator framework approach with the purpose of monitoring the DRGs.

4.1. Developing indicators based on the reports submitted under Article 6 of the UCPM

Keeping in mind the background information provided in Section 3.1, indicators have been developed based on the reports submitted under Article 6 of the UCPM. In order to build a complete framework, additional layers are required. In particular, as we will explore in subsequent sections, DRG No 4 is not addressed by the MS/PS reporting. That goal is for the UCPM to address, with performance goal indicators already having been explored by experts.

Based on an analysis of the reports submitted, a set of questions was developed to provide an overview of the information provided. In essence, it is a translation of the 'Accompanying guidance to the template' of the reporting guidelines in question.

For example:

Q1. Risk assessment process

Describe how the risk assessment process fits into the overall disaster risk management framework. Detail legislative, procedural and institutional aspects. Please explain whether responsibility for the risk assessment lies at national level and/or at an appropriate sub-national level.

Translates into:

- Has the MS/PS included a description of how the risk assessment process fits into the overall disaster risk management framework?
- Has the MS/PS detailed legislative, procedural and institutional aspects?
- Has the MS/PS explained whether responsibility for the risk assessment lies at national and/or at an appropriate sub-national level?

These questions were then followed by a set of more detailed questions describing the content of the reporting. Using them as a self-assessment survey, it is possible to score the answers to the analytical questions, creating indicators for all reporting countries per question. **Figure 10** shows the scoring, and the resulting indicator, for the example presented above.

Figure 10. An example of the scoring of the information provided in the MS/PS Article 6 summaries

Q1.1. Has the MS/PS included a description on how the risk assessment process fits into the overall disaster risk management framework?

	MS1	MS2	MS3	MS4	...																
MS/PS scored replies	3	3	3	3	3	3	2	3	3	3	3	3	3	2	1	3	3	3	3	3	1	3

Q1.2. Has the MS/PS detailed legislative, procedural and institutional aspects?

	MS1	MS2	MS3	MS4	...																	
MS/PS scored replies	3	3	3	3	3	1	2	3	3	3	3	3	2	2	3	3	3	3	3	3	2	3

Q1.3. Has the MS/PS explained whether responsibility for the risk assessment lies at national and/or at an appropriate sub-national level?

	MS1	MS2	MS3	MS4	...																	
MS/PS scored replies	3	3	1	3	3	3	2	3	3	3	3	3	2	2	1	3	1	3	3	3	2	3

NB: 'Yes' means 3 points, 'Unclear' 2 points and 'No' 1 point.

