

Monitoring and evaluation of national adaptation policies throughout the policy cycle





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Executive summary

Notwithstanding the extremely important efforts to keep global warming well below 2 °C, as set out in the Paris Agreement, adaptation is a necessity. The Global Goal on Adaptation, established in the Paris Agreement, aims to enhance adaptive capacity, strengthen resilience and reduce vulnerability to climate change. Given the impact of climate-related hazards, as well as of slow-onset events (such as sea level rise), the question is not whether adaptation is necessary, but what are the adaptation options to increase resilience.

Adaptation policies need to be developed to avoid or reduce the negative impact of the current and future climate. Details of the impact of climate-related hazards can be found in various EEA products, such as reports (e.g. EEA, 2017b), indicators (e.g. EEA, 2019d) and novel formats like story maps (e.g. EEA, 2020).

Unlike climate change mitigation, there is no universal unit of measurement for adaptation. The perceptions of effectiveness and even success vary. Focusing on national-level adaptation and measuring the change in overall vulnerability may leave open the questions 'vulnerability of whom?', 'to what?' and 'who decides?', which is likely to lead to the views of local, less powerful stakeholders and especially vulnerable groups being obscured (Dilling et al., 2019).

The central question remains: 'Are we getting more resilient?' Nowadays, none of the adaptation policies and frameworks fully answers that question. Increased awareness of adaptation is, however, often seen as a proxy for increased adaptive capacity and one of the elements used to measure the success of adaptation policies.

Progress in national adaptation policies

In April 2020, all EU Member States and all except one of the EEA member countries had an adaptation policy in place. In almost every country, a national adaptation strategy (NAS) was developed first, mostly followed by a national adaptation plan (NAP). Since the adoption of the EU adaptation strategy in 2013, the number of countries with a NAP more than doubled to 21 in April 2020. Eleven EEA member countries have already adopted a second or revised NAS and more are in the process of doing so.

'Is our society getting more resilient?'

Notwithstanding the success in terms of numbers, to the extent that all EEA member countries except one have adaptation policies adopted, the idea of what a NAS or NAP should cover remains underdeveloped. Consequently, there is a huge variety in level of detail and issues covered from country to country. In our understanding, a well-developed NAS articulates a (long-term) vision of how to deal with climate change impacts. It describes the horizontal and vertical coordination structures and identifies the various stakeholders and areas of action (sectors or themes). Compared with the NAS, the NAP then ideally has a shorter time horizon (roughly up to a decade). The NAP specifies how the NAS is implemented and by whom, preferably including the expected expenditure too. The level of detail varies, taking into account the lifetime of the NAP and the specific national context.

There is increased coherence between adaptation and diverse related policy fields, and more adaptation aspects are integrated into other (e.g. sectoral) policies. This mainstreaming of adaptation requires specific monitoring by those responsible for these policies and fit-for-purpose reporting to the bodies coordinating adaptation policies to allow a fair and complete evaluation of the adaptation policies.

Climate change assessments and knowledge

Adaptation planning is often based on conditional, uncertain or otherwise incomplete understanding of changing climate risks. Thus, monitoring, reporting and evaluation (MRE) is also expected to continuously improve existing knowledge on climate change impacts and vulnerability and/or to help identify key challenges, opportunities and remaining knowledge gaps.

Over recent years, climate change impact and vulnerability (CCIV) assessments have been more extensively using climate and socio-economic scenarios as well as results from climate change impact models, including information on economic costs, human health and ecosystems.

Notwithstanding these improvements, more holistic and partly detailed CCIV assessments are needed for compound and cascading hazards (multi-risk assessments), as well as for the transboundary and cross-border impacts and spill-over effects in between sectors. As national risk assessments have parts in common with CCIV assessments, there is a need to intensify coordination efforts in countries where this is currently not the case and to further streamline joint efforts to increase the coherence and complementarity among policy areas.

Monitoring, reporting and evaluation

MRE serves multiple purposes such as tracing progress made, assessing what has been accomplished and communicating the processes and outcomes of adaptation. It provides feedback on adaptation progress and performance, namely whether the adaptation goals, targets and efforts are sufficient and how they contribute to reducing vulnerability to climate change (Berrang-Ford et al., 2019). But the overarching goal of MRE is to enable 'new information and lessons learned to shape future decisions' (EEA, 2015b) within an iterative policy- and agenda-setting cycle.

To evaluate adaptation policies, programmes, measures, etc., and criteria such as their effectiveness, efficiency or coherence, it has to be clear what they are being evaluated against. Therefore, useful MRE does not start at the very end of the adaptation policy cycle but is included in every step: by setting goals and well-defined objectives that are as specific as possible in planning documents and when identifying and assessing options, as well as monitoring over time the baseline conditions and progress. The evaluation itself needs to be a specific and separate effort to focus on getting deeper insights into some elements and to progress from these insights, feeding back into adaptation policy revision. Only a limited number of countries gained deeper insights through evaluation.

MRE has the potential to be a key means of informing more effective adaptation implementation. Over time, there will be greater clarity on what works and what does not, and this will help to avoid maladaptation.

Adaptation indicators

MRE can support adaptation across all levels of governance. The scope and objectives of MRE, however, vary from the international to the national and further to the local levels. Indicators are a key way to connect levels and seek synergies, but they are not necessarily directly transferable across levels and policy domains.

There is high demand for supporting the development of adaptation indicators, and the first sets of national-level adaptation indicators are operational in Europe. These indicators support mainly monitoring of adaptation, and experience of their use for evaluation is still limited. Evaluation of adaptation policies and their implementation benefits from the use of mixed methods, whereby quantitative and qualitative information and evidence from multiple sources, such as indicator data and stakeholder views, are combined.

Considering the cross-cutting nature and the importance of mainstreaming climate change adaptation across different sectors, aiming for synergies with other communities and creating integrated visions as well as joint efforts is an (and perhaps **the**) effective and efficient way forward. Although national adaptation indicators should be based on specific evaluation questions for each NAS and NAP, one can imagine a small set of European adaptation indicators, e.g. indicators relevant for adaptation that have already been prepared under the scope of the Sendai Framework for Disaster Risk Reduction or the Sustainable Development Goals. As most of the indicators for the global frameworks are of a basic nature, they should not be seen as a replacement for, but rather as complementary to, the national evaluations undertaken.

Adaptation finance

Financial support is key in enabling adaptation action. To measure the efficiency of the investment, necessary and planned expenditures as well as actual spending should be known. Although the total need for investment is typically information that relates to the long-term vision (ideally a part of the NAS), planned expenditure is related to different programmes of measures (and expected to be part of a NAP), and monitoring the actual spending indicates how well implementation is on track. Although progress is slowly being made, much of this information is still missing today.

Public finance is increasingly being directed towards climate change adaptation (e.g. through European structural funding programmes), but private sector finance is harder to identify. Awareness raising will be needed for this to come on stream, and MRE of adaptation financing from both public and private sources needs to evolve.

The final report of the technical expert group doing the preparatory work on the EU taxonomy for sustainable finance contains recommendations relating to the overarching design of the taxonomy, as well as guidance on how companies and financial institutions can make disclosures using the taxonomy (TEG, 2020a). The report is supplemented by a technical annex containing an updated list of technical screening criteria for economic activities that can substantially contribute to climate change mitigation or adaptation, including an assessment of significant harm to other environmental objectives (biodiversity, water, pollution and a circular economy) (TEG, 2020b). The Council of the EU has adopted the Taxonomy Regulation which, for climate change mitigation and adaptation, should be established by the end of 2020 (EU, 2020).

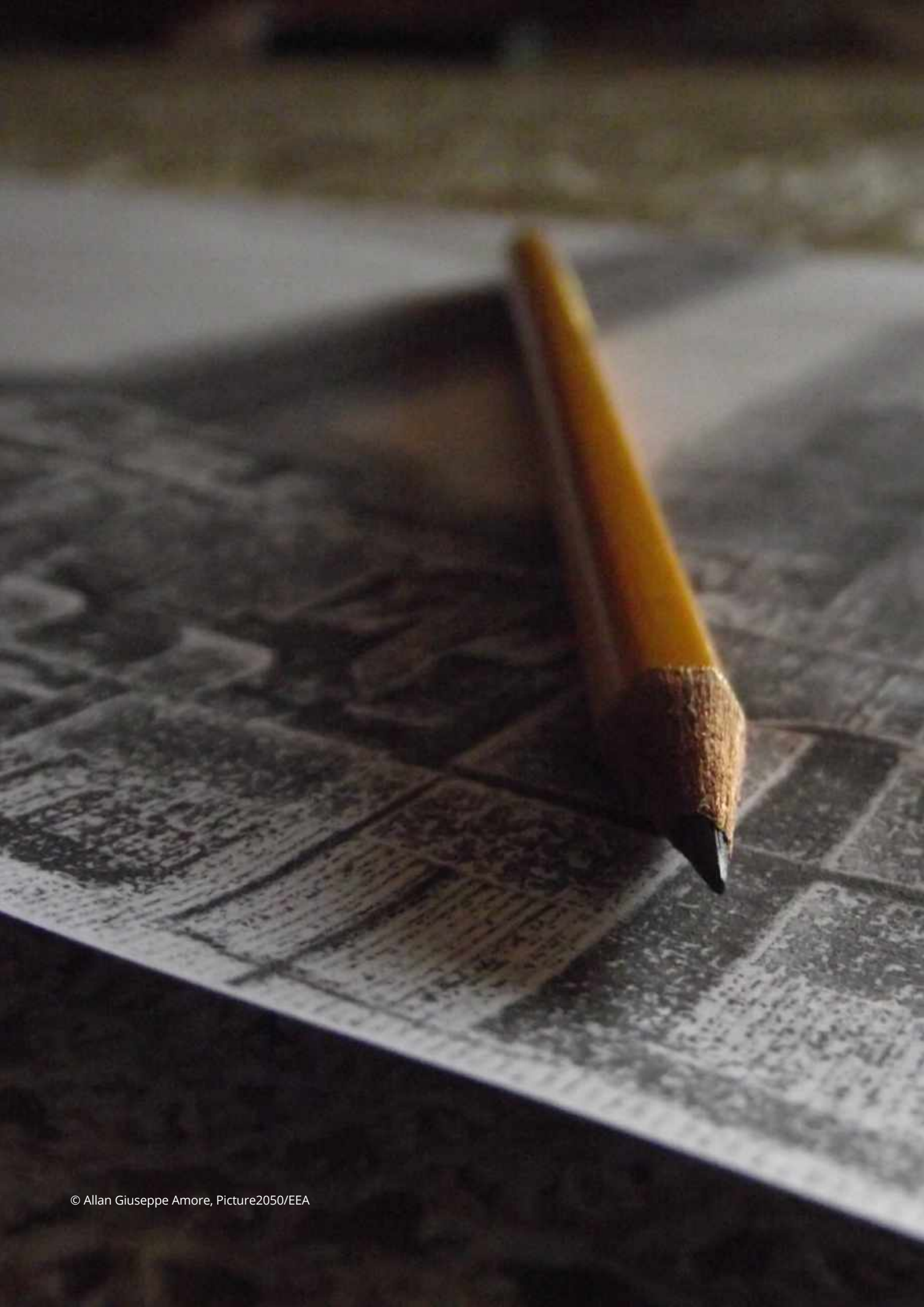
European Commission guidelines on climate-related reporting (EC, 2019f) do recognise that companies will benefit from better disclosure of climate-related information. Improvements envisaged are the increased awareness and understanding of climate-related risks and opportunities, improved risk management, better informed decision-making and improved strategic planning, better and more constructive dialogues with stakeholders (e.g. investors and shareholders), an enhanced corporate reputation and a more diverse investor base.

Learning and stakeholder engagement

As more countries gain experience of implementing national adaptation policies, information from monitoring and evaluating activities has emerged as a significant source of knowledge for developing adaptation policies, actions and measures. Understanding what works, under which conditions and why offers insights on which countries can draw to revise and further improve their adaptation policies. Learning is a key function of MRE for adaptation policies. Lessons learned on progress, outcomes and impacts in particular enhance adaptation policies and practices when monitored against specific targets.

Co-production of knowledge and various forms of stakeholder engagement have progressed in recent years and participatory approaches are common in adaptation policy development and MRE, contributing to further building up resilience and increasing adaptive capacity. Stakeholder engagement processes can help to ensure uptake from sectoral stakeholders and thus strongly support implementation. This varies between statutory requirements (such as climate acts) and voluntary approaches, under which stakeholder engagement comes more strongly into play in implementing the measures envisaged in adaptation action plans.

Stakeholder engagement is crucial for MRE, first, to receive relevant quantitative and qualitative data for monitoring the process and progress and, second, for interpreting the available data and deriving relevant messages from it. Thus, MRE is essential in contributing to further building up resilience and increasing adaptive capacity in EEA member countries.



Aim, scope, outline and reading guidance

Aim of the report

Monitoring*, reporting* and evaluation* (MRE) ⁽¹⁾ was identified as an emerging area in the EEA's 2014 report on national adaptation policy processes (EEA, 2014a) and was further described in its 2015 technical report *National monitoring, reporting and evaluation of climate change adaptation in Europe* (EEA, 2015b). The need for sharing lessons learned on MRE has been continually increasing ever since. Over the last 5 years, lots of progress has been made globally in policy fields connected to adaptation, such as sustainable development or disaster risk reduction, and at national level with the development and implementation of national adaptation policies and, already in several cases, the revision of them.

This report provides an overview of country developments in terms of strategies and plans for climate change adaptation (CCA) and their implementation in a context of global and European policy frameworks ⁽²⁾. The report brings together lessons learned — at the national level — on adaptation MRE, future directions and opportunities for mutual learning on evaluating CCA strategies and plans at national and European levels ⁽³⁾ and the implications of emerging reporting requirements from relevant EU policies ⁽⁴⁾ to improve evaluation at the EU level.



WORKING DEFINITIONS ⁽⁵⁾

Monitoring aims to map climate change impacts and adaptation efforts across actors (and sectors or policy fields) via criteria or indicators and showcases changes over time.

Reporting aims to showcase and present the monitoring results to a broader audience and make the experience gained and lessons learned available to all kinds of stakeholders.

Evaluation classifies and assesses the mainstreaming efforts, based on the monitoring criteria and indicators.

Monitoring is usually undertaken on an ongoing basis, while reporting and evaluation are typically only conducted at specific, usually strategic, points in time.

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- ⁽¹⁾ See the glossary for definitions of terms marked with an asterisk (*) in the text. Some key definitions are also given boxes in the main text as well as appearing in the glossary.
 - ⁽²⁾ Global policy frameworks include the Paris Agreement (UNFCCC, 2015), the Sendai Framework on Disaster Risk Reduction (UNDRR, 2020) and the Sustainable Development Agenda 2030 (UN, 2017c). European policies include the EU adaptation strategy (EC, 2013c, 2018b, 2018e), the Regulation on the Governance of the Energy Union and Climate Action (EU, 2018b) or the EU Civil Protection Mechanism (EU, 2019b).
 - ⁽³⁾ Such as the development of a revised EU adaptation strategy and its impact assessment.
 - ⁽⁴⁾ Formal reporting on adaptation by EU Member States will no longer take place under the Monitoring Mechanism Regulation Art. 15 but under the Energy Union and Climate Action Governance Regulation Art. 19 (EU, 2013b, 2018b).
 - ⁽⁵⁾ Across European countries, slightly different definitions are in use. The definitions used in this report are relatively general to cover as far as possible all national situations and are not put forward to replace definitions already in place.

Scope

The EU strategy on adaptation to climate change (EC, 2013c), also known as the 'EU adaptation strategy', and the evaluation of the EU adaptation strategy (EC, 2018a, 2018b, 2018e) highlighted multiple issues covered by the topics addressed in this report:

- Support for the development of national adaptation policies was the focus of a specific action of the EU adaptation strategy, but the following stages in the policy cycle, namely implementation of adaptation actions and its monitoring and evaluation (see Section 1.2) were only touched upon lightly. A revised EU adaptation strategy could have the latter elements more at its core, and this report supports that by providing an overview of concepts and recent developments, e.g. on financing implementation, ecosystem-based solutions and climate-proofing of infrastructure.
- Although cross-cutting in nature, there is a need for dedicated adaptation planning. Priorities, synergies and conflicts and mainstreaming of adaptation all happen in a specific context, in which the involvement of relevant stakeholders (multiple stakeholders, including the private sector) is essential for a sound and successful implementation.
- Key knowledge gaps defined in 2013 were:
 - information on damage and adaptation costs and benefits;
 - regional- and local-level analyses and risk assessments;
 - frameworks, models and tools to support decision-making and to assess how effective the various adaptation measures are; and
 - means of monitoring and evaluating past adaptation efforts (EC, 2013c, Action 4).
- The evaluation of the EU adaptation strategy was mainly a process or implementation evaluation, determining whether activities have been implemented as intended without the ability to evaluate their quality. Although the 2013 impact assessment of the EU adaptation strategy (EC, 2013a) sets out numerical targets, these targets were not appropriate for measuring real progress. If we are to evaluate the outputs*, results* and impacts* of a strategy ⁽⁶⁾, this report demonstrates the need for clear objectives (measurable steps) instead of only goals (broad primary results), as well as frameworks for monitoring and reporting.
- A revision of the EU adaptation strategy is expected ⁽⁷⁾ to address directly and more explicitly the multiple levels of governance (European, national and sub-national), while considering transnational aspects of adaptation and international (global) developments.
- Nowadays, although adaptation policies — be it at EU or national level — refer to a variety of frameworks, goals and tools, none of them is able to fully answer questions about increased resilience or adaptive capacity. Increased awareness of adaptation is, however, often seen as a proxy for increased adaptive capacity and one of the elements of measuring the success of the adaptation policies. This report cannot provide definitive answers to these questions, but it discusses some of the prerequisites for a meaningful evaluation of policies and their implementation and gives examples of good practice from European countries.

Assessing progress towards the global goal on adaptation, originating from the Paris Agreement, with the limited information available is done by the *Adaptation gap reports*, and in particular the one on monitoring and evaluation — 'towards global assessment' (UN Environment DTU Partnership, 2017). This report focuses in more detail on the European and national scales (of the EEA's member countries) while fitting within the overall global framework.

Many of these knowledge gaps have not yet been fully bridged, and new ones have emerged.

⁽⁶⁾ Outputs, results and impacts as understood in the 'Better regulation toolbox' (EC, 2017b), e.g. tool no 47, Evaluation criteria and questions.

⁽⁷⁾ Taking into account the subsidiarity principle (outside the scope of this report).

Outline and reading guidance

The withdrawal of the United Kingdom from the European Union did not affect the production of this report. Data reported by the United Kingdom are included in all analyses and assessments contained herein, unless otherwise indicated.

Therefore, in all overviews and examples and where the number of countries is counted, the United Kingdom is included when we refer to the EU-28 (the 28 EU Member States) and the EEA-33 (the 33 EEA member countries).

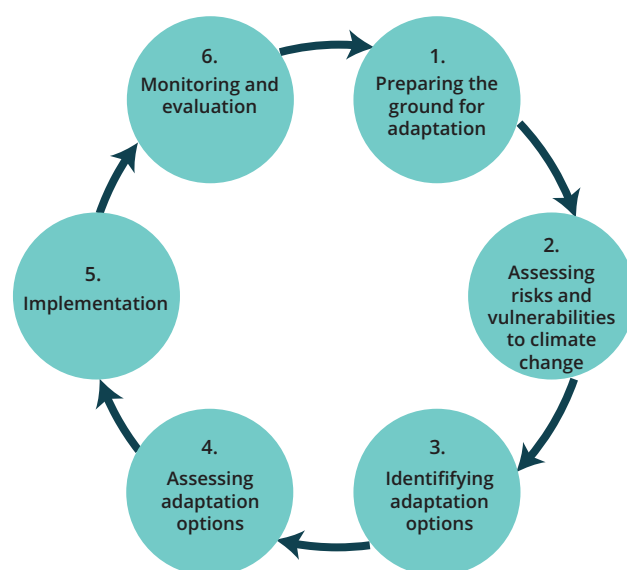
The first chapter of this report summarises EU and global policies relevant to the policy landscape in which CCA takes place (Section 1.1). Sections 1.2-1.4, respectively, introduce and summarise progress in national adaptation policies (details in Chapter 2), their implementation (details in Chapter 3) and MRE (details in Chapter 4).

The second chapter describes the knowledge base for developing adaptation policy. It includes aspects of several stages of the adaptation policy cycle, from preparing the ground for adaptation to assessing risks and vulnerabilities (see Section 2.1). The third chapter focuses on the implementation of adaptation policies, including aspects such as mainstreaming of adaptation and the conditions to support it.

The fourth chapter on MRE is key to the circular notion of the adaptation policy cycle. The question 'Is our society getting more resilient?' is not easy to answer and cannot be answered without evaluating the national adaptation policies and actions. An evaluation cannot be undertaken properly if it is unclear what is being evaluated and how progress is measured. Therefore, MRE cannot be done as the last step of the cycle but needs to be built in to each and every step. That is also done in this report: the MRE aspects are present in each of the chapters in this report (see in particular Sections 2.4 and 3.4). The fifth chapter gives an overview of lessons learned and an outlook for future developments.

The structure of this report, as explained above, broadly follows the adaptation policy cycle, and the different steps are explained in the adaptation support tool (AST), available on Climate-ADAPT (see Figure 0.1). Chapter 2 covers the knowledge base including several aspects from steps 1-3 in the AST, Chapter 3 is on implementation (step 5 in the AST) and Chapter 4 on MRE (step 6 in the AST).

Figure 0.1 Adaptation policy cycle, based on the adaptation support tool



Source: Climate-ADAPT (<https://climate-adapt.eea.europa.eu/knowledge/tools/adaptation-support-tool>).

Target audience for this report

The main audience we had in mind when writing this report is experts involved in national adaptation policies, strategies and plans and those involved in climate change (adaptation) at the European level. This report is also meant as an input for managers in sectors and activity fields that are mentioned in national adaptation plans and those who are responsible for the measures described therein.

Given the importance of stakeholder involvement, the financing of measures and principle of **working with nature instead of against it**, experts in these fields will find useful information in this report too.

Foundations of this report

Since the report on national adaptation policy processes (EEA, 2014a), the EEA has continued to work with and support its member countries on adaptation policies. The following reports give you an overview of those particularly focusing on aspects of MRE⁽⁸⁾. This report updates previous reports in which information had become outdated and it also covers new issues complementary to those covered in the reports below.

- *National adaptation policy processes in European countries — 2014* (EEA, 2014a). This report presents the findings of a self-assessment questionnaire on national adaptation policy processes in Europe. MRE was one of the key topics explored in this report, which acted as the springboard for the EEA-ETC/CCA work that followed later on in this field.
- *National monitoring, reporting and evaluation of climate change adaptation in Europe* (EEA, 2015b). This report provides insights into adaptation monitoring, reporting and evaluation systems at the national level in Europe. At the time of its publication, it constituted the first attempt to consolidate emerging information across European countries. Among other things, the report demonstrated the importance of and interest in countries sharing their experiences, especially when it comes to the methods that can be used to monitor and evaluate adaptation policies.
- *Climate change, impacts and vulnerability in Europe 2016 — An indicator-based report* (EEA, 2017b). This fourth edition of the Climate change, impacts and vulnerability in Europe report aimed to support the implementation and evaluation of the 2013 EU adaptation strategy, which took place in 2017–2018, and the development and implementation of national and transnational adaptation strategies and plans. It includes detailed information on types of climate change indicators.
- *Monitoring, reporting and evaluation of national level adaptation in Europe: Lessons and experiences from other policy domains* (ETC/CCA, 2017). Transferable lessons learned from evaluation communities working in the policy fields of biodiversity, adaptation and international development, and sustainability may inform MRE systems for CCA. The aim of this working paper is to reveal insightful, inspirational and relevant perspectives for those working on MRE systems for adaptation in Europe, in particular at the national level.

- *National climate change vulnerability and risk assessments in Europe 2018* (EEA, 2018a). This report presents an overview of national climate change impact, vulnerability and risk assessments. It is also intended as an input to the review of the EU adaptation strategy.
- *Indicators for adaptation to climate change at national level — Lessons from emerging practice in Europe* (ETC/CCA, 2018b). The specific focus of this technical paper is adaptation indicators and indicator sets, and it is accompanied by an online database with examples of adaptation indicator sets from different European countries⁽⁹⁾. This paper forms the basis of Chapter 4 in this report.

This report also makes use of country information that has become available in recent years.

- For EU Member States, the 'country scoreboards', as published in a staff working document (EC, 2018a), which is part of the evaluation of the EU adaptation strategy. While there were some methodological limitations, countries that are in the earlier stages of their adaptation planning may find these assessments useful for identifying relevant dimensions of the adaptation policy process. For countries with more established adaptation policies and programmes, the scoreboard indicators can work as a useful tool for benchmarking and reflection (ETC/CCA, 2018b).
- Mandatory for EU Member States and on a voluntary basis for non-EU EEA member countries⁽¹⁰⁾, the reporting from March 2019 under Article 15 of the Monitoring Mechanism Regulation (EU, 2013b), as published in the country profiles of Climate-ADAPT (<https://climate-adapt.eea.europa.eu/countries-regions/countries>).
- For all EEA member countries, all being Annex I Parties to the Kyoto Protocol, the adaptation information in the Seventh National Communication⁽¹¹⁾, due by the end of 2017. Due to the structure of this reporting, which is a free text format with less structured questions than the sources above, this information is not assessed in a systematic way but used to collect additional information and examples of good practice.

⁽⁸⁾ For all EEA reports on adaptation, see <https://www.eea.europa.eu/themes/climate-change-adaptation/publications>.

⁽⁹⁾ See ETC/CCA (2018b) for a detailed description of the online database that is available at https://www.eionet.europa.eu/etcs/etc-cca/products/etc-cca-reports/tp_3-2018/annex_tp_3-2018.xlsx.

⁽¹⁰⁾ The EEA member countries are the EU Member States, the four European Free Trade Association countries (Iceland, Liechtenstein, Norway and Switzerland) and Turkey.

⁽¹¹⁾ The overview page with the submissions of all Annex I Parties can be found at <https://unfccc.int/NC7> (accessed 13.4.2020). We used the latest submission available (June 2019).

1 Main developments and progress

Key messages

- Almost all European countries have adopted national adaptation policies. In 2013, when the EU adaptation strategy was adopted, 21 EEA member countries had a national adaptation strategy (NAS) in place, and in nine countries a national adaptation plan (NAP) was in place. By the end of 2019, the numbers had increased to 30 and 20, respectively. In April 2020, all EU countries had adopted an adaptation policy (NAS and/or NAP).
- In 2013, there was very limited experience of evaluating national adaptation policies. By the end of 2019, 11 European countries had revised their NAS. Several countries have also updated their NAP, sometimes more than once.
- Both the global and the European policy context have changed over recent years, with climate change adaptation getting a higher priority, next to climate change mitigation in climate policy.
- There is increased coherence between adaptation and diverse related policy fields and more adaptation aspects are integrated into other (e.g. sectoral) policies.

1.1 Main policy developments on adaptation

In 2014, the EEA published a report on national adaptation policy processes in European countries (EEA, 2014a). That report, based on the results of a self-assessment survey sent out in 2013 to authorities responsible for coordinating adaptation at national level, identified eight key topics on national adaptation policy processes across Europe:

1. public and policymakers' awareness of the need for adaptation;
2. knowledge generation and use;
3. planning adaptation;
4. coordination of adaptation;
5. stakeholder involvement;
6. implementation of adaptation;
7. transnational cooperation; and
8. monitoring, reporting and evaluation.

Many of the observations and findings from the 2014 report are still valid, and this report builds on that foundation. However, the context has changed significantly over the last few years. Firstly, most countries are much more developed in terms of the governance of their adaptation policies than they were in 2013-2014, including the revision of their national adaptation strategies* (NASs) and national adaptation plans* (NAPs). Secondly, the EU adaptation strategy (EC, 2013c), which was newly adopted in 2013, was subject to an evaluation in 2017-2018 (EC, 2018e). Thirdly, Member States (MSs) reported on adaptation actions under the Monitoring Mechanism Regulation in 2015 and 2019 (EU, 2013b). Finally, following the Paris Agreement and its global goal on adaptation (UNFCCC, 2015), the global context has also changed. Therefore, this report focuses on topics where major developments have taken place since 2014 or where a need for future development is identified.

1.1.1 EU policies on adaptation

EU adaptation strategy

The EU adaptation strategy (EC, 2013c) has three overarching objectives: (1) promoting action by MSs; (2) better informed decision-making; and (3) climate-proofing EU action: promoting adaptation in key vulnerable sectors. The first action within the first objective encourages all MSs to adopt comprehensive adaptation strategies. To identify key indicators for measuring MSs' level of readiness, an adaptation preparedness scoreboard was developed in 2014. In 2017, the revised scoreboard (EC, 2017e) was used by the European Commission to collect information from MSs primarily for the ongoing evaluation of the EU adaptation strategy. The adaptation scoreboard takes a process-based approach. Its indicators focus on different steps of the adaptation policymaking process, starting with (1) preparing the ground for adaptation, followed by (2) assessment of risks and vulnerabilities, (3) identification of adaptation options and (4) their implementation through to (5) monitoring and evaluation. For each step, the main areas of performance are specified, and each is broken down into various key domains of relevance. Although this process does not entail formal reporting requirements for European countries, they have been consulted in the process of developing the scoreboard and have an important role in generating and collecting the information. Overall, the scoreboard facilitates developing an overview of progress on adaptation policymaking and implementation at national level in EU MSs (ETC/CCA, 2018b).

The country scoreboards, as published in a staff working document (EC, 2018a), reflect the country's situation and create opportunities for systematic analysis of a country's progress in adaptation over time, which can provide other countries with inspiration for and guidance on the assessment of their national adaptation policy processes. In addition, a horizontal assessment of the country fiches, looking at the questions for each step of the adaptation policymaking process, was made (EC, 2018b, Annex IX). Although there were some methodological limitations, countries that are in the earlier stages of their adaptation planning may find these assessments useful for identifying relevant dimensions of the adaptation policy process. For countries with more established adaptation policies and programmes, the scoreboard indicators can work as a useful tool for benchmarking and reflection (ETC/CCA, 2018b).

The evaluation of the EU adaptation strategy (EC, 2018b, 2018e) (see Box 1.1) was an evidence-based judgement of the extent to which the EU adaptation strategy is effective, efficient, relevant, coherent and has achieved EU added value, in line with the Better Regulation Guidelines (EC, 2017c). Stakeholders recognised that the greatest benefit of the EU adaptation strategy was its mainstreaming into other EU policies and encouraging action at all levels of governance. While the overall evaluation was positive for all evaluation criteria, there are lessons to be drawn with regard to potential gaps or to step-up efforts in future (EC, 2018b).

Box 1.1 The evaluation of the EU adaptation strategy

An evaluation package of the EU adaptation strategy was published in 2018, including a report on the strategy's implementation (EC, 2018e), a summary of the evaluation of the strategy (EC, 2018b) and an adaptation preparedness scoreboard for the EU Member States (EC, 2018a). Overall, the evaluation found that the strategy has delivered on its objectives and made progress against each of its eight individual actions even if progress was different in each action. The strategy has contributed to raising decision-makers' awareness of and focus on the need for climate adaptation activities. It catalysed activities at several governance levels and has channelled efforts to integrate climate change and adaptation into different EU level policies and budgets.

Despite the progress made, diverse gaps still remain. For instance, the strategy's eight actions could be better integrated in a more structured and holistic way, rather than on an ad hoc basis. Mainstreaming efforts should also be intensified to better support progress in implementing the Sendai Framework for Disaster Risk Reduction and the United Nations Sustainable Development Goals. Despite efforts within the EU, the international dimension and the European Neighbourhood Policy are absent from the current EU adaptation strategy. The support to Member States was rather less efficient in terms of implementing or monitoring adaptation strategies and their related adaptation plans.

Moreover, further promotion to develop and implement local adaptation plans is necessary. Ecosystem-based adaptation should be promoted because of its multiple benefits. Private sector investment needs to be further channelled, e.g. through the action plan on financing sustainable growth (EC, 2018d) and the subsequent legislative proposals adopted in 2018. Based on standardised Earth observation data, e.g. Copernicus, climate services need to be further developed into business opportunities. Adaptation activities need to be better integrated into different sectoral policies, such as the EU maritime and fisheries policies or public health policies and links to mitigation policies need to be further promoted.