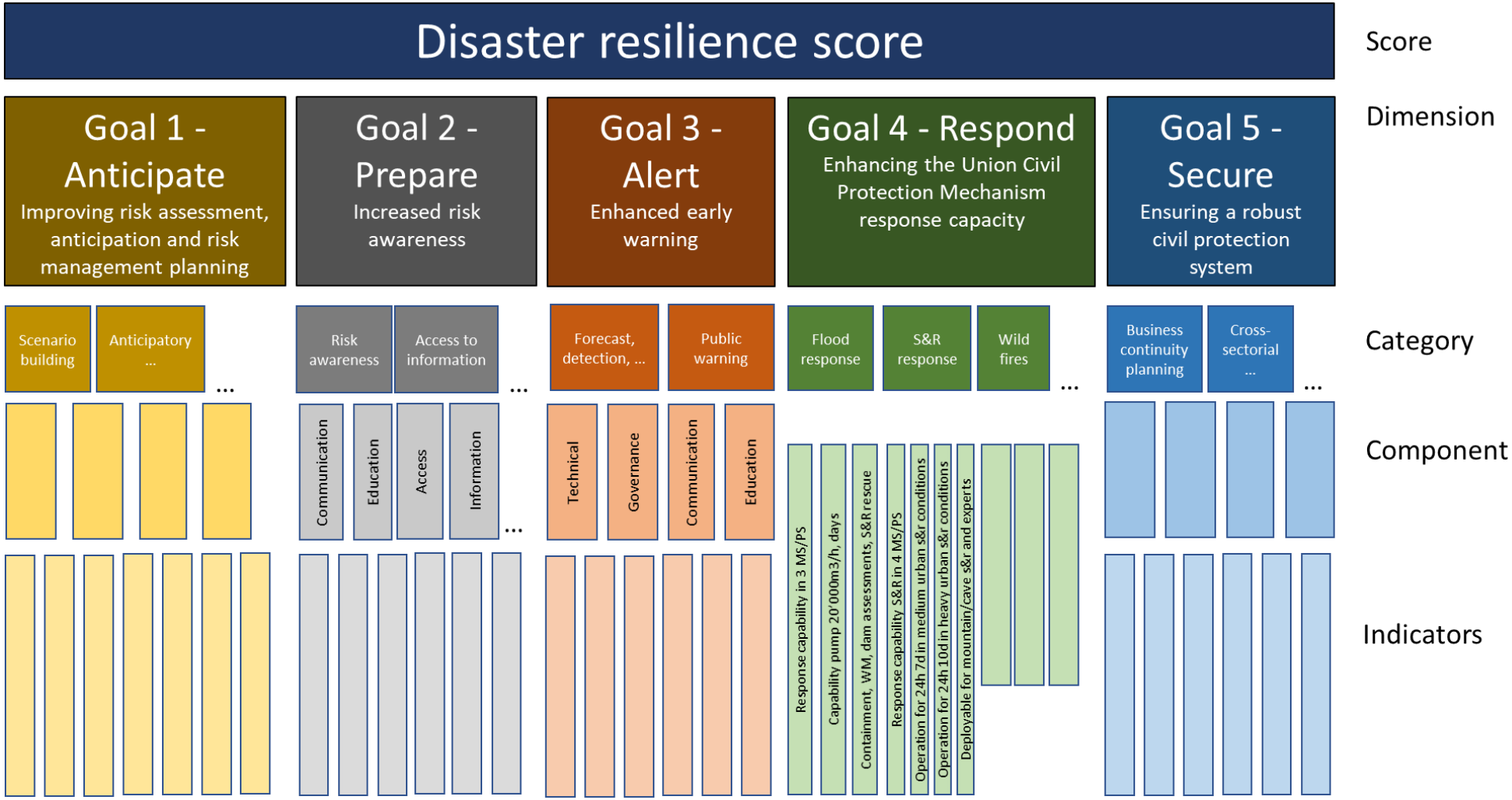
Source: JRC, 2021.

4.2. Composite indicator approach

The example of using the information in the Article 6 summaries, as presented in Section 4.1, cannot provide a complete picture of a potential DRG composite indicator framework. However, it can be complementary, in particular in cases for which there are currently no adequate indicators identified. It is important to point out again that indicators should be explored within specific topics by expert groups. DRG No 4 on UCPM response capacities is a good example of a goal for which quantitative indicators were developed by experts. Other goals are expressed in a qualitative manner and are inherently more difficult to pin down in indicators.

Figure 11 demonstrates the hierarchical decision tree designed for bottom-up assessment of the implementation of the DRGs. The top level is the score, then below it come the dimensions (goals), categories (specific objectives), components and finally indicators. Following this decision tree, an example of the resulting scores based on the indicators has been developed using the information provided in the summary reports submitted under Article 6.

Figure 11. Composite indicator framework for monitoring the implementation of the DRGs



NB: The structure is complete, but the number of categories, components and indicators is reduced for clarity. S&R = search and rescue.

Source: JRC, 2022.

Using the framework explored in this section, and the indicators developed from the analysis of information provided in the summaries submitted under Article 6 of the UCPM, **Figure 12** shows an example of the composition of one the dimensions (goals). It is possible to do this for most goals, but, to continue the exploration of this approach, further work will be required to better identify and define components and indicators under each category of the goals.

Figure 12. Example of how indicators from the analysis of information provided in the Article 6 summaries could be aggregated into components, categories and finally the dimension for DRG goal No 3 – Alert, enhanced early warning

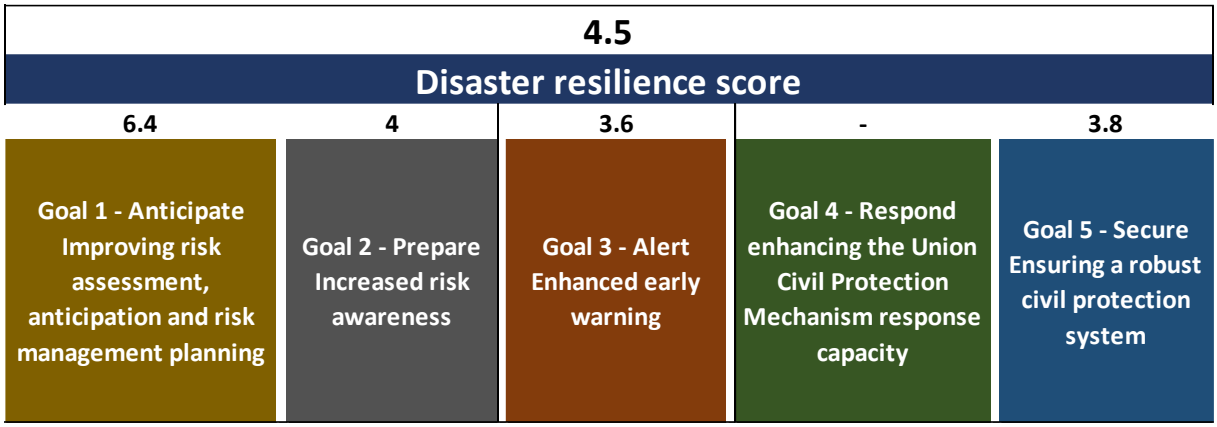
Indicators		Components		Category		Dimension	
Are systems in place for early hazard detection and monitoring of key risks?	8.6	Technical	**5.0**	Forecasting, detection and monitoring capability	**4.2**	**Enhanced early warning**	**3.6**
Are forecast methodologies integrated into the system?	4.8						
Are Copernicus services used?	1.6						
Are national EWS connected to EWS available at European and global levels?	5.2	Governance	**3.4**				
Are national EWS shared with other countries?	2.7						
Are links established to relevant departments (meteorological, seismic monitoring), academic institutions, nationally and regionally?	2.3						
Is something done to ensure that what is communicated by the EWS is understood and recipients know what to do?	1.8	Communication	**1.8**	Public warning	**3.0**		
Is there a strategy/another approach to educate the public and raise awareness?	5.5	Education	**4.2**				
Is that approach considering educating the public on the correct interpretation of warning signals?	3.0						

NB: EWS = early warning system.

Source: JRC, 2022.

Figure 13 shows the top layers, the dimensions (goals) and the final score. The aggregation is simplified to a certain extent, as more work needs to be done on the structure, as outlined in the previous paragraph. It is important to note that no score can currently be calculated for **DRG No 4 – Respond, enhancing the Union Civil Protection Mechanism response capacity**. This goal defines specific objectives in the area of response capacities. The overall aim is to provide operational and results-based indicators for these specific objectives that will support a concrete and measurable follow-up to the effort to strengthen EU-wide resilience in the civil protection sector through response capacities made available under the UCPM. This can certainly be developed into indicators; however, there is currently no established baseline, and the only available data are the final goals for the response capacity.

Figure 13. Simplified aggregation of indicators, based on the analysis of information provided in the Article 6 summaries, into a composite indicator



NB: There is currently no indicator data for DRG No 4, as indicated in the section above.

Source: JRC, 2022.

5. The Risk Data Hub as a data repository and possible reporting tool

Data play a central role in designing, implementing and evaluating the impact and effectiveness of the DRGs. Collecting and reporting data for the DRG targets and indicators can be very challenging because of:

1) the diversity of sources and data collection processes within countries and across different countries;
2) the heterogeneity of the taxonomies in use;
3) the diversity of methods for recording disaster-related damage and losses and for assessing risks.

The Disaster Risk Management Knowledge Centre **Risk Data Hub** could provide an infrastructure for collecting, hosting, treating and making available the data needed to assess the impact and effectiveness of the implementation of the DRGs.