Some of these topics will be handled in more detail in this report, notably the improvements in implementation and monitoring, reporting and evaluation (and the related need for indicators to monitor the socio-economic impacts of national strategies), the opportunities for mainstreaming adaptation, the role of finance and private investment and the continued need for transnational coordination. In the European Green Deal, the European Commission will adopt a new and more ambitious EU strategy on adaptation to climate change in 2020/2021 (EC, 2019c, 2019d). Despite the close link between the conclusions of the evaluation of the EU adaptation strategy and the topics of this report, aspects such as better spatial downscaling of adaptation knowledge to the local level and the adoption of local adaptation strategies are not covered here ⁽¹²⁾.

Monitoring Mechanism Regulation and the Regulation on the Governance of the Energy Union and Climate Action

Although the scoreboard made for the EU adaptation strategy described the main areas of performance for each step of the policymaking process in EU MSs, countries' formal reporting requirements on national adaptation actions arise from Article 15 of the Monitoring Mechanism Regulation (MMR) (EU, 2013b). The last reporting on adaptation took place in 2019 and the reporting guidance requests MSs to provide information on (EC, 2019e):

- policy and legal framework (adaptation strategies and plans);
- information on impacts, vulnerability and adaptation (observations and projections, impact and vulnerability assessments, research and monitoring progress);
- priority sectors and adaptation action; and
- engaging stakeholders: participation and capacity building (governance, and adaptation capacity, dissemination, education, training).

The reported information forms the basis of the country information available on the European climate change adaptation (CCA) portal Climate-ADAPT (EEA, 2019c). From March 2021 onwards, and every 2 years thereafter, national adaptation actions will be reported as part of the Regulation on the Governance of the Energy Union and Climate Action, also known as 'the Governance Regulation' (EU, 2018b, Article 19 and Part 1 of Annex VIII). That regulation includes the same elements as the MMR, but additional details of the reporting will be specified in an implementing act. Although the content of the implementing act primarily refers to the information that

needs to be reported on adaptation actions in Annex VIII, Part 1, of the new regulation, it will also be derived from the Katowice Decision setting out the modalities, procedures and guidelines for reporting under the transparency framework of the Paris Agreement (UNFCCC, 2019a, 2019b).

Other EU policies of relevance for adaptation

One of the aspects of CCA is its cross-cutting nature and the need to mainstream or even integrate it into sectoral ⁽¹³⁾ policies, such as civil protection, water or biodiversity (see also Box 1.2 and Section 3.1). The Seventh Environmental Action Programme (7th EAP) 2014-2020, 'Living well, within the limits of our planet' (EU, 2013a), in its third action focuses on 'safeguarding the Union's citizens from environment-related pressures and risks to health and well-being'. This requires, inter alia, the integration of CCA and disaster risk management into EU policy initiatives (including sectoral policies) and understanding how biodiversity adapts to climate change and how the loss of biodiversity affects human health (EU, 2013a). In an annual indicator report series in support of the 7th EAP ⁽¹⁴⁾, the EEA maintained an indicator on the number of countries that have adopted a national adaptation strategy or plan (EEA, 2018b) (see also Section 1.2).

The Council of the European Union adopted a set of conclusions on 4 October 2019 regarding the development of an Eighth Environment Action Plan (8th EAP) for 2021-2030 (EU, 2019a).

Other relevant key sectors are agriculture and energy. Almost all European countries have concluded a national climate change impact, vulnerability or risk assessment that covers the energy sector. Most countries also include energy as a relevant sector in their national adaptation strategies and/or plans (EEA, 2019a). Furthermore, all countries should consider the impacts of climate change on the current and future energy system in the development of their national climate and energy plans and long-term strategies under the Energy Union (EU, 2018b; EEA, 2019a). Based on the 2019 reporting under the MMR (EU, 2013b) all NASs explicitly mention agriculture as one of the priority sectors. Twenty EU MSs prepared specific climate change impacts and vulnerability (CCIV) assessments* for the agriculture sector and 13 MSs introduced specific adaptation measures in the agriculture sector at national and regional levels (EEA, 2019b). The proposed new common agricultural policy for 2021-2027 has adaptation elevated to an objective, which could lead to MSs having to increase their financing of adaptation measures in the sector. However, to ensure that adaptation is adequately included in national strategic plans, the policy framework should require MSs to offer measures with a direct link to adaptation (EEA, 2019b).

⁽¹²⁾ In 2020, the EEA will publish a report on local level and urban adaptation to climate change in Europe.

⁽¹³⁾ Some countries refer to sectors, others to themes or topics. Some items, e.g. civil protection, are not considered a sector but rather a cross-cutting topic in the NASs and NAPs of some countries.

⁽¹⁴⁾ <https://www.eea.europa.eu/airs>

Box 1.2 Climate change in the EU reporting on water

As one example on mainstreaming, water and climate change are intrinsically linked and the water sector is one of the main sectors relevant for climate change adaptation (CCA) (EC, 2012a). CCA is not explicitly referred to in the Water Framework Directive (WFD) (EU, 2000) or the Floods Directive (FD) (EU, 2007). However, in practice, requirements to consider CCA have been added to river basin management and flood risk management planning processes as EU Member States (MSs) agreed that climate-related threats and adaptation planning should be incorporated in the river basin management and flood risk management plans from the 2009-2015 planning cycle onwards (CIS WFD, 2009). In the public consultation for the fitness check of the WFD and FD, two thirds of all respondents (after excluding the 'do not know' replies) indicated that water and climate policies (adaptation and mitigation) were at least partially coherent. Nevertheless, 18 % of respondents described these policies as incoherent, while only 12 % found them fully coherent (EC, 2019b).

Contrary to the progress in reporting on water quality, where climate change challenges are only mentioned in a footnote, the European Commission's most recent progress report on the implementation of the WFD and FD explicitly addresses these challenges when it comes to floods (EC, 2019h).

In the flood risk management plans (FRMPs) (2015), 24 out of 26 assessed MS reports considered at least some aspects of climate change. However, only 14 MSs have made specific links between their FRMPs and their national adaptation strategies (NASs) (EC, 2019b) (see Section 1.2). Coordination of the measures in the next FRMPs (by 2021) and the measures in the NASs, as well as enhanced consideration of likely climate change impacts (using modelling tools such as those available through Copernicus, see Section 2.1) are among the Commission's recommendations (EC, 2019h).

1.1.2 Global policy context

As for the European level, the global context for CCA has changed over recent years with a number of multilateral frameworks introduced under the United Nations (UN): the Paris Agreement on climate change, the Sendai Framework for Disaster Risk Reduction (SFDRR) and the 2030 Sustainable Development Agenda with the Sustainable Development Goals (UNFCCC, 2015; UNDRR, 2015; UN, 2015). Their aims, mandates, key players and monitoring and reporting systems were compared and analysed in the ETC/CCA (2018b) report and summarized in Table 1.1.

Paris Agreement

Following the introduction of the global goal on adaptation in the Paris Agreement, adaptation and mitigation are considered equally important pillars in international climate policy. The Paris Agreement calls on Parties to recognise adaptation as a global challenge and address it at local to international level with the 'development or enhancement of relevant plans, policies and/or contributions'. Monitoring, evaluation and learning is recognised as an important step in the adaptation process (UNFCCC, 2015, Article 7).

A global stocktake in 2023 and every 5 years thereafter will review the overall progress made towards achieving the global adaptation goal. The outcome will inform Parties in updating and enhancing their national actions and enhance international cooperation. To make this happen, each Party will not only engage in developing adaptation actions, but also — as appropriate — periodically submit an adaptation

communication with information related to CCIV and CCA. A transparency framework is there to give a clear and common understanding of climate change actions, so that the nationally submitted information can inform the global stocktake. Ideally, the national efforts will include country-specific reports not only on adaptation planning and implementation but also on monitoring and evaluation of the progress in adaptation as well as data at country level that allow global comparability.

Further guidance on communicating on adaptation and on the development of modalities and procedures for the operation and use of a public registry was given in the Katowice climate package (UNFCCC, 2019a, Decisions 9 and 10/CMA.1). However, it is at the Parties' discretion to provide information on adaptation and no method, uniform set of indicators or framework for monitoring, evaluation and reporting for all countries is being developed, as it is seen as not useful, owing to the context-specific nature of adaptation (Adaptation Committee, 2015). The tools and frameworks available for adaptation monitoring, reporting and evaluation (MRE) are typically not designed to be aggregated at global level, as they are relevant to specific contexts. Nevertheless, national adaptation MRE systems as they are can facilitate global knowledge sharing, learning and transparency in addition to offering domestic benefits if the purpose, goal and context are clearly communicated. Hence, the existing frameworks can provide insights into opportunities for synthesising and partly aggregating country-level progress (UN Environment DTU Partnership, 2017).

Table 1.1 Overview of the Paris Agreement, Sendai Framework for Disaster Risk Reduction and 2030 Agenda for Sustainable Development

KEY points	Paris Agreement	Sendai Framework for Disaster Risk Reduction	2030 Agenda for Sustainable Development
Date of adoption	195 nations adopted the Agreement in December 2015; went into force on 4 November 2016	UN member states adopted in March 2015 at the World Conference on Disaster Risk Reduction, held in Sendai, Japan	193 member countries agreed to the Sustainable Development Goals in September 2015; went into force in January 2016
Aim	Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development Establishing a global goal on adaptation of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable development and ensuring an adequate adaptation response in the context of the temperature goal	Four priorities for action: Priority 1. Understanding disaster risk Priority 2. Strengthening disaster risk governance to manage disaster risk Priority 3. Investing in disaster risk reduction for resilience Priority 4. Enhancing disaster preparedness for effective response and to 'build back better' in recovery, rehabilitation and reconstruction	17 goals aiming to end poverty, hunger and inequality, take action on climate change and the environment, improve access to health and education, build strong institutions and partnerships and more
Mandate	Voluntary	Voluntary, non-binding	Voluntary, non-binding
Key players for implementation	Governments, EU, private sector and other societal players	Governments, EU, regional, sub-regional and transboundary cooperation, communities and businesses	Governments, EU, private sector, civil society
Monitoring/ reporting systems	No common indicator framework. Biannual transparency reports and the Adaptation Communication define headings/topics that reporting on adaptation should cover (UNFCCC, 2019a, 2019b)	38 indicators available (UN, 2016)	232 indicators available (UN, 2017a) ^(b)
Current and upcoming processes for reporting adaptation	Biennial reporting, starting from 2021 (there are already national communications to the United Nations Framework Convention on Climate Change taking place every 4 years and including information on adaptation, the most recent in 2017/2018 ^(a)), binding for Annex I countries)	Biennial reporting, starting from 2015-2016	Up to annual reporting, depending on the indicator and starting from 2015

Notes: ^(a) The 2017/2018 reporting was the Seventh National Communication (NC7), available at <https://unfccc.int/NC7> (accessed 13 April 2020).

^(b) At the 51st session of the UN Statistical Commission (3-6 March 2020), MSs adopted 36 changes to the global framework of SDG indicators. The indicators on climate action also saw changes, proposed by the Inter-Agency and Expert Group on SDG Indicators (IAEG-SDGs). This was the result of its 2020 comprehensive review process, which greatly improved the quality of the framework while keeping the number of indicators the same as in the original framework adopted in July 2017. The IAEG-SDGs emphasised that the proposals not included in the revised framework still have a valuable role to play in the follow-up and review process of the SDGs through national, regional and thematic monitoring and can provide important additional information and complement the global indicator framework (UN, 2020).

Source: Adapted from ETC/CCA (2018b).

Sendai Framework for Disaster Risk Reduction and Sustainable Development Goals

The Sendai Framework for Disaster Risk Reduction (SFDRR) and the 17 Sustainable Development Goals (SDGs) have strong links to CCA and synergies could arise at the national level where all frameworks need to be implemented. Contrary to the Paris Agreement, the SFDRR has a monitoring process, including indicators (UNDRR, 2020), and the SDGs have indicators and a monitoring framework (Schmidt-Traub et al., 2015; UN, 2017a). The link between CCA and the SDGs is directly visible in Goal 13 'Take urgent action to combat climate change and its impacts', highlighting that the implementation of the Paris Agreement is essential to achieve the SDGs. As a number of SDGs are affected by climate change ⁽¹⁵⁾, the link between the 2030 Agenda for Sustainable Development and adaptation goes well beyond Goal 13 on climate action.

Synergies between the different frameworks are also found at the European level. In the reporting guidelines for rescEU (EC, 2019a), the strengthened EU Civil Protection Mechanism (EU, 2019b), reporting fields dedicated to climate change impacts and adaptation measures are introduced as part of the risk assessment and risk management capability assessment, respectively. The EU is also committed to playing an active role in the implementation of the SDGs (EC, 2016b). A dedicated website <https://ec.europa.eu/eurostat/web/sdi> (Eurostat, 2019a) accompanies a yearly report on (actually) 100 EU SDG indicators, many of them supporting more than one SDG (Eurostat, 2019b).

Other global frameworks of relevance for adaptation

Similar to the situation for the national and EU policies, CCA is of direct or indirect relevance for other global frameworks too. Examples are the Convention on Biological Diversity (UNCBD, 1992), the Convention to Combat Desertification (UNCCD, 2020) or the New Urban Agenda (UN, 2017b). The links between the Paris Agreement and the examples above are in some cases synergistic, meaning that addressing one of them will at the same time advance progress for the other objectives or at least make such achievements easier or more robust. In other cases, there will be tensions and trade-offs where the single-minded pursuit of one framework may undermine the possibilities for progress on another. This is particularly important in cases where interactions are very strong, such as for challenges related to climate change and biodiversity, as described in the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) global assessment report (IPBES, 2019).

Connections between biodiversity and climate change are recognised as being of vital importance. On the one hand, Aichi biodiversity target 15 of the Convention on Biological Diversity (UNCBD, 2012a) states that improving biodiversity enhances ecosystem resilience and the contributions that biodiversity can make towards CCA. On the other hand, climate change affects other pressures on biodiversity. The interactions between the drivers of biodiversity and climate change are strong, bi-directional and mostly positive as shown by the Intergovernmental Panel on Climate Change special report *Global warming of 1.5 °C* (IPCC, 2018), the IPBES global assessment (IPBES, 2019) and its assessment of land degradation and restoration (IPBES, 2018).

1.2 Progress in national adaptation policies

In 2013, the year the EU adaptation strategy was published (EC, 2013c), 21 out of 33 EEA member countries had a NAS and only nine of them had a NAP (see Table 1.2). By the end of 2019 ⁽¹⁶⁾, 30 countries had a NAS and 20 had a NAP. In April 2020, Croatia adopted a NAS (MZOE, 2020), being the last EU MS to adopt an adaptation policy (NAS and/or NAP) leaving Iceland as the only EEA member country without information on adaptation policies.

At the international level, developing adaptation plans was one of the objectives of the Cancun Adaptation Framework, decided during the 16th Conference of the Parties in 2010 (UNFCCC, 2011, 2019c). In the Paris Agreement (UNFCCC, 2015, Article 7), all Parties (as appropriate) are required to engage in adaptation planning and implementation through, for example, NAPs, vulnerability assessments and monitoring and evaluation, and to provide adaptation communications recorded in a public registry.

1.2.1 National adaptation policy documents

Approximately one quarter of the EEA member countries have created a legal basis for adaptation through a designated act (i.e. Croatia, Finland, Greece, Hungary, Ireland, Sweden, Switzerland, United Kingdom). These acts have provided a legal requirement to develop national adaptation policies. In most cases, non-binding policy frameworks for adaptation aim to reduce vulnerability and/or increase resilience to climate change effects. Furthermore, they follow goals such as increasing adaptive capacity and readiness to adapt to climate change impacts. Others aim to support policymakers in tackling CCA by providing the best available knowledge ⁽¹⁷⁾.

⁽¹⁵⁾ Indicators with relevance for climate impacts and adaptation are found in SDGs 1, 2, 6, 11, 13 and 15 (ETC/CCA, 2018b). See Annex A: Indicators with relevance for climate impacts and adaptation in the Sustainable Development Goals for more details.

⁽¹⁶⁾ All country examples in this section are based on the adaptation preparedness scoreboard (EC, 2018a) and the 2019 reporting on adaptation actions (EU, 2013b, Article 15) for EU MSs. For non-EU EEA member countries, the information is based on voluntary country updates, as published on the country pages of Climate-ADAPT (<https://climate-adapt.eea.europa.eu/countries-regions/countries>).

⁽¹⁷⁾ More details of the underlying knowledge developed to support adaptation policies can be found in Chapter 2.

Table 1.2 Overview of the adoption of national adaptation strategies and plans by EEA Member States

EEA Member States	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Austria													*		
Belgium															
Bulgaria															
Croatia ⁽¹⁾															
Cyprus															
Czechia															
Denmark															
Estonia															
Finland										*					
France															
Germany											*				
Greece ⁽²⁾															
Hungary ⁽³⁾														*	
Ireland ⁽⁴⁾															*
Italy															
Latvia ⁽⁵⁾															
Lithuania															
Luxembourg														*	
Malta ⁽⁶⁾															
Netherlands ⁽⁷⁾												*			
Poland															
Portugal											*				
Romania												*			
Slovakia														*	
Slovenia															
Spain															
Sweden ⁽⁸⁾														*	
United Kingdom															
Iceland															
Liechtenstein															
Norway															
Switzerland															
Turkey															

	No adaptation policy adopted
	National adaptation strategy (NAS) adopted
	NAS and national adaptation plan (NAP) adopted
*	NAS revision adopted

Notes: (1) Croatia adopted a NAS on 7 April 2020.

(2) Greece is developing 13 regional adaptation plans (RAPs). The LIFE-IP AdaptInGR project aims to boost the implementation of the NAS and RAPs and will provide guidelines for the future revision of the RAPs (2025-2026).

(3) The Hungarian Parliament adopted the second national climate change strategy (NCCS-II) in October 2018. The NCCS-II includes the NAS. The review of the first NCCS (including the adaptation elements) took place in 2013 and was updated again after the adoption of the Paris Agreement. Hungary had a NAP for the period 2010-2012 that was not renewed after that. The Hungarian Government adopted a new NAP in January 2020, which is part of the first climate change action plan.

(4) In 2019, Ireland completed a series of sectoral adaptation plans (SAPs) and each of Ireland's 31 local authorities has also had a local adaptation strategy in place since 2019.

(5) Latvia has a NAP but no NAS.

(6) Malta reported that it has adopted a NAP; however, the documentation provided is some sectoral adaptation plans that do not cover all sectors from the NAS and often have a focus on mitigation.

(7) The Netherlands has a NAS/implementation programme as well as the Delta programme.

(8) In 2009, the Swedish Parliament adopted a coherent policy for climate and energy, which includes the initial steps to be taken by Swedish society to adapt to a changing climate. Although it is not called a NAS, it has the characteristics of one and was based on its assessment of vulnerability of climate change impacts (completed in 2007). Sweden has RAPs covering all Swedish regions and also SAPs.

Based on the 2019 reporting by EU MSs under Article 15 of the MMR (EU, 2013b).

Sources: Adapted from EEA (2018b, 2019e (Chapter7)) and Climate-ADAPT (2020).

In most countries, the environment ministry is the main body responsible for adaptation. To address the complexity of adaptation, the ministries have set up mechanisms to coordinate between administrative divisions and levels of governance. Most countries have established soft steering and coordinating mechanisms such as an interministerial committee (e.g. Austria and Germany), a national coordination council on climate change (e.g. Bulgaria), working groups (e.g. Czechia), a national adaptation steering committee (e.g. Ireland) or a national climate change adaptation committee (e.g. Greece). Only a few countries have no specifically designated coordination mechanism in place for CCA (e.g. Hungary is lacking horizontal coordination* structures, Slovenia lacks vertical* structures). Overall, it seems that countries have established stronger mechanisms for vertical than for horizontal coordination (Bauer et al., 2012; EC, 2018b).

The diversity of what is described in national adaptation policies among countries is considerable, making it difficult to provide clear definitions of what a NAS or a NAP is or even what the core elements are ⁽¹⁸⁾. Nevertheless, some overall characteristics can be identified and the following sections give some working definitions for NASs and NAPs.

National adaptation strategies



WORKING DEFINITIONS

A **National adaptation strategy (NAS)** is a national document that articulates a national strategic vision for adaptation to prepare the country for current and expected impacts of climate change. A NAS mostly summarises climate-related risks and vulnerabilities as well as identifying various actors and sectors as areas of action. These strategies facilitate the process of coordinating, the adaptation response at the horizontal and vertical levels as well as helping to raise awareness for adaptation among various stakeholders. A NAS usually provides the framework for adaptation in which other governance approaches emerge. NASs are mainly designed by national governments and informed by the scientific community.

Source: based on Bauer et al., 2012; EEA, 2014a, 2018b; Grothman, 2011.



WORKING DEFINITIONS

Horizontal coordination mechanisms refer to institutions and processes in place to support the integration of adaptation into sector policies. It requires that those responsible for different policy areas within an administrative level (e.g. national) exchange information and adjust their activities to ensure that adaptation efforts result in coherent action responding to the unavoidable impacts of and, where possible, benefiting from climate change (EEA, 2014a).

Vertical coordination mechanisms refer to institutions and processes in place to support integration of adaptation through multiple administrative levels within a country (i.e. national, provincial, regional, local/city level). This requires that information on and approaches to adaptation are transferred and exchanged effectively within each policy area from the national to the sub-national levels and vice versa (EEA, 2014a).

Although there is a general definition of NAS, the actual content may vary significantly from country to country and NASs can fulfil many different roles in the political process. These can be demonstrating vision and leadership, capturing political commitment or political symbolism, providing a comprehensive framework (Dupuis and Biesbroek, 2013) as well as guiding public adaptation and organising the governance of adaptation (Bauer et al., 2012; Sanderson et al., 2018).

Overall, existing NASs are mostly comprehensive, integrated, multi-sectoral documents that involve several levels of governance (Casado-Asensio and Steurer, 2014). They usually include very little information on implementation. Only a few countries (e.g. Hungary, Lithuania and Romania) have published strategies integrating mitigation and adaptation topics.

⁽¹⁸⁾ Links to the latest version of countries' NASs and NAPs can be found in the country pages on Climate-ADAPT (<https://climate-adapt.eea.europa.eu/countries-regions/countries>).

National adaptation plans

WORKING DEFINITION

A national adaptation plan (NAP) is national document that articulates how a country's NAS is to be implemented (and by whom). In most cases, the NAP outlines a strategic planning process for implementing adaptation. It presents adaptation measures in varying levels of detail, e.g. it may provide information on the goal of the measures and the next steps needed, assign responsibilities and actors, and outline time-frames and deadlines (EEA, 2014a).

As the NAS provides only the framework for adaptation, national public authorities take one or several of the following three steps in moving beyond the NAS (EEA, 2014a):

1. developing national ⁽¹⁹⁾ and/or sectoral adaptation plans (NAPs and SAPs) in which more specific goals and instruments are set out and resources are allocated and responsibilities for implementation are defined;
2. mainstreaming adaptation into existing instruments, processes and structures (see Chapter 3);
3. expecting spontaneous follow-up and implementation at local, regional or sectoral levels.

Although the NAPs often follow the structure of and add detail to what is described in the NAS, the first German NAP took a different approach by not replicating the sectoral structure of the NAS but by grouping adaptation activities into national and strategic as well as international pillars ⁽²⁰⁾. In the case of Ireland, under the Climate Act, all relevant ministries had to prepare their SAPs. France has published management plans focusing on specific ecosystems that include adaptation to climate change (e.g. sea and coastline).

In some countries, NAS and NAP are developed in parallel or even combined into one document. However, in general, a NAS addresses a longer time horizon than a NAP and therefore is revised less frequently (see Section 1.2.2). The absence of a formally adopted NAP does not necessarily imply a lack of adaptation measures being taken at the different governance levels, including the national level. From all EU countries, Norway, Switzerland and Turkey there is evidence that substantial efforts are in place on adaptation. The distinction between NAS and NAP is not made by the United Nations

Framework Convention on Climate Change (UNFCCC) at the international level, where only the term NAP is used.

1.2.2 Planning for the next policy cycle: the revision of national adaptation policies

National CCIV assessments are often conducted to support the development or revision of a NAS and/or NAP (EEA, 2018a). Most NASs and NAPs follow a sectoral approach and most countries cover agriculture, health, water management, biodiversity and forestry (EEA, 2018a; EC, 2018b). Other sectors such as construction, infrastructure, economy or tourism are addressed in fewer countries, but they will have to adapt as well to make societies and economies resilient. Including all relevant sectors and coordinating the different contributions should be done when NASs and NAPs are revised.

While the responsible entities and the various stakeholders for measures are often well defined in the NAP, information on the implementation process and even more on the budgets and costs (and on who is responsible for them) is often lacking. Positive examples are the NAP in Czechia, which includes information on the sources of adaptation finance, the Estonian NAP, which includes prognoses for the budget requested for adaptation, and more recently the Greek regional adaptation plans (RAPs), which include information on the measures' estimated budgets, sources of funding and those responsible for their implementation. Only some NAPs include information on how to monitor and evaluate the implementation process and its effectiveness either on a general level (e.g. Austria) or by providing indicators for measuring the implementation of proposed adaptation measures (e.g. Belgium, Czechia).

Even when developed in parallel, the time horizon of a NAS is often further into the future than that of a NAP (e.g. Romania, where the NAS applies up until 2030, while the NAP extends to 2020). Some countries have had experience of updating adaptation measures already, but in 2013 no EEA member country had adopted a revised NAS. Consequently, the need for knowledge on the evaluation of adaptation policies was less well understood compared with the knowledge needs in the earlier steps of the policy cycle. At the end of 2019, 11 countries formally adopted a revised NAS (see Table 1.2) and some others are in the process of doing so (e.g. Czechia). In addition, several countries (e.g. France, Spain, Switzerland, United Kingdom) have a detailed procedure to update their NAP ⁽²¹⁾. All (other) countries can learn from these revisions, as these countries have been through the whole adaptation policy cycle at least once (see Section 1.4 and Chapter 4).

⁽¹⁹⁾ Depending on the division of responsibilities within and the governmental structure of a country, regional plans might be developed that together amount to an action plan covering the whole territory of a country.

⁽²⁰⁾ The second German NAP (2015) is structured into sectoral clusters that represent all sectoral action fields outlined in the German NAS.

⁽²¹⁾ Unfortunately, there is no reporting in place so far that gives a complete and undisputed overview of all NAP updates in EEA member countries.

1.3 Progress in implementation of adaptation policies

Implementation of adaptation policies at the national level has progressed significantly in comparison with 2014, when implementation was assessed as being at an early stage across Europe (EEA, 2014a). According to the evaluation of the EU adaptation strategy (EC, 2018b), at least 22 MSs were found to be implementing their NAS and/or NAP in 2018. However, there were differences between countries when it comes to approaches, the numbers of sectors and priority actions selected for implementation and the mechanisms used for implementation. Mainstreaming of CCA into key national and sectoral planning processes and policymaking is a typical approach to implementing national adaptation policies.

Adaptive management — as is widely applied in water and flood risk management — is a concept that emphasises (1) iterative planning that leads to (2) implementation, accompanied by (3) monitoring/review of outcomes* and crucially (4) learning from review outcomes and responding with adaptive planning (Holling, 1978; Walters, 1986; Swanson and Bhadwal, 2009). One approach to further put adaptive management into practice is the development of adaptation pathways (see Box 1.3).

Adaptation pathways help decision-makers to sequence measures for flexible and dynamic implementation with limited undesirable and maladaptive consequences and to deal with uncertainties by identifying sequences of potential actions and measures (Zandvoort et al., 2017). When connected with sound monitoring and evaluation of implementation, this approach can help to support learning over time and increase resilience or adaptive capacity.

Implementing adaptation at the European level has progressed steadily since the adoption of the EU adaptation strategy in 2013. Notable actions include dedicated instruments such as the financial support for adaptation projects in EU MSs through the LIFE programme ⁽²²⁾ and the continuous strengthening of the evidence base to support decision-making (EC, 2017a). Mainstreaming of adaptation into key EU policies is also the primary approach to implementing adaptation at the European level.

Box 1.3 Adaptation pathways: the example of ecosystem-based adaptation

One example of an area where adaptive management plays an essential role in implementation is ecosystem-based adaptation (EbA) (Arkema et al., 2006; Curtin and Pallezo, 2010). The EEA has elaborated EbA in various recent publications (e.g. EEA, 2012, 2015a, 2015d, 2016, 2017a) and will publish a detailed assessment on nature-based solutions and ecosystem-based approaches (NBS/EApp) for climate change adaptation in 2021 (EEA, forthcoming). While systematic and wide-ranging application of EbA measures is a novel and emerging approach in adaptation, the basic idea is not new and includes methods for creating new ecosystems (such as green roofs, protecting forests, flood plains and urban water retention basins) and for protecting existing ecosystem functions (such as recreational urban forests). NBS/EApp has also been embraced in the *Global assessment report on biodiversity and ecosystem services* (IPBES, 2019).

Identification and implementation of NSB/EApp options is most common in sectors directly dependent on the production capacity of certain ecosystems, such as agricultural lands and forests. In the built environment, water management-related NSB/EApp measures are most common (McVittie et al., 2017), but NSB/EApp opportunities for the health sector are still rarely identified and less often assessed than in sectors related to biomass production. In general, NSB/EApp options are more often taken into consideration in thematic/sectoral plans than in national adaptation plans (NAPs).

In addition to climate change, the need to enhance ecosystem services arises from several other societal challenges, including land use change and biodiversity loss. NSB/EApp can thus serve the targets of many committed sustainability policies, such as the Sustainable Development Goals (UN, 2015), the Aichi biodiversity targets (UNCBD, 2012b), the Sendai Framework for Disaster Risk Reduction 2015-2030 (UNDRR, 2015) and the EU green infrastructure strategy (EC, 2013d). The green transition initiative in Denmark's NAP is an example of a more holistic approach in which EbA is part of a wider set of solutions.

⁽²²⁾ The LIFE programme is the EU's funding instrument for the environment and climate action, created in 1992. The funding period 2014-2020 has a budget of EUR 3.4 billion (<https://ec.europa.eu/easme/en/life>).

1.4 Progress in monitoring and evaluation of national adaptation policies

As more countries advance from planning to implementing adaptation actions, the need for understanding progress in and the effects of adaptation interventions increases. Monitoring and evaluation of adaptation interventions aim to understand how effective, efficient and equitable the adaptation actions are. They further enable adjusting policies and actions to accommodate new information on climate change and socio-economic conditions, as well as lessons learned from the experience of implementing adaptation. This learning opportunity starts at the national level, but it can be extended across countries (e.g. between neighbouring countries or within European biogeographical regions (EU, 1992) or international river basin districts (EC, 2012b)).

Although almost all European countries have NASs and NAPs in place, to date fewer countries have progressed to a stage of monitoring and evaluating their implementation and effects. National efforts to monitor, report and evaluate national adaptation policies are continuously developing and countries commonly emphasise the need for understanding the progress of their national adaptation policies and their implementation. The need for monitoring also arises out of European (such as the MMR/Governance Regulation — the former in 2015 and 2019, the latter from 2021 onwards and every 2 years thereafter) and global reporting requirements (such as the UNFCCC; see Table 1.1), although reporting requirements for adaptation are less extensive and less prescriptive than those for climate change mitigation policies and measures.

In 2018, 16 EU MSs were undertaking some monitoring and reporting activities at national level (EC, 2018b, p. 148). The focus and scope of such activities vary across countries. The most commonly covered areas were integration of adaptation in sectoral policies (13 countries), implementation of a NAS/NAP (11 countries) and implementation at sub-national or local levels (nine countries). Evidence of evaluation activities in adaptation policy is available from even fewer countries, but encouragingly 24 EU MSs reported that they have planned periodic reviews of their NAS and/or NAP. By contrast, in 2014, seven EEA member countries reported that they were implementing an MRE scheme. Six additional countries were working on MRE schemes and 12 more were planning to do so in the future (EEA, 2014a, p. 97). It is thus evident that there is great demand for sharing lessons learned and experiences of national adaptation MRE to support countries as they move towards revising and improving their adaptation policy frameworks.