Thanks to the adoption of a harmonised terminology for hazards, disaster loss indicators, assets and exposure and to the harmonising of its architecture, which allows storing, sharing and displaying different formats of data (text, tables and geospatial data) at different scales (from the single asset level to a pan-European level), the RDH could offer a possible solution for online reporting of disaster risks to complement Article 6 reports or self-assessments.

In general, the RDH offers a collaborative tool for disaster risk management that covers both the prevention and response phases. The portal can be classified as a web application that composes and displays maps of data analysed (risk analysis module ([16]), disaster loss data module ([17]) and external projects portal).

The RDH is a multi-context platform, as it can be used to access exposure and vulnerability assessments (useful for risk reduction), as well as a catalogue of historical events for analysing empirical vulnerabilities and trends. The output consists of various analyses based on available data. The RDH has been developed as a decision support system that integrates spatial data along with statistical analysis.

Countries' self-assessment reports (e.g. the reports submitted under Article 6 of the UCPM) could be adapted to be directly submitted to the information management system, either through the dedicated user corner section or through a newly designed functionality tailored to the DRGs.

The key advantages of expanding the RDH to enable reporting on the DRGs would be the following:

- The RDH enables statistics on indicators to be generated and presented in the form of a scoreboard. This allows refining of the indicators and inputs collected from Member States into actionable information that can be presented to decision-makers in a coherent and consistent way.
- The data collected can be visualised using maps, tables, charts or summary reports with different levels of detail and spatial and temporal scales (the information can be easily gathered, aggregated and displayed for the whole of Europe).
- The data collected for DRG purposes can be combined with other data sources available in the RDH (such as the vulnerability indicators) to gain more insight into the resilience of a country in the regional context.
- The data collected can be analysed in relation to the multi-scale risk assessments or disaster losses available in the RDH to monitor the impact of the DRGs as a disaster reduction measure.
- e-Reporting on the DRGs using the RDH can ensure coherence of content and a structured format for all reports and can facilitate the exploitation and analysis of the results and the availability of the reports at any time.

Using the RDH and the structure provided it would be possible to upload, analyse and visualise data at different geographical levels. In the current context of the development of the DRGs, Europe-wide and

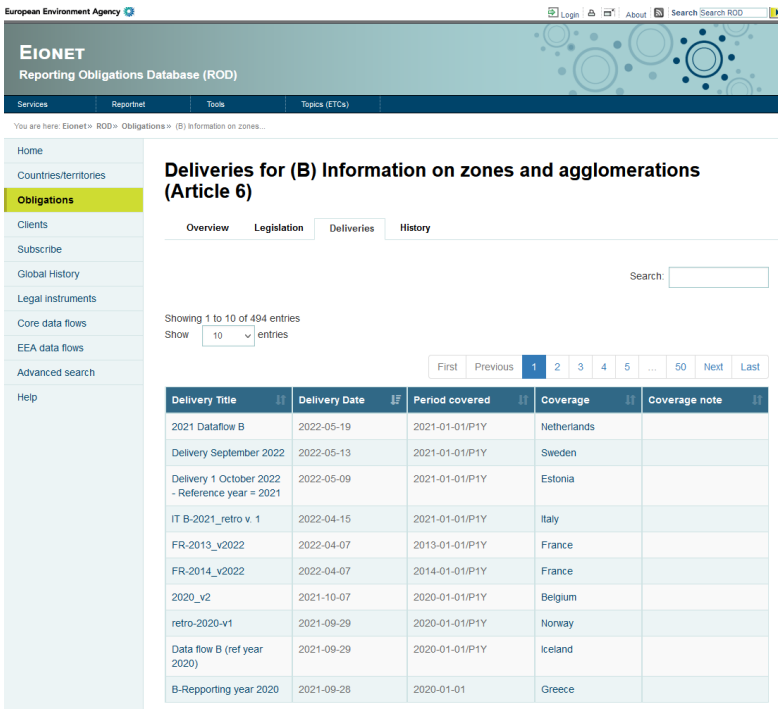
([16]) The risk analysis portal uses single hazard exposure analysis, which once uploaded triggers various types of continually changing calculations. First, a running code combines the exposure – assessed individually for different return periods – into an expected annual exposure (EAE). Second, a running code on the client side combines the EAE with the vulnerability index values, giving a value for risk. A multi-hazard selection on the map portal will trigger a code that will combine the single hazard exposures (EAEs) into a multi-hazard exposure.

([17]) The disaster loss data portal will trigger a code which disaggregates the recorded economic losses from past events into sectors/sub-types of economic losses.

country-specific levels would be the most relevant. However, in future it should be possible to disaggregate further and work with data on vulnerability at NUTS2 and NUTS3 levels, which refer to the local administrative level and individual/household level, respectively.

Reportnet, available on the European Environment Information and Observation Network (Eionet) Portal is an example of an e-reporting platform, initially used for reporting environmental data to the EEA, that has become the central tool for fulfilling for the EEA's reporting obligations (the Reporting Obligations Database (ROD)). Reportnet is a group of web applications and processes developed by the EEA to support international environmental reporting. It contains ROD ([18]) records that describe countries' environmental reporting obligations to international organisations. **Figure 14** shows an example of the main interface for consulting the MS/PS reports submitted under the ambient air quality directive (2011/850/EU) ([19]), also known as the implementing decisions on reporting.

Figure 14. Screenshot from the Eionet Reporting Obligations Database

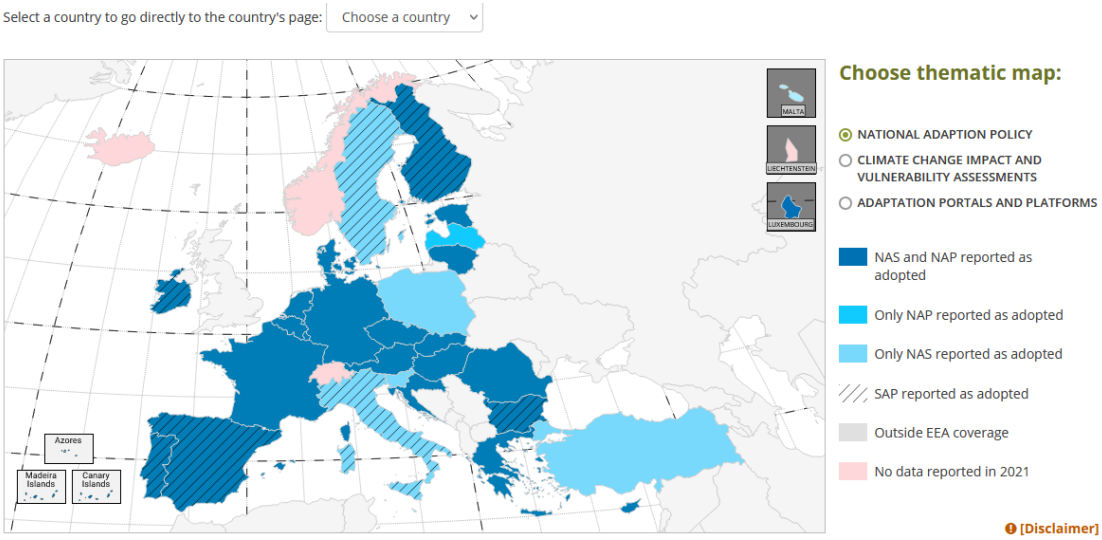


Source: Eionet, 2022.

Streamlining and centralising reporting and data services, as well as the information products, in a unique platform facilitates the monitoring of the content, data exchange, and the display and analysis of the reports submitted (**Figure 15**). This is exemplified in the country profiles made available on the Climate-ADAPT portal, which builds on the information and the national reports collected from the ROD under the national adaptation actions set out in the 2018 regulation on the governance of the energy union and climate action (Regulation (EU) 2018/1999) ([20]).

([18]) https://rod.eionet.europa.eu/.
([19]) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32011D0850.
([20]) https://eur-lex.europa.eu/eli/reg/2018/1999.

Figure 15. Thematic maps illustrate the reported status of and information provided by the EEA member countries on Reportnet and made available through the ROD



Source: Eionet, 2022.

6. Conclusions and next steps

This report explores some pathways for measuring the DRGs and monitoring their implementation. The work for the report was done in parallel with the work of developing the goals within the DPEG. The report focuses mainly on one approach, but it would be possible to explore other approaches in further detail, such as a purely qualitative or purely quantitative approach.