2 Knowledge supporting adaptation policy developments

Key messages

Climate change assessments and knowledge

- Knowledge on climate change impacts, vulnerabilities and risks has improved sizeably at national, transnational and European scales over recent years:
 - Operational products from Copernicus Climate Change Services, the coordinated downscaling experiment (Cordex) initiatives and downscaled products available at national levels are becoming available at very high resolutions.
 - Climate change impact and vulnerability (CCIV) assessments are now more extensively using climate and socio-economic scenarios as well as results from climate change impact models, including information about economic costs, human health and ecosystems.
- There is a need to improve links to risk assessments from related policy fields, such as national risk assessments (NRAs), as NRAs and CCIV assessments have some parts in common and synergies can be capitalised on. Not all countries are coordinating efforts between different kinds of risk assessment and there is a clear need to further streamline joint efforts and thus increase coherence and complementarity among policy areas.
- More holistic and partly detailed risk assessments are needed for compound and cascading hazards (multi-risk assessments), as well as for the transboundary and cross-border impacts and spill-over effects in between sectors.

Climate change adaptation policies and action

- Clear formulation of adaptation policies, and in particular their aims and targets, enables a more focused monitoring, reporting and evaluation (MRE) system. Well-defined MRE objectives can create outcomes that demonstrate the effectiveness and efficiency of adaptation policies and practices.
- Learning is a key function of monitoring and evaluation of adaptation policies. Lessons learned on progress, outcomes and impact in particular enhance adaptation policies and practices when monitored against specific targets.
- Co-production of knowledge and various forms of stakeholder engagement have progressed in recent years and participatory approaches are common in adaptation policy development and MRE, contributing to further building up resilience and increasing adaptive capacity.

To develop adaptation policies and to plan for adaptation measures, sufficient awareness of climate change impacts and vulnerabilities is needed. To develop such awareness, countries should have access to information about the drivers of climate change and its actual and potential impacts on natural and socio-economic systems. In addition, more detailed assessments in a variety of sectors should consider different climate and socio-economic scenarios, as well as direct and indirect impacts and related uncertainties.

Developing potential adaptation options will have to take into account the local context and it requires assessments at a finer geographical scale and knowledge of the legal and technical requirements, costs and benefits, avoided impacts and potential implementation barriers.

Climate change impact and vulnerability (CCIV) assessments, both sectoral and multi-sectoral, are one of the most important information sources for developing national adaptation policies

in the EU. A variety of approaches and methods is used to produce national CCIV assessments — including a literature review, Intergovernmental Panel on Climate Change (IPCC)-like national assessments, extensive model-based studies or different forms of stakeholder consultation — and assess up to 19 different sectors. Common challenges include data gaps, the integration of quantitative and descriptive information and the comparison of climate risks across sectors (EEA, 2018a).

This chapter provides an overview of recent developments in Europe in the knowledge base for developing adaptation policies. In particular, the following sections focus on how scientific knowledge of climate risks is evolving (Section 2.1.1), how CCIV assessments are linked to national risk assessments (NRAs)* (Section 2.1.2) and about the transnational* aspects of CCIV assessments (Section 2.1.3). The chapter also reflects on the knowledge needed to revise adaptation policies after an evaluation (Section 2.2) and on the role of stakeholder involvement in policy development (Section 2.3). The last section of this Chapter (Section 2.4) summarises lessons learned and key challenges related to the first stages of the adaptation policy cycle: preparing the ground for adaptation, assessing risks and vulnerabilities and identifying adaptation options (see Figure 0.1).

2.1 Increasing the knowledge base on climate risks improves adaptation policies

There has been sizeable progress in the production and uptake of knowledge supporting national adaptation policies in Europe. Ensemble climate projections are available and used to undertake CCIV assessments and some countries have developed national web platforms facilitating access to climate knowledge and services. However, different sources of data and a variety of methods are used for assessing climate risks and identifying/prioritising adaptation options. The remaining information gaps can be addressed through exchange of experience and coordinated assessment of cross-border climate impacts and harmonisation of risk and vulnerability metrics.

2.1.1 *Climate change, impacts and vulnerability assessments*

An analysis of the state of play of national adaptation policies in Europe (EEA, 2014a) showed that most European countries had already developed (or were implementing) climate risk and/or vulnerability assessments. These assessments were

primarily done for national public authorities and at the country level, addressing agriculture, water, forestry, human health and biodiversity as the most relevant sectors. Some countries also completed climate risk assessment at the sub-national scale and for specific sectors of interest, e.g. industry, finance/insurance, cultural heritage, business and services. However, only a few national assessments addressed the impacts of climate change on ecosystems, landscape processes, air quality or cross-border interactions.

All EEA member countries have completed vulnerability assessments as part of their national adaptation planning (EC, 2018a). A variety of CCIV assessment methods has been used, including qualitative methods — such as empirical analysis based on existing databases, literature reviews or expert judgements) — and sophisticated quantitative methods, such as scenario analysis, impact modelling, indicators and indexes. A systematic review of climate change adaptation (CCA) modelling approaches and tools has been commissioned by the European Commission Directorate-General for Climate Action and the report from this study will be published in 2020/2021.

Climate models

Within the World Climate Research Programme Coordinated Regional Downscaling Experiment (Cordex), high-resolution regional climate change ensembles have been produced for Europe (Jacob et al., 2013). These Euro-Cordex simulations⁽²³⁾ have been widely used by EU Member States (MSs) to develop national adaptation policies (EC, 2018a).

While EU MSs so far have used model projections from the fifth phase of the Coupled Model Intercomparison Project (CMIP5) or even earlier versions, results from the sixth phase (CMIP6) are now available (Editorial, 2019). Another key data source for future CCIV assessments will be the Copernicus Climate Change Service (C3S); operational since 2017 and part of the EU Earth observation programme 'Copernicus', providing data and information on environment and society through satellite and in situ observations. C3S in particular provides information and services on the past, present and future climate (C3S, 2019). Since 2019, the Climate Data Store⁽²⁴⁾ has provided access to a vast amount of climate information, including climate re-analysis, forecasts and projections, as well as elaborated data such as essential climate variables.

While some countries have employed ensembles of global or continental climate projections, others have developed and employed their own regional climate simulations. Some examples of these initiatives are shown in Box 2.1.

⁽²³⁾ Euro-Cordex simulations are available at <https://euro-cordex.net/060376/index.php.en>.

⁽²⁴⁾ <https://cds.climate.copernicus.eu/#/home><https://cds.climate.copernicus.eu/#/home>

Box 2.1 Examples of enhanced climate modelling in support of national adaptation planning

United Kingdom

In the United Kingdom, the Climate Programme of the Meteorological Office's Hadley Centre (UKCP), version 2018, provides a set of future climate projections at a 12 km scale for the United Kingdom. The climate model is further downscaled to 2.2 km, allowing realistic simulation of high impact events such as localised heavy rainfall in summer (MetOffice, 2020).

Belgium

Instead, in Belgium, the Cordex.be consortium used four regional climate models (RCMs), previously created for the Euro-Cordex project, to produce limited area model (LAM) runs at a resolution of about 4 km (instead of the 12.5 km Cordex resolution) on a domain centred over Belgium. In this way, the LAM runs provide more detailed as well as more realistic descriptions of future climate projections (RMI Belgium, 2020).

The Netherlands

The Regional Atmospheric Climate Model (RACMO), developed by the Royal Netherlands Meteorological Institute (KNMI), based on the high-resolution limited area model (Hirlam), is used for downscaling global climate model projections at a finer spatial and temporal resolution. For example, climate projections for the RCP8.5 scenario*, previously run by the CMIP5 model, have been further downscaled using the RACMO2 set-up at a grid spacing of roughly 10 km (van den Hurk et al., 2014).

Denmark

In 2019, the Danish Meteorological Institute (DMI) launched the Danish Climate Atlas in support of climate adaptation policies at national and municipal levels. It shows short-, medium- and long-term scenarios for temperature, rainfall, extreme events, and relative sea level and storm surge heights. As it provides useful information on areas at risk of being affected by climate extremes up to a spatial resolution of 1 km, it is also relevant for utility companies, infrastructure, agriculture, emergency management, insurance and many other sectors (DMI, 2019).

In addition to the recent updates on climate modelling, the increased knowledge base on CCIV approaches has also nurtured the development and revision of CCIV assessments across Europe (EEA, 2018a).

Multi-sector and multi-scale assessments

Multi-risk assessment is still a big challenge for the scientific community (Kappes et al., 2012; Gill and Malamud, 2014; Gallina et al., 2016; Sperotto et al., 2017) — because of, for example, the complex and uncertain combinations of hazardous events or the continuous changes and interactions of exposed socio-ecological systems — but there has been an increasing demand for multi-risk information from policymakers in recent years. Multi-risk assessment analyses the interrelated effects that multiple hazards can have on a variety of vulnerable sectors and elements at risk. For example, a flood can trigger a landslide, damaging critical infrastructures (e.g. water and power networks, roads and railways) and consequently access

to relevant services for society (energy and water supply, emergency services). Other examples are a combination of rainfall and a storm surge that can lead to a compound event requiring the simultaneous management of flood risk in coastal and river plains, or a region hit by several consecutive hazards that may face amplified risks due to increased vulnerability (and reduced adaptive capacity) after each individual event.

Going beyond the traditional single-sector analysis, most EEA member countries produced a multi-sectoral assessment allowing a more comprehensive evaluation of impacts and elements at risk across multiple sectors. Moreover, the assessments were produced not only at the national scale but also at higher spatial resolutions (sub-national level) to facilitate the identification of regional risk/vulnerability hot spots and adaptation priorities (EEA, 2018a).

Box 2.2 presents examples of a multi-sector assessment approach in Croatia and a multi-level analysis in Belgium.

Box 2.2 Multi-sector assessment in Croatia and multi-scale assessment in Belgium

Croatia: multi-sector assessment

In 2017, Croatia published a vulnerability assessment in the framework of the drafting of the national adaptation strategy, delivering a deep cross-sectoral climate change impact analysis, with information on the impacts on each chosen sector individually as well as on how the changes in one sector are reflected in the impacts on another (MZOE, 2017).

Eight resource sectors were identified (hydrology, water and marine resource management; agriculture; forestry; fishing; biodiversity; energy; tourism; health) along with two transversal sectors (spatial planning and coastal area management; disaster risk management). These were analysed for their relative importance and for how the changing climate parameters are affecting the sectors in terms of disaster risk management.

Climate change is treated as a driver for modelling vulnerability based on the Intergovernmental Panel on Climate Change's RCP4.5 scenario in conjunction with previous national climate change analysis, with projections to both 2040 and 2070. Eleven hazards were considered, nine of which pertained to climate change (including extreme temperatures, drought, snow and ice). The resulting insights on climate change were used to analyse the sectoral and cross-sectoral impacts, including the production of an accessible cross-sectoral impact matrix.

Social vulnerability was incorporated within the analysis, including a consideration of human health. For example, clear guidelines are published for limiting the risk to health from heat waves in an annually published protocol for protection (Ministarstvo Zdravstva, 2017). In this way, all the relevant dimensions of vulnerability (physical, environmental and socio-economic) are considered in the analysis.

Belgium: multi-scale assessment supports regional- and local-scale adaptation strategies

With strongly differentiated systems of governance between the Flemish, Walloon and Brussels regions, Belgium has built upon earlier adaptation plans from each region and from the federal level to adopt a national adaptation plan that places a strong emphasis on the sub-national scale. Adaptation plans can also be found on a local scale for individual cities such as Antwerp and Gent to further add to the multi-level approach (Nationale klimaatcommissie, 2016).

Quantitative and qualitative assessment approaches

Although the assessments were mostly country specific, all recent CCIV assessments have allowed a forward-looking analysis covering multiple periods (early, mid- and late 21st century) and significant progress in the use of mixed methods*, combining qualitative and quantitative data and information, was detected (EEA, 2018a). In addition to the use of existing literature and expert opinion (workshops, interviews), an increasing number of countries applied coordinated modelling exercises and composite indices and considered demographic and socio-economic scenarios, either quantitatively or qualitatively, in the analysis (see examples in Box 2.3).

The *Adaptation gap report 2018* (UN Environment DTU Partnership, 2018) has identified a list of composite indices as the most relevant to track adaptation. The list includes openly available indices such as ND-GAIN (Chen et al., 2015), INFORM (Marin-Ferrer et al., 2017) and the *World risk report* (BEH, 2017). The INFORM and World Risk indices are focused on ranking countries in terms of disaster risk by combining hazard and exposure, vulnerability and coping capacity, which are not perfect measures for adaptation goals. The Global Climate

Risk Index (Eckstein et al., 2019), developed by GermanWatch, can be also mentioned but may be criticised in the same way, as it mostly focuses on the impacts of climate disasters rather than adaptation.

ND-GAIN (developed by the Notre Dame Global Adaptation Initiative) is one of the few well-known indices measuring a country's vulnerability to climate change and other global challenges in combination with its readiness to improve resilience (by targeting adaptation measures). The index aims to help the private and public sectors to prioritise climate adaptation, ultimately lowering risk and enhancing readiness. To our knowledge, there are no indices developed by high-level international institutes covering topics identical to those of ND-GAIN.

The Sendai Framework for Disaster Risk Reduction (SFDRR) highlights disaster resilience at all levels through implementing socio-economic, structural and institutional measures that reduce hazard, exposure and vulnerability and strengthen resilience. At the same time, one observes that international guidelines and frameworks, such as the risk indicators from the SFDRR are not (or seldom) used in European CCIV assessments (UN, 2016; Chen et al., 2015; see more in Chapter 4).

Box 2.3 Assessment approaches combining qualitative and quantitative information in Germany and Latvia**Germany**

In 2015, Germany's first stage of climate change, impacts and vulnerability (CCIV) assessment was published, in which a specific vulnerability methodology was developed by scientists in conjunction with the relevant authorities in an approach that crossed multiple disciplines (Deutsche Bundesregierung, 2015). Scientific officers working in the government administration mediated the transition between the data and methodological approaches provided by researchers through to federally appropriate policy decisions. A co-design of the assessment was therefore reached, with objectivity and transparency from both sides, and incorporating a wide range of knowledge aspects.

The most relevant climate impacts were then assessed in a step-by-step integrated approach considering both biophysical and socio-economic impacts. This was done consistently across all relevant sectors and allowed a full evaluation of the risks. (e.g. water management, forestry, trade and industry, buildings, human health) The risks for individual sectors were then assessed against each other in a congruous manner. In the second stage of the assessment (Buth et al., 2017), a full review of case studies, the literature and the latest available socio-economic data was integrated with a state-of-the-art collection of climate change information.

Latvia

In Latvia, the analysis in the CCIV assessment covered the cause-effect relationships between climate change parameters and their environmental and sectoral impacts (VARAM, 2020). This also incorporated socio-economic losses and gains to reveal the interaction between climate change and other environmental impacts.

Assessment of adaptation options

Even if the majority of CCIV assessments identified concrete adaptation measures, broadening their scope and making them relevant to many stages of the adaptation policy cycle (EEA, 2018a), the methods applied for identifying and evaluating adaptation options vary across countries.

Useful information for comparing and prioritising adaptation options includes the scope of the measure, the social and ecological costs and benefits, those responsible for implementing the measure, the financial resources needed, and the time frame required for its implementation.

Given the importance of assessing possible options in terms of time, costs, benefits and efforts as well as cross-cutting issues, trade-offs and synergies, methodologies to prioritise and select the preferred measures easily become complex and have partly overlapping methods. Step 4 of the adaptation support tool (see Figure 0.1) is about assessing adaptation options ⁽²⁵⁾ and includes information on costs and benefits for different climate hazards and economic sectors as well as links to the Mediation Toolbox ⁽²⁶⁾ for more options.

Finally, the example of Cyprus (see Box 2.4) shows that it is important to engage multiple actors in this process to integrate different viewpoints in assessing different options. Bringing

knowledge of a wider range of policies and frameworks at international, European and national levels, e.g. the Sustainable Development Goals (SDGs), sectoral policies such as the Water Framework Directive or environmental assessment directives (see Section 3.1.2), to the same table will be helpful to capitalise on synergies and select measures supporting different agendas.