The tools and instruments proposed cover the panoply of approaches that can also be useful for implementing the DRGs. Other mechanisms such as stress-testing methods can be useful if they combine risk and resilience stress testing into a tiered approach tailored to systemic risks (Linkov et al., 2022).

Peer-reviewed assessment frameworks focusing on the area of disaster resilience and other self-assessments represent other instruments for assessing and monitoring resilience, as identified in the guidelines for conducting peer reviews published in February 2020 by the Technical Committee on Security and Resilience of the International Organization for Standardization ([21]).

Lastly, multi-hazard and dynamic impact scenarios combined with cost-benefit and multi-criteria analysis can also help in assessing the effectiveness of disaster risk reduction policies and options for the implementation of disaster resilience pathways (Zuccaro et al., 2018).

There is still work to be done to refine the composite indicators approach by complementing it with additional components, dimensions and associated indices. Taking ownership, trust and transparency are essential in that process, as is full alignment with the ongoing discussions with **MS/PS representatives** in DPEG and with the other expert groups. This approach also facilitates the potential integration of the approach into MS/PS national planning, embedding the sustainable building of resilience into the governance of risk.

There are also a couple of concrete steps that could benefit the work already presented in this report:

- introduce the concept of accessibility (or remoteness) and incorporate distance-decay metrics for the accessibility of the emergency services (e.g. hospitals, fire and rescue stations) relating to the infrastructural component of resilience (Jha et al., 2013);
- harmonise as far as possible the indicator dashboard across scales (national, NUTS2 and NUTS3) to enable further comparisons and improve the overall consistency of the index;
- expand the indicator dashboard and data especially at lower administrative levels (e.g. NUTS3), focusing on high-resolution statistical data collection and sampling.

In conclusion, different EU institutions and stakeholders are encouraged to participate in the design and data collection procedures. This will be essential to better address the key issues regarding the design and implementation of the DRGs.

([21]) https://www.iso.org/obp/ui/#iso:std:iso:22392:ed-1:v1:en.

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Abbreviations and definitions

DPEG	Expert Group for Disaster Prevention and Risk Management
DG ECHO	Directorate-General for European Civil Protection and Humanitarian Aid Operations
DRG	disaster resilience goal
EEA	European Environment Agency
Eionet	European Environment Information and Observation Network
JRC	Joint Research Centre
MS/PS	Member State/participating state
NAP	national adaptation plan
NAS	national adaptation strategy
NRA	national risk assessment
NUTS	Vulnerability levels
RDH	Risk Data Hub
RMCA	risk management capability assessment
ROD	Reporting Obligations Database
UCPM	Union Civil Protection Mechanism
UNDP	United Nations Development Programme

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Annexes

Annex 1. Mapping of disaster resilience measurements

Measurement	Developer/ affiliation	Focus	Components	Smallest unit of analysis	Methodology	Participatory?	Data sources	Stage of development
National level								
Hyogo framework for action (HFA) monitor	UNISDR (globally)	Progress towards HFA using 31 indicators on three levels (outcomes, goals, priorities)	Indicators for the outcome, three strategic goals and five priority areas	Local government or country	Self-assessment by governments on scale from 1 to 5; mostly input related	Yes (self-assessment)	Primary (self-assessment)	Implementation; 2009, 2011 and 2013
WorldRiskIndex	UNU-EHSNAL	Disaster risk value for 173 countries	Exposure, susceptibility, coping capacities, adaptation	Country	Quantitative; weighted composite index with 28 indicators	No	Secondary data only	Implementation; annually since 2011
Global Focus Model	UN OCHA and Maplecroft	Hazards, vulnerabilities and response capacity at country level	hazard, vulnerability, capacities, humanitarian need	Country and region	Quantitative; weighted composite index	No	Secondary data only; some data from Maplecroft's proprietary indices	Implementation; annually since 2007
Socioeconomic resilience index	Maplecroft	Socioeconomic resilience as part of a natural hazards risk atlas	Not known	Country	Not known	No	Not known	Implementation; at least since 2011; only paid access
Risk reduction index	DARA	Measurement of underlying risks; so far Latin America and western Africa	Environment and natural resources, socioeconomic conditions, land use and the built environment, governance	Country	Mostly qualitative; local perceptions about underlying risk using key informants	Yes (perception surveys)	Primary data (questionnaire, workshops)	Implementation; partially since 2010

Prevalent vulnerability index	Inter-American Development Bank	Part of a set of four indicators that measure the potential impact of natural hazards	Exposure, susceptibility, socioeconomic fragility and resilience	Country (but also sub-national)	Composite index consisting of three sets of eight high-level indicators	No	Secondary data only	Implementation; partially in Latin America
Country resilience rating	World Economic Forum	Resilience of countries to global risks	Robustness, redundancy, resourcefulness, response and recovery	Country	Mix of quantitative (mostly existing indices) and perception data	Yes (perception surveys)	Secondary data and perception surveys	Indicators defined
AGIR results framework	AGIR	Food and nutrition resilience in Sahel and West Africa	Four impact indicators and a set of outcome indicators for 4 objectives	Country	Quantitative and qualitative sets of individual indicators for each objective	No	Secondary data; indicators drawn from existing programmes and initiatives	Indicators defined
Post-2015 indicators for disaster risk reduction	UNISDR	Disaster risk reduction including economic resilience	Not defined, but might refer to economy, capital stock, investment and saving levels, trade flows, insurance penetration, fiscal resilience, social protection, etc.	Not defined yet	Not defined yet	No	Secondary data only	Planning; indicators only partially defined

Measurement	Developer/affiliation	Focus	Components	Smallest unit of analysis	Methodology	Participatory?	Data sources	Stage of development
Sub-national level								
Resilience capacity index	Network on Building Resilient Regions	Single statistic summarising a region's score on 12 equally weighted indicators in the United States	Economic, socio-demographic, community connectivity capacities	US communities	Numerical indicators; some use of existing composite indicators	No	Secondary data only	Implementation: data for United States
Baseline resilience indicators for communities	Hazards, Vulnerability & Resilience Institute, University of South Carolina	Set of indicators based on the Disaster Resilience of Place model	Ecological, social, economic, infrastructure, Institutional, competencies	Communities	Numerical and yes/no indicators; use of existing composite indicators	No	Secondary data only	Implementation; partially in South Carolina, United States
ResilUS	Huxley College of the Environment, Western Washington University	Prototype simulation model of community resilience in the United States	Recovery module, loss estimation module	US communities	Not known	Probabilistic methods	Secondary data only	Implementation; prototyping in 3 study areas
Tsunami recovery impact assessment and monitoring system	Indonesia, Sri Lanka, Maldives, Thailand, IFRC, WHO, UNDP	Common approach to monitoring recovery efforts and assessing impact in four countries affected by the 2004 tsunami in Asia	Vital needs, basic social services, infrastructure, livelihoods	Indonesia, Sri Lanka, Maldives, Thailand	28 quantitative output indicators, 20 outcome indicators and 3 impact indicators on recovery	Includes qualitative tools in addition to indicators	Secondary and primary data; qualitative data for triangulation	Implementation; (in Indonesia, Sri Lanka, Maldives, Thailand)
DRLA/UEH evaluation	Tulane University / University of	Model to measure the relationship	Wealth, debt and credit, coping behaviours,	Households	Quantitative composite indicators and	Yes (surveys)	Primary data (surveys and	Implementation (in Haiti)