Increasing importance is assigned to the potential loss of ecosystems and ecosystem services. Consequently, countries have often identified ecosystem-based adaptation (EbA)* measures in their adaptation options to increase the ecosystem service potential compared with 'traditional' or grey measures (EEA, 2015a). For instance, some countries have assessed agricultural crops or wood species that are more resilient to changing growing conditions, or revised logging plans to avoid areas that are sensitive to increasing rainfall and run-off.

The benefits of EbA usually apply to a wide range of sectors and stakeholders. Therefore, cost-benefit analysis of EbA may lack a knowledge base, and the need to assess and rank against other options calls for more comprehensive methodologies. For instance, natural capital methodologies are powerful tools to help value nature's benefits, raise levels of understanding and inform planning processes (GCA, 2019).

⁽²⁵⁾ Read more on adaptation options on Climate-ADAPT at <https://climate-adapt.eea.europa.eu/knowledge/adaptation-information/adaptation-measures>.

⁽²⁶⁾ <http://mediation-project.eu/platform/toolbox/toolbox.html>

Box 2.4 Ranking of adaptation options in Italy and Cyprus**Italy**

Italy's proposed national adaptation plan (NAP) (currently under evaluation) builds upon previous climate change, impacts and vulnerability (CCIV) reports to identify vulnerable sectors, adaptation actions, and climate change indicators to come up with a robust method of systematically ranking priority issues (CMCC, 2017).

Vulnerable sectors (including coastal zones, water resources, agriculture, food production, tourism, urban areas and energy) and homogeneous climatic regions were first identified within the national adaptation strategy (NAS) based on literature review, risk indices and expert appraisal. The NAP, building on the information in the NAS, proposes sets of adaptation actions for each sector and region. These are available in a database of 350 different adaptation actions. Based on effectiveness, economic efficiency, second-order effects, considerations of political implementation, and performance under uncertainty, all actions were reviewed to find the most preferable.

Two RCP scenarios (RCP4.5 and RCP8.5) were first used to rank the climate risks and specific impacts for different regions and sectors and then to identify priority measures in relation to the different risk scenarios. The same measure, in fact, can be ranked with very high priority in the RCP4.5 scenario, but can only be ranked with high/medium priority if the climate scenario becomes worse and further measures are needed to achieve a higher level of protection for the elements at risk. Some actions were identified as useful for only one specific sector, whereas others could be useful for more than one sector or on the national scale.

Cyprus

Taking into account 11 sectors ^(a), Cyprus applied a multi-criteria analysis of adaptation measures using a qualitative approach. The evaluation criteria — efficiency, economic and technical viability, urgency, public acceptance, and how useful they would be even without climate change — were used to weight the proposed measures as well as stakeholder input from non-governmental organisations, national authorities, research institutes and civil society organisations.

The results are presented in the NAS (Environment Department Cyprus, 2017), where adaptation measures are weighted according to their importance in terms of criteria categorised as technical, social or environmental. A cost-benefit analysis is planned to integrate economic criteria within this system. The highest performing measures are integrated within the NAP.

Note: ^(a) Water resources, land use, seaside areas, biodiversity, forestry, agriculture, fisheries, tourism, energy, infrastructure, public health.

Science-policy interface

The results of the vulnerability assessments are an important input when developing any policy for a country and there is a need to ensure that the scientific assessment is effectively connected to the policy development (EEA, 2018a). A diverse and dynamic interaction between science and policy is necessary to avoid knowledge gaps, such as a lack of up-to-date adaptation awareness and not considering cross-border impacts.

The possibility of feedback between scientists and policymakers, as well as effective sharing of knowledge and information, will be crucial to the successful implementation of adaptation policy (see the example in Box 2.5).

Strengthening the science-policy interface can also be approached by incorporating scientific information in monitoring and evaluation processes. An example is the results of the most recent national climate risk assessment from Finland, incorporated in the mid-term evaluation of the Finnish NAP in 2018-2019 (see Box 2.6).

Box 2.5 Linking science to policy in Portugal

Portugal has been reducing the gaps between science and policy by improving access to information and knowledge transfer and through the governance structure of the national adaptation strategy (NAS), particularly under its 'research and innovation' thematic area and its scientific panel.

The NAS 'research and innovation' thematic area, coordinated by the Portuguese Environment Agency and the public Foundation for Science and Technology, intends to ensure the effective implementation of the NAS through promoting national science and knowledge in relevant areas. This thematic area ensures interaction between other NAS structures, especially the sectoral working groups coordinated by central administration bodies responsible for the development and implementation of sectoral policies. In addition, a cross-sectoral scientific panel of 20 scientists is responsible for advising and providing scientific support to the activities taking place under the NAS. The scientific panel also follows the progress of the NAS and provides suggestions for its implementation.

A good example of outcomes of both of these structures is the research and innovation agenda for climate change, developed in 2019, which the scientific panel had a vital role in drafting. The development of this agenda ensured articulation with the NAS sectoral central administration bodies and other stakeholders to identify needs and knowledge gaps.

User-friendly climate platforms such as Portal do Clima ^(a) and adaptIS ^(b) bring together knowledge on climate change indicators and adaptation measures in an accessible manner for both stakeholders and the general public. These tools promote the uptake of knowledge by making information available in local languages, presenting inspirational and practical case studies and using interactive websites to encourage stakeholder collaboration.

A scientific process providing guidance to policymakers is the recently introduced Portuguese climate change, impacts and vulnerability assessment, which will establish a roadmap for adaptation that will be central to the revision of the NAS.

Notes: ^(a) <http://portaldoclima.pt/en>
^(b) <http://www.adaptis.uc.pt>

Box 2.6 Use of climate risk assessment results in the mid-term evaluation of Finland's national adaptation plan

In Finland, the most recent national weather and climate risk assessment was completed in 2018. The assessment covered hydro-meteorological and climatic risks for different sectors, including various natural resource-based sectors (e.g. water management, biodiversity, forestry and agriculture) as well as energy, transport, industry, built environment, finance, insurance and human health.

Also in 2018, the mid-term evaluation of the national adaptation plan (NAP) started. The results of the national weather and climate risk assessment were used as inputs to the mid-term evaluation. Findings on sectoral risks and connections to other sectors identified (i.e. how risks transfer and cascade across sectors) were discussed in sectoral focus group interviews. National-level stakeholders from ministries and agencies were engaged to discuss and prioritise the risks identified. Stakeholders were also asked to assess their sector's current level of readiness to respond to these risks.

This way of using the results of the most recent climate risk assessment enabled the mid-term evaluation to be more up to date. Stakeholders were able to assess their sector's capacity to manage risks based on the latest information on risks, rather than relying on information on risks that had served as the knowledge base for the development of the NAP many years earlier. The previous aggregation of climate risks and vulnerabilities had been published in 2012.

Source: Mäkinen et al. (2019a) — a version in English is under preparation.

2.1.2 National risk assessments

The Decision on the EU Civil Protection Mechanism, amended in 2019 (EU, 2019b), obliges the EU MSs⁽²⁷⁾ to conduct, every 3 years, national risk assessments (NRAs) and assessments of risk management capability. NRAs are expected to identify natural and man-made risks that are sufficiently serious to trigger major civil contingencies. The summaries of the assessment are to be made available to the European Commission. For key risks with cross-border impacts, and for risks characterised by low probability but high impact, the reporting obligation includes a summary of the priority prevention and preparedness measures adopted.

An analysis of the 2015 NRAs, conducted by the Commission, shows different levels of detail and completeness. NRAs are completed from sub-national risk assessments, assembled into national inventories or built around risk scenarios of national significance. Most assessments pondered short time-frame scenarios (up to the next 5 years). Longer horizons allowing the capture of the impacts of climate change on weather and climate-related hazards would lead to better informed policies and more resilient development (EC, 2017d). National CCIV assessments could benefit from closer coordination with national risk assessments conducted with a view to disaster prevention and risk reduction (EEA, 2018a). The analysis by the Commission of updated NRAs submitted in 2018 is under development and is expected to be published in 2020 (personal communication with the European Commission Directorate-General for European Civil Protection and Humanitarian Aid Operations).

The Disaster Risk Management Knowledge Centre (DRMKC) was launched in 2016 to bring together the expertise of various Commission services and to create a knowledge platform engaging experts, practitioners and policymakers, within and beyond the EU. It has been established to foster partnership, co-develop knowledge and support innovative disaster risk management solutions that benefit NRA processes. The DRMKC publishes periodic review reports (Poljanšek et al., 2017) on disaster risk management. In 2019, the Joint Research Centre developed and published *Recommendations for national risk assessment for disaster risk management* (Poljanšek et al., 2019).

The Organisation for Economic Co-operation and Development (OECD) has reviewed NRAs in 20 developed countries (OECD, 2018b), including in 15 European countries⁽²⁸⁾. The review found that longer term assessments of the potential effects of climate change are beginning to feed into national planning and regulations. The OECD has systematically promoted NRAs as a good practice in disaster risk management

since 2009 and inaugurated the High-Level Risk Forum to facilitate the exchange of experiences and insights. Jointly with the G20 nations, the OECD developed a methodological framework for disaster risk assessment and risk financing (OECD, 2012). The 2018 review builds upon expert interviews and includes countries' fiches summarising the governance framework, methods used and challenges encountered.

2.1.3 Assessment of transnational climate risks

The negative impacts of climate change outside Europe are considerable and may result in increasing risks for Europe and its countries. Such international impacts occur, for example, through the distribution of pests and diseases, disruption of food and trade flows, import of resources for industries, increasing price fluctuations due to weather extremes, increasing social disruption in vulnerable states and an increasing pressure on humanitarian aid programmes. This aspect of international climate risk falls outside the scope of this report, as the EEA is working on a briefing addressing this complex topic (EEA, forthcoming).

Countries within Europe also face the need to respond to transnational risks and adaptation challenges in transboundary river basins, addressing flood risks, droughts and water quality issues, and in so-called mega-regions such as the Alps or the Baltic Sea, addressing the other climate-related risks. Awareness of transnational climate risks is increasing both at the European level and at the national level. All but one EU MS integrated some elements of transboundary cooperation to address common challenges with relevant countries, almost invariably with regard to water, and more occasionally with regard to biodiversity, energy or health issues (EC, 2018b). The focus in the EU adaptation strategy (EC, 2013c) was also on the transnational impacts occurring within the European border, while the recent review of its implementation (EC, 2018e) recommends an increasing emphasis on risks from climate impacts that (may) materialise elsewhere. European vulnerability to transnational effects is expected to increase in the coming decades, but quantitative projections are not available (EEA, 2017b, Section 6.4).

There are six major pathways through which climate change impacts can be transferred: biophysical, critical infrastructural, trade, financial, social and geopolitical pathways (Rüttinger et al., 2015; Vonk et al., 2015; Benzie et al., 2016; EEA, 2017b; Forzieri et al., 2018; Hedlund et al., 2018; Tobin et al., 2018). At the European level, there are multiple policy instruments that address some elements of transnational risks within Europe, mainly related to the biophysical and critical

⁽²⁷⁾ And other participating countries, being Iceland, Montenegro, North Macedonia, Norway, Serbia and Turkey.

⁽²⁸⁾ Austria, Denmark, Estonia, Finland, Germany, Hungary, the Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

infrastructural pathways, as well as transnational risks beyond Europe's borders, mainly related to the social and geo-political pathways, as well as transnational risks beyond Europe's borders, mainly related to the social and geo-political pathways (see Table 2.1 for some examples). It is interesting to note that the strongest evidence of cross-border impacts is for economic effects and shocks (EC and High Representative of the Union for Foreign Affairs and Security Policy, 2017), but that there seem to be no policy instruments in place at the European level dealing with climate change for the trade and financial pathways.

Cross-border and transnational climate risks are one area where new knowledge is rapidly emerging (Benzie et al., 2019; Benzie and Persson, 2019). Two projects have been initiated to address these risks under the EU research and innovation framework programme Horizon 2020: Cascades (Cascading climate risks: towards adaptive and resilient European societies, 2019-2023) and Receipt (Remote climate effects and their impact on European sustainability, policy and trade, 2019-2023) (Cordis, 2019a, 2019d). Further comparative assessment is needed to analyse how the transnational climate risks identified have been translated into policy responses within the climate adaptation or national security policy domains.

Table 2.1 Overview of European transnational climate risks and examples of EU policies addressing them

Types of pathways	Types of risks	Examples of EU policy instruments
Biophysical	Physical: water, wildfire	- Transboundary floods, droughts, wildfires ... - EU Floods Directive (EU, 2007) and EU Water Framework Directive (EU, 2000) and transboundary river commissions, for the Danube, Rhine, Meuse, etc. - Interreg regions ^(a), EU macro-regional strategies ^(b) and other territorial conventions ^(c)
	- Human vector-borne diseases - Pests and diseases	- Arrival of new human diseases and animal/plant pests and diseases - EU and World Health Organization Parma Declaration ^(d) - WHO Global Outbreak Alert and Response Network (GOARN) ^(e), together with the European Centre for Disease Prevention and Control ^(f)
	Plant/animal species mobility	- Changing distribution patterns of species affecting nature conservation targets and ecosystem functioning - EU Birds and Habitats Directives (EU, 1992, 2010)
Critical infrastructure	Disruption of (transboundary) electricity, transport and information and communication technology networks ...	EU initiatives to reduce risks concerning critical infrastructure ^(g) (see also Box 3.2 Examples of initiatives to reduce transboundary critical infrastructure risks)
Social	Social disruption and increasing mobility and movement of people beyond borders	- Partnership framework with third countries under the European agenda on migration (EC, 2016c) - EU external investment plan: investing together in creating jobs and development (EC, 2020c)
Geo-political	Disruption of political stability of vulnerable states	- Global strategy for the European Union's foreign and security policy (EEAS, 2017) - Strategic approach to resilience in the EU's external action (EC and High Representative of the Union for Foreign Affairs and Security Policy, 2017) - Foreign Affairs Council conclusions on climate diplomacy (EU, 2018a)

Notes: ^(a) <https://interreg.eu/list-of-programmes>

^(b) https://ec.europa.eu/regional_policy/en/policy/cooperation/macro-regional-strategies

^(c) For example the European Outline Convention on Transfrontier Co-operation between Territorial Communities or Authorities (<https://www.coe.int/en/web/conventions/full-list/-/conventions/rms/0900001680078b0c>)

^(d) http://www.euro.who.int/__data/assets/pdf_file/0011/78608/E93618.pdf

^(e) https://www.who.int/ihr/alert_and_response/outbreak-network/en

^(f) <https://www.ecdc.europa.eu/en/home>

^(g) For example <https://ec.europa.eu/jrc/en/research-topic/critical-infrastructure-protection>, https://ec.europa.eu/home-affairs/what-we-do/networks/critical_infrastructure_warning_information_network_en

2.2 Monitoring, reporting and evaluation informs policy revisions and planning of measures

Information generated by MRE of adaptation policies enhances the knowledge base for adjusting policies and measures. Countries that have longer experience of implementing adaptation policies can make use of regular monitoring results to steer the adaptation process. Periodic evaluation of adaptation policies can support the revision of policies by offering lessons learned in implementation and insights into what is working, under what conditions and why.

In 2015, only a handful of European countries were at a stage of implementing adaptation MRE and only Finland, Germany and Portugal had adopted a second NAS. The limited evidence available indicated that countries were using the results of MRE to inform revisions of adaptation strategies and plans. There was, however, little evidence of how these results were influencing policy revisions (EEA, 2015b).

Up to 2019, 11 countries had revised their NAS (see Table 1.2). In addition, a number of countries, including Austria, France, Spain, Switzerland and the United Kingdom had revised their NAP (see examples from Austria and the United Kingdom in Box 2.7), sometimes already more than once (e.g. Spain). However, 24 out of 28 MSs had plans for periodically reviewing their NAS and/or NAP. Information on NAP revisions and on the frequency of planned policy revisions is not consistently available. The most common time-frame among those

countries that stated one for policy revisions is every 4-5 years but it ranges from once a year to once a decade (EC, 2018b, 2018e; EEA, 2019c).

Although policy processes and national circumstances vary across countries, there are also shared lessons to be learnt. Insights, in particular from countries working with adaptation indicators (ETC/CCA, 2018b), highlight the importance of addressing MRE at the stage of policy development. Clear formulation of an adaptation policy (either strategy or plan) and especially its aims and targets enables a more focused MRE system. Concrete targets facilitate their monitoring and eventually bring about an improved knowledge base, including lessons learned on progress, outcomes and impact, that can enhance adaptation policy and practice. Furthermore, clear formulation of the requirements and objectives of MRE creates a mandate for using the results of MRE more effectively to inform policymaking and practice, and evaluations can better demonstrate the effectiveness and efficiency of adaptation policy and practice (EEA, 2015b; Mäkinen et al., 2019b).

There still is a clear need for better understanding of how to set more explicit and clear objectives that can be more easily measured, monitored and towards which progress can be assessed. Finding a balance between setting explicit policy objectives/aims/targets and maintaining the flexibility of MRE systems is likely to be beneficial (EEA, 2015b; ETC/CCA, 2018b). Given the iterative nature of adaptation, it is essential that MRE also supports the identification of emerging issues in addition to assessing past performance.

Box 2.7 Policy revisions and planning of measures in the United Kingdom and Austria

United Kingdom

In the United Kingdom the first national adaptation programme (similar to a national adaptation plan, so hereafter NAP), published in 2013, was evaluated twice (2015 and 2017) by the Committee on Climate Change (CCC), which is the United Kingdom's independent advisory body on adaptation and mitigation policies and progress. The key criticisms of the 2013 NAP were that it required clear priorities for adaptation to be set; it needed to ensure that objectives were outcome focused, measurable, time bound and under clear ownership; and it needed to prioritise the core set of policies and actions that would have the biggest impact (CCC, 2017). These points should have informed and improved the United Kingdom's second NAP, published in 2018, but the CCC's 2019 evaluation of the second NAP made it clear that the 'Government has failed to increase adaptation policy ambition and implementation through its latest National Adaptation Programme' (CCC, 2019). So, although the UK has a logical monitoring, reporting and evaluation (MRE) process, it has so far not improved progress in adaptation because the CCC's recommendations have not been implemented.

Austria

In Austria, the first progress report (Kronberger-Kießwetter et al., 2015; Bundesministerium Landwirtschaft, Regionen und Tourismus, 2019) on the implementation of the Austrian adaptation strategy helped to clarify the definition of adaptation targets at the sectoral and single measure levels. Based on these MRE results, sector goals were introduced in the revised national adaptation strategy (NAS) and NAP. One of the lessons learned was that not all aspects of adaptation processes are 'measurable'; thus, the analysis of quantitative and qualitative data and information only provides input for partial or indirect statements. As there are different ways of interpreting quantitative and qualitative data, a common understanding is needed and can be ensured with strong stakeholder engagement during MRE and NAS/NAP revision.

In addition to the results of adaptation MRE, revisions of policies and measures may also benefit from monitoring and evaluation of other, closely linked policy fields. Given the connectedness of CCA to sustainable development and disaster risk reduction, lessons learned in these policy fields can also be informative for further developing national adaptation policies (ETC/CCA, 2017).

The insights and experiences collected through MRE should be harnessed to ensure policy coherence, to understand and address challenges identified throughout the reviews of progress, to build resilience comprehensively across societies and to foster learning processes. The IPCC special report *Managing the risks of extreme events and disasters to advance climate change adaptation* (IPCC, 2012) adapted the theory of institutional learning and 'learning loops', not least drawing on insights from MRE. In single-loop learning processes, strategies and plans are revised based on the difference between what is/has been expected and what is/has been observed.

Single-loop learning focuses on improving the efficiency of actions and identifying possible marginal improvements. Double-loop learning comprises evaluation of whether policy goals and targets are (still) appropriate and whether previously identified opportunities have been exploited. Triple-loop learning questions deeply rooted norms and principles that guide adaptation and risk mitigation actions. In doing so, it addresses 'social structures, cultural norms, dominant value structures, and other constructs that mediate risk and risk management' (IPCC, 2012).

2.3 Stakeholder involvement has a key role in adaptation's success

The true engagement of stakeholders in the policy development and planning process is likely to improve the outcomes of the process (Gardner et al., 2009). Stakeholders' views can be particularly informative in assessing the viability of adaptation options and in ensuring that measures are appropriate for their intended contexts. Importantly, stakeholder engagement* in policy development and adaptation planning paves the way for their implementation.

The objective of effective and inclusive adaptation action has given rise to the notion of 'deeper' forms of stakeholder involvement, such as active involvement, partnerships and empowerment, throughout the policy cycle, in development, implementation and evaluation processes. The added value of stakeholder involvement in general in developing and implementing adaptation policy has been widely recognised in both policy documents and the scientific literature (EEA, 2014a; Conde and Lonsdale, 2015; Wamsler, 2017; IPCC, 2018). The overall aim of stakeholder in policy processes is to address challenging problems, such as CCA, that one party alone would not be able to solve, to accelerate action by building on possible existing synergies and to create win-win conditions for all stakeholders (ISPRA, 2014).

However, a decade ago the use of deeper forms of involvement was not the norm in adaptation-related decision-making processes (Gardner et al., 2009; EEA, 2014a). There are many possible reasons for this, but particularly important are the facts that stakeholder engagement is demanding in terms of time, resources and skills, and it involves giving up a degree of control to people beyond the instigating group or organisation, which can threaten the adoption of a preferred outcome (EEA, 2014b). Although there are no truly comparable data available on the type or level of engagement, all except two EU MSs have dedicated processes in place to involve stakeholders when planning adaptation policies. Government authorities, local authorities, non-governmental organisations (NGOs) and research organisations are in one way or another involved in almost all countries, while the private sector and the general public are involved in a structured way in fewer than 20 countries (EC, 2018b).

In general, horizontal inclusion, involving governmental stakeholders from national and sub-national level, is more comprehensive than vertical inclusion, involving stakeholders from the private sector, interest groups (e.g. NGOs), scientific community or general public. For example, in Czechia for the preparation of the 2015 NAS, a comprehensive group of representatives of national governmental bodies and the scientific community was actively involved, and regional and municipal representatives also had an opportunity to participate through consultation, whereas no representatives from the private sector were involved in the active development phase of the NAS. NGOs (and their associations) were mainly involved in the preparation of the NAP rather than of the NAS. Moreover, more collaborative forms of stakeholder involvement, dialogue processes, workshops, panels, partnerships and empowerment are more common in the case of governmental actors, whereas stakeholders from other sectors have typically been involved in more straightforward consultation, information gathering or information sharing. For example, for the Swiss NAS (2012), several federal agencies shared the responsibility of adaptation, while the views of other stakeholders, authorities, insurance companies and NGOs were addressed through a survey. Box 2.8 gives a more detailed example from Northern Ireland.

There are no clear data available on stakeholder involvement during the revision of adaptation policies compared with their involvement during the original policy development. For example, in Austria, the stakeholders that were involved in the broad engagement process during the preparation of the first NAS and NAP (EEA, 2014a) were involved in a written consultation procedure during the revision.

In Ireland, the federal ministry that coordinates national adaptation policy has recently enhanced the stakeholder working groups supporting policy development, implementation and monitoring. In 2016, the Climate Change Advisory Council was established, providing advice in relation to the preparation of the national adaptation framework.

Box 2.8 Cross-sectoral participation in Northern Ireland

Under the 2008 UK Climate Act, the Northern Ireland Executive is legally required to develop a climate change adaptation programme (NICCAP) every 5 years. These programmes outline how the government will work to address the opportunities and challenges of climate change as identified in the Climate Change Risk Assessment National Summary report for Northern Ireland.

The preparation of NICCAP 2019-2024 was the first time that adaptation activities from external stakeholders had been included in the Northern Ireland adaptation programme. The existing adaptation work planned by civil society was mapped and an online submission form was used to gather proposed actions for inclusion in the NICCAP. Furthermore, the information gathered was presented and published as a chapter, 'Civil society and local government adapts', in NICCAP 2019-2024. It details the adaptation activities to be undertaken during the 5 year programme by three groups of external stakeholders (academic, voluntary and community, and private). The chapter was written by Climate NI, a partnership of external stakeholders from a range of key sectors, which provides advice and support to government with the aim of increasing the understanding of the impacts of climate change, sharing best practice and promoting action to address the impacts of climate change.

Departments tasked with developing sectoral adaptation plans are also required to consult the Climate Change Advisory Council on their preparation, and the letters from the Council (2020) providing advice and recommendations on draft sectoral adaptation plans are publicly available. In 2018, the federal ministry entered into a 5-year financial commitment of EUR 10 million to establish four climate action regional offices (CAROs). In addition to developing local adaptation climate action measures, CAROs enable more coordinated engagement across the whole of government and will help build on the experience and expertise that exists across the sector, supporting national adaptation policy.

In Portugal the level of stakeholder involvement was strengthened between the first and the revised NAS. During the development of the first NAS, a consultative process was conducted to involve stakeholders in defining key action areas and adaptation measures. The revision of the strategy emphasises the importance of engaging a large number of stakeholders in defining and planning adaptation policies. The organisational structure consists of nine sectoral working groups and six cross-cutting thematic area working groups, which have responsibility for identifying adaptation measures and implementing these in coordination with other working groups and stakeholders at the national and sub-national levels. A scientific panel and the Interministerial Commission on Air, Climate Change and the Circular Economy support the stakeholder consultation process.

2.4 Lessons learned, remaining knowledge gaps and key challenges for developing adaptation policy

MRE serves multiple purposes such as tracing progress made, assessing what has been accomplished, and communicating the processes and outcomes of adaptation. It provides feedback on the adaptation's progress and performance, namely whether

the adaptation goals, targets and efforts are sufficient and how they contribute to reducing vulnerability to climate change. But the overarching goal of MRE is to enable 'new information and lessons learned to shape future decisions' within an iterative policy- and agenda-setting cycle. Adaptation planning is often based on a conditional, uncertain or otherwise incomplete understanding of changing climate risks. Thus, MRE is also expected to continuously improve existing knowledge on climate change impacts and vulnerability and/or to help identify key challenges, opportunities and remaining knowledge gaps.

As more countries gain experience of implementing national adaptation policies, information from monitoring and evaluation activities has emerged as a significant source of knowledge for developing adaptation policies and measures. Understanding what works, under which conditions and why offers insights on which countries can draw to revise and further improve their adaptation policies. Knowledge of how implementation has progressed and the lessons learned from the process also provides substantial opportunities for learning that can support the development of policies and measures more broadly. Back in 2013, the EU adaptation strategy emphasised four areas in which knowledge gaps hampered adoption and/or implementation of adaptation actions (EC, 2013c, emphasis added):

1. **making the case for action:** projected costs and benefits of impacts and adaptation;
2. **scale:** regional- and local-level analyses and risk assessments and assessments at ecological zone level;
3. **uncertainty:** frameworks, models and tools to support decision-making within uncertainty and to assess the effectiveness of adaptation measures;
4. **measuring progress:** monitoring and evaluation of past adaptation efforts.

The 2018 evaluation of the strategy acknowledged that, despite a substantial increase in the knowledge base, none of the priority knowledge gaps have been fully closed, and new gaps have emerged (EC, 2018b). From among the persistent gaps, the European Commission staff working document highlighted (EC, 2018b):

- costs and benefits of effective adaptation solutions;
- detailed knowledge of regional- and local-level adaptation issues;
- design and implementation of climate services conveying the best available climate data to support adaptation;
- decision-making and policymaking support tools and assessments;
- robust methods and tools to address uncertainties.

Persistent knowledge gaps related to MRE include monitoring systems and tools to evaluate past adaptation efforts and the design and choice of indicators measuring the progress of adaptation and the effectiveness of adaptation measures.

The Commission also commissioned studies to assess our knowledge in selected thematic areas: vulnerability assessment, ecosystem-based adaptation, infrastructure adaptation (Downing, 2017; Hendel-Blackford et al., 2017; McVittie et al., 2017). These studies have highlighted additional gaps such as the transferability of context-specific evidence; performing ecosystem approaches on a large scale; and prioritising competing land use objectives.

Advanced climate risk assessment needs to respond to comprehensive scenarios addressing both climate and societal dynamics, capture interdependencies of impacts across different sectors and geographical regions, and trace cascading and spill-over impacts using standardised approaches and tools, making it possible to compare and prioritise risks. Contemporary assessments pay insufficient attention to compound or correlated climate extremes (Sadegh et al., 2018; IPCC, 2018). National CCIV assessments could benefit from closer coordination with national risk assessments conducted with a view to disaster prevention and risk reduction (EEA, 2018a).

Since the adoption of the EU adaptation strategy, significant investments have been made by many MSs to transfer adaptation data and information to a range of stakeholders, e.g. through national web-based platforms. At the European scale, this role is fulfilled by Climate-ADAPT (EEA, 2015c, 2018c). Further capacity-building efforts are needed to foster the education and training of different sectors of society and ensure stakeholders' capacity to use and act upon improvements in the knowledge base. As the knowledge base for adaptation policymaking improves, effective and targeted communication of information to different stakeholders enhances their capacity

to use the best available knowledge. Supporting regular dialogue between policymakers and the scientific community, as well as other stakeholder groups, further increases the capacity of different actors to use information on climate risks in their planning and decision-making processes.

The complementarity of national risk assessment and climate risk assessments ensures that climate change is mainstreamed into implementing prevention and preparedness measures. There is a need to improve the level of coherence among different national/regional risk assessments and to mainstream the cross-sectoral dimension in risk or multi-risk assessment. This is relevant in cases such as climate change policy, spatial planning and EU legislation in the areas of flood risk, droughts, risks of accidents with dangerous substances and risks to the European critical infrastructure.

The overall aim of stakeholder involvement in policy processes is to address challenging problems that one party alone would not be able to solve, to accelerate action by building on possible existing synergies and to create win-win conditions for all stakeholders (ISPRA, 2014). The benefit of stakeholder involvement in adaptation policy development and implementation has been widely recognised in both policy documents and the scientific literature (EEA, 2014a; Conde and Lonsdale, 2015; Wamsler, 2017; IPCC, 2018).

In MRE, stakeholders' views can be particularly informative in assessing the viability of adaptation options and in ensuring that measures are appropriate for their intended contexts. Importantly, stakeholder involvement in policy development and adaptation planning paves the way for their implementation.

The objective of effective and inclusive adaptation action has given rise to the notion of 'deeper' forms of stakeholder involvement, such as active involvement, partnerships and empowerment, throughout the policy cycle — in development, implementation and evaluation processes. The use of deeper forms of stakeholder involvement was not the norm in adaptation-related decision-making processes (Gardner et al., 2009; EEA, 2014a) a decade ago.

Although there are no truly comparable data available on the type or level of engagement, all except two EU MSs have dedicated processes in place to involve stakeholders when planning adaptation policies. Government authorities, local authorities, NGOs and research organisations are one way or another involved in almost all countries, while the private sector and the general public is involved in a structured way in fewer than 20 countries (EC, 2018b).

Particularly important are the facts that stakeholder engagement is demanding in terms of time, resources and skills, and it involves giving up a degree of control to people beyond the instigating group or organisation, which can threaten the adoption of a preferred outcome (EEA, 2014b).



3 Implementation of adaptation

Key messages

- At EU level, the mainstreaming of climate adaptation into policy has become much more widespread, covering a broader range of sectors including water, urban, disaster risk reduction and agriculture as well as cross-sectoral policies such as those on environmental impact assessment and insurance policy.
- EEA member countries are mainly addressing the agriculture, water, biodiversity and forestry sectors in their national adaptation policies. However, only six EU Member States have national policy instruments that promote adaptation at sectoral level, in line with national priorities and in areas where adaptation is mainstreamed in EU policies.
- Awareness of and collaboration on transboundary climate change challenges within the European territory is high, and climate change risks are increasingly better integrated (albeit unevenly across countries) in the European Floods Directive and instruments such as the Interreg regions, EU macro-regions and various other sea or territorial conventions. Most transnational collaboration and projects within Europe focus on 'soft actions' and are not expected to directly implement concrete adaptation actions on the ground. On water issues, the focus of adaptation is mainly on floods, while the ecological status aspects of the Water Framework Directive are lagging behind.
- Stakeholder engagement can help to ensure uptake from sectoral actors and thus strongly support implementation. This varies between statutory requirements (such as climate acts) and voluntary approaches, under which stakeholder engagement comes more strongly into play for implementing the measures envisaged in the climate adaptation action plans.
- Monitoring and evaluation are very relevant to documenting the impacts of implemented policies and can ensure that learning loops are in place to further support implementation. Monitoring, reporting and evaluation has the potential to be a key means of informing more effective adaptation implementation. Over time, there will be greater clarity on what works and what does not, which will help to avoid maladaptation.
- Public finance is increasingly being directed towards climate change adaptation (e.g. through European structural funding programmes), but private sector finance is harder to identify. Awareness of the need for this to come onstream needs to be raised, and monitoring, reporting and evaluation of adaptation financing from both public and private sources needs to evolve.
- EEA member countries have included ecosystem-based adaptation (EbA) in assessing and implementing adaptation options in various ways, but implementing EbA on a large scale is at the experimental stage. Nevertheless, increasing monitoring and evaluation of EbA before and beyond the project implementation phase will help to identify benefits and potential trade-offs.