resilience framework for Haiti	Haiti	between a shock, humanitarian assistance and resilience	human capital, protection and security, community networks, and psychosocial status		qualitative tools		focus groups)	
Indonesia disaster recovery index	Government of Indonesia	Measurement of recovery after volcano eruption and floods in Indonesia	22 recovery variables	Communities in Indonesia	Household survey and longitudinal data	Not known	Primary data (household surveys)	Implementation (in Indonesia)
FAO resilience tool	FAO	Root causes of household vulnerability	Assets, income and food access, access to basic services, social safety, adaptive capacity, stability	Communities	Quantitative indicators combined into an overall 'resilience score'	No	Secondary data only	Implementation (in selected areas)
Livelihoods Change Over Time	Tufts University, Mekelle University	Ability to 'bounce back' from major regional food security crises in northern Ethiopia	Three types of analysis: (1) household welfare over time, (2) food security dynamics, (3) poverty traps	Households	Quantitative indices; poverty traps framework from Carter & Barrett	Yes (self-reports)	Secondary and primary data (four rounds of a household survey over 2 years)	Implementation (in selected areas)
PEOPLES resilience framework	Multidisciplinary Center for Earthquake Engineering Research	Comprehensive measurement framework building upon MCEER R4 resilience framework	Population and demographics, environmental/ecosystem, services, infrastructure, lifestyle, economic, social–cultural	Communities	Mix of quantitative data; use of existing composite indicators	Not known	Secondary data only	Potential indicators identified
Community-	UNDP Drylands	Universal and	Survival and	Households (for	Numerical and	Yes (interviews,	Primary data	Potential indicators

based resilience analysis	Development Centre	context-specific measurement framework for resilience	livelihood protection threshold; physical, human, financial, natural and social	meta-indicator), communities	yes/no indicators; qualitative data	focus group discussions)	collection in combination with secondary data	identified
Minimum characteristics of NRRC	Nepal Risk Reduction Consortium (NRRC)	Suggested indicator framework on the output level	Institutional, information, assessments, teams, plans, funding, infrastructure, warning systems	Communities in Nepal	Mostly yes/no and numerical indicators	No	Primary data collection required in most cases	Potential indicators identified
USAID resilience domain framework	USAID	Results matrix with a set of indicators for three objectives and the goal	Income and access to food, assets, adaptive capacity, social capital and safety nets, governance, nutrition and health	Communities	Numerical indicators	Yes (self-perception survey)	Secondary and primary (surveys) data	Potential indicators identified (piloted in Kenya and Ethiopia)
Expert consultation on resilience measurement for food security	FAO/WFP	Proposed framework for measuring food security resilience	Four set of indicators for baseline well-being and basic conditions, disturbances, response, and end-line well-being	Not known	Numerical indicators	No	Secondary data	Indicators defined

ODI disaster risk management indicators	ODI	Indicators and targets for disaster risk management for post-2015 development goals with an emphasis on economic impacts	Indicators on impact, outcomes, outputs and inputs for international, national, sub-national and local levels	Individuals, households and communities	Numerical sets of individual indicators organised by levels in a matrix	No	Secondary data only	Indicators defined
Basket of indicators of economic resilience	London School of Economics and Political Science	Economic lens to complement more direct humanitarian and poverty reduction goals	Set of 10 economic indicators on input, output, outcome and impact level	Communities	Numerical indicators	No	Secondary data only	Indicators defined
Resilience costs approach	Institute of Development Studies	Measurement of costs of resilience (social, psychological, ecological, etc).	*Ex ante* investments, cost of destruction, *ex post* costs of recovery	Households and communities	Not known	Not known	Not known	No measurement framework
MCEER R4 resilience framework	Multidisciplinary Center for Earthquake Engineering Research	Measurement framework with a focus on infrastructure	Robustness, redundancy, resourcefulness, rapidity	Communities	Not known	Not known	Not known	No measurement framework
Network of adaptive capacities	Norries (2008)	Theory of community resilience	Economic, social, information and communication, community competencies	Communities	Not known	Not known	Not known	No measurement framework

NB: AGIR, Global Alliance for Resilience Initiative; DRLA, Disaster Resilience Leadership Academy; FAO, Food and Agriculture Organization of the United Nations; IFRC, International Federation of Red Cross and Red Crescent Societies; MCEER, Multidisciplinary Center for Earthquake Engineering Research; ODI, Overseas Development Institute; UEH, University of Economics Ho Chi Minh City; UNISDR, United Nations Office for Disaster Risk Reduction; UN OCHA, United Nations Office for the Coordination of Humanitarian Affairs; UNU-EHS, United Nations University Institute for Environment and Human Security; USAID, United States Agency for International Development; WFP, World Food Programme; WHO, World Health Organization.

Source: Winderl, 2014.

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