In the context of the adaptation policy cycle (Figure 0.1), implementation* is defined as putting 'a public adaptation policy into effect' — converting adaptation options into action. Once policymakers decide on, formulate and adopt an adaptation policy, then it is implemented, i.e. activities identified in the policy document are translated into concrete actions. The Intergovernmental Panel on Climate Change

(IPCC, 2014c, Chapter 15) identified the important role of monitoring and evaluation in informing implementation as 'implementing adaptation is a dynamic iterative learning process, and monitoring and evaluation help to adjust policy responses and actions to accommodate, for example, the availability of new information such as changes in climate and socio-economic conditions.'

The plurality of impacts of a changing climate across all kinds of human activity, and across all policy areas requires a multi-sectoral and cross-cutting approach. Thus, this chapter looks at different kinds of implementation and its enabling factors, starting with mainstreaming as a key feature of implementation, ensuring that adaptation is considered appropriately in diverse sectors and across sectors and disciplines.

Additional enabling/supporting factors are highly relevant, including, for example, stakeholder involvement and other participatory elements. In addition, the ongoing growth of the knowledge base during implementation is of importance, as well as the role of standards and guidance. For adaptation measures to be implemented, finance and other resources from both the public and private sectors must be available.

Implementation is looked at partly from actions per sector/theme and is partly monitored through sectoral action plans, updates and evaluations (e.g. Finland). The status of adaptation measures implemented in one theme/sector can, in the next step, be aggregated to the overall implementation level per theme/sector (e.g. Austria). This can be, for example, structured along the vulnerable sectors and thus can pinpoint priority sectors by country. Other sectoral/thematic reporting obligations can be used to support adaptation reporting. The financial performance of individual activities is monitored to some extent (e.g. in Lithuania, where this is done on an annual basis). Progress towards integrating adaptation into policy sectors can also be monitored through these reporting obligations. Water is one example of a sector where monitoring takes place for adaptation measures (e.g. as performed in the Dutch Delta programme or in the Danube River Basin Water Management Plan). Monitoring of adaptation, due to its cross-cutting nature, is often the duty of diverse agencies and ministries working on issues related to climate change adaptation (CCA). Thus, it is key to have adaptation components within their responsibility, which also ensures implementation. Often the 'line' ministries, with their sectoral/thematic adaptation plans, programmes and projects, are responsible for implementation and for its monitoring (EC, 2018a).

Tracking the progress of CCA, based on an Australian case study, also arrives at the conclusion, based on adaptation conferences organised, that there is evidence that adaptation in Australia is moving from being largely planning based towards implementation. There is also a call for research targeting identified knowledge gaps as essential to support effective adaptation (Palutikof et al., 2019).

3.1 Mainstreaming approaches and experiences

The term 'mainstreaming'* refers to the integration of CCA into related government policies in several sectors. Mainstreaming can also involve setting up institutional or organisational structures, or designing and implementing programmes, plans and projects in such a way that they 'automatically' take adaptation into account (Climate Policy Info Hub, 2020). Mainstreaming of CCA into other policy areas is seen as a major tool in adaptation policy and by definition aims to ensure coherence within vertical and horizontal adaptation policy development and its implementation. Also the NAP Global Network (Dazé et al., 2016; Price-Kelly et al., 2017) considered key elements for vertical integration that help monitoring, reporting and evaluation (MRE), which are institutional arrangements (e.g. decentralisation), information sharing (e.g. local needs and knowledge) and capacity building (e.g. a monitoring and evaluation system supported by different levels, integrating data and information for different governance levels and supporting learning and the integration of adaptation approaches into local planning).

Mainstreaming of CCA into EU sectoral policies and EU funds, including agriculture, biodiversity, buildings, coastal zones, disaster risk reduction (DRR), ecosystem-based adaptation, energy, finance, forestry, health, marine and fisheries, transport, urban, water management, as well as migration and social issues, is an essential component of a successful comprehensive adaptation policy ⁽²⁹⁾.

Various strategies for mainstreaming are being used that complement and reinforce each other. It can take place at different 'levels' (Wamsler and Pauleit, 2016), be it:

- legislative: e.g. acts and laws;
- strategies: diverse sectoral strategies;
- programmes/plans: diverse sectoral plans; or
- projects: all kinds of projects from soft or green to grey measures or actions.

Table 3.1 provides an overview of various complementary strategies for (and levels of) mainstreaming. Wamsler and Pauleit (2016) focused their research on the municipal levels of Germany and Sweden, but the focus in this chapter lies on mainstreaming efforts at the European, transnational and national levels and on providing different examples of MRE. Different ways of mainstreaming are then applied at different governance levels and also related to the governance structures of EEA member countries.

⁽²⁹⁾ As presented and summarised for existing sectoral adaptation policies on the Climate-ADAPT portal: <https://climate-adapt.eea.europa.eu/eu-adaptation-policy/sector-policies>.

Table 3.1 Complementary strategies for (and levels of) mainstreaming

Strategy	Level of mainstreaming
Regulatory mainstreaming	Modifying formal and informal planning procedures, including planning strategies and frameworks, regulations, policies and legislation, and related instruments that lead to the integration of adaptation .
Directed mainstreaming	Giving higher level support to redirect the focus to aspects related to mainstreaming adaptation by, for example, providing topic-specific funding, promoting new projects, supporting staff education or directing responsibilities.
Add-on mainstreaming	Establishing specific projects, programmes or plans that are not an integral part of the implementing body's sector work but directly target adaptation or have adaptation-relevant aspects.
Programmatic mainstreaming	Modifying the implementing body's sector work by integrating aspects related to adaptation into plans, programmes, projects and operations.
Intra- and inter-organisational mainstreaming	Promoting collaboration and networking with other departments, individual sections or stakeholders (e.g. other governmental and non-governmental organisations, educational and research bodies and the general public) to generate shared understanding and knowledge, develop competence and steer collective issues of adaptation .
Managerial mainstreaming	Modifying managerial and working structures, including internal formal and informal norms and job descriptions, and configuring sections or departments, as well as personnel and financial assets, to better address and institutionalise aspects related to adaptation .

Source: Adapted from Wamsler and Pauleit (2016).

Many national adaptation strategies (NASs) and even more clearly national adaptation plans (NAPs) focus on mainstreaming adaptation into policies, strategies, programmes, plans and projects as an important approach for succeeding in implementing adaptation (defined as regulatory mainstreaming in Table 3.1). Mainstreaming can play a part in 'sectors of substance' such as water management, forestry and agriculture. The efforts are in the direction of identifying the potential impacts on the sector (e.g. by monitoring relevant criteria or indicators) and then paying more attention to them. Direct adoption of CCA aspects in a sector policy (e.g. modifying the building code, developing a new standard) is direct evidence of mainstreaming. Other policies, which have more of a procedural nature, such as environmental impact assessment, strategic environmental assessment, finance or taxation, are about climate-related criteria that do vary, depending on the context. Nevertheless, mainstreaming efforts can only become a reality if lived in practice and if progress and effects are monitored and tracked in terms of their implementation.

The majority of EEA member countries use and facilitate different kinds of and mixes of mainstreaming as a 'soft' measure to foster adaptation. Mainstreaming is one of the approaches supporting adaptation becoming an integral part of different policies/policy instruments (e.g. legislation, strategies, plans, programmes, projects, finance, education) for various themes and sectors (e.g. agriculture, water management, civil protection, health, transport, forestry and insurance). Additional mainstreaming into EU funds has also taken place (see Section 3.3) (EC, 2018b). If CCA is integrated into different

policies/policy instruments, its progress needs to be monitored and the results disseminated.

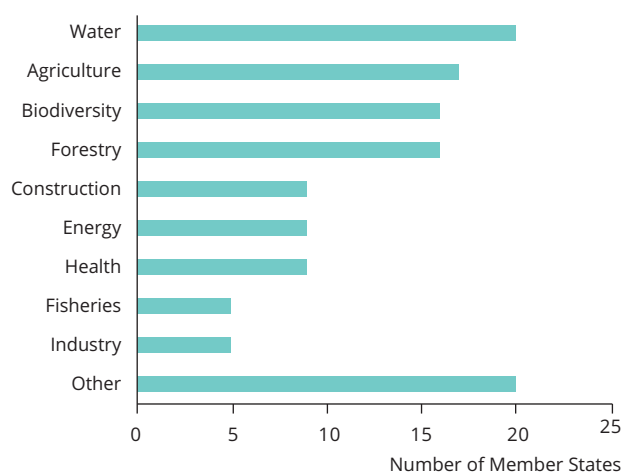
3.1.1 Mainstreaming at sectoral level

Adaptation had been mainstreamed into a broad range of sectors such as inland water, transport, biodiversity, migration and mobility, agriculture and forestry, maritime spatial planning, integrated coastal management, energy, disaster risk prevention and management, research, health and the environment. Mainstreaming into sectoral policies took place in particular in water policy, urban policy, DRR policy and the common agricultural policy (CAP). Progress on (regulatory) mainstreaming is clear in current EU policies and programmes. There might still be margin for improvement in the integration of adaptation in some EU common policies, such as trade and fisheries (EC, 2018e).

For some sectors, such as water management (see, for example, the guidance document *River basin management in a changing climate* (CIS WFD, 2009)) and agriculture, climate impacts are better understood and often refer to the near term. There is also guidance on dealing with climate change impacts in Natura 2000 areas (EC, 2013f). For these sectors, mainstreaming is more straightforward and easier to achieve in practice, whereas other areas in which climate change has been a more distant or abstract concept may require additional guidance to take mainstreaming on board.

At the country level and based on Member States' (MSs) reporting, only six MSs⁽³⁰⁾ have national policy instruments that promote adaptation at sectoral level, in line with national priorities and in areas where adaptation is mainstreamed in EU policies. However, all but two of the other countries are promoting adaptation in certain sectors, although there are significant gaps in others (e.g. construction, energy, fisheries, health and industry) (see Figure 3.1). In addition to those sectors specified in the figure, small numbers of MSs are mainstreaming adaptation in a wide range of 'other' individual sectors including insurance or (only in Denmark and Germany) alternative policy instruments providing incentives to invest in risk prevention (EC, 2018b).

Figure 3.1 Sectors in which national policy instruments promote adaptation



Note Data for 28 EU Member States only.

Source: EC (2018b, p. 147).

Some sectoral mainstreaming efforts in the areas of DRR, infrastructure, water, health and finance are described in this section.

Disaster risk reduction

There is a clear overlap between CCA and DRR. The connection is visible in terms of mainstreaming, for example:

- 'Both CCA and DRR are currently mainstreamed into key EU policies and strategies, including those for critical infrastructure protection, environmental protection, financial instruments of the Cohesion Policy and the EU Structural and Investment Funds (ESIF), agriculture, food and nutrition' (EEA, 2017a, p. 11).
- 'Adaptation to likely impacts of climate change is integrated (mainstreamed) in major EU sectoral policies by means of the European Union Solidarity Fund (EUSF)' (EEA, 2017a, p. 15).
- 'Adaptation to likely impacts of climate change is integrated (mainstreamed) in major EU sectoral policies by means of the European Structural and Investment Fund (ESIF)' (EEA, 2017a, p. 140).

In addition, climate projections (climate impacts) are considered in national disaster risk management plans (DRR strategies) in 9 out of 28 EU MSs (EC, 2018b).

Box 3.1 provides an example from Austria, where multi-level governance and exchange between stakeholders from DRR, natural hazard management and CCA collaborated in a working group on self-responsible risk precaution to develop a practical tool to be used by municipalities to support the first screening for natural hazard risks in a changing climate.

Box 3.1 Working Group on Self-Responsible Risk Precaution in Austria

In Austria, the Conference of State Environment Ministers (LURK), passed a resolution in 2015 that paved the way for tackling cross-cutting measures of the Austrian adaptation strategy and action plan by installing issue-specific horizontal and multi-level task forces. In 2017, the first of such interorganisational working groups was formed.

The so-called LURK AG is a temporary, informal, non-public and cross-sectoral cooperation format dedicated to the topic of 'self-responsible risk precaution'. It aligns administrative actors from the national and state levels representing the two policy fields, climate change adaptation (CCA) and natural hazard management. From an intense horizontal governance process, LURK AG has recently produced a tool to assess both climate impacts and natural hazards in municipalities in an integrated way, aiming at strengthening risk prevention and the preparedness of municipal and private actors. The group has also developed an implementation concept and a governance model for the country-wide launch of the assessment tool. The working group is a unique example of multi-level governance (led at national and state levels) and mainstreaming of CCA into natural hazard management at the municipal level.

Source: Lexer and Buschmann (2018).

⁽³⁰⁾ Belgium, Finland, Germany, Slovakia, Sweden and the United Kingdom.

Infrastructure

Concerning the biophysical risks to infrastructure, the EU focuses on mainstreaming CCA and thus increasing resilience in all major EU infrastructure investments and projects. To deal with transnational risks within Europe and support the

implementation of adaptation at the transnational scale, examples of EU initiatives on reducing risks to transboundary critical infrastructure are provided in Box 3.2.

Box 3.2 Examples of initiatives to reduce transboundary critical infrastructure risks

Infrastructures are 'critical infrastructures' when they are vital to ensure health, wealth and security. They include transport systems, energy systems, information and communication technology (ICT) systems, industry, water supply networks, and education and health infrastructures (e.g. Forzieri et al., 2018). The **physical** transnational **critical infrastructure** risks encompass mainly the transport systems, energy systems and ICT networks.

Climate change and extreme weather events increasingly affect all components of the energy system, with specific risks for hydropower in relation to water scarcity and thermal power plant cooling. Weather extremes affect the availability of primary energy sources (in particular renewable energy sources), the transformation, transmission, distribution and storage of energy, and energy demand. Future vulnerability will change further, as the European society and economy become more and more dependent on and interconnected by electricity and ICT systems, and the future energy system will be increasingly dependent on large- and small-scale wind, water and solar power. It is crucial that the changing risks and vulnerabilities are considered in the transition to clean energy (EEA, 2019a).

In addition, transboundary awareness of the changing vulnerabilities will be of importance as well as insights on the adaptation options to reduce these risks. A European Commission Joint Research Centre study concludes that, without adequate adaptation, damage to critical infrastructure in Europe due to climate extremes may increase on average six-fold by mid-century, with transport, energy and industry facing the highest losses with a 15-fold increase (Forzieri et al., 2016).

The EU aims to reduce future climate risks in critical infrastructure by, for example:

- mainstreaming climate adaptation in infrastructural investments from the European Regional Development Fund and Cohesion Fund (see Section 3.3) (EC, 2016d);
- the EU guidance on climate change and major projects in the 2014-2020 funding period (EC, 2016a);
- the CEN-CENELEC project on climate-proofing existing standards in infrastructure, mandated and financed by the European Commission Directorate-General for Climate Action (CEN-CENELEC, 2016, 2020);
- the EU financial institutions working group on climate change, integrating climate change into project development (EUFIWACC, 2016).

An example of active interaction between countries addressing critical infrastructure and adaptation challenges is the Benelux and North Rhine-Westphalia transboundary collaboration (Government of the Netherlands, 2013; Van Eerd et al., 2014; Benelux, 2016).

Benelux climate adaptation working group

The risks and opportunities of climate change and extreme weather conditions for the energy systems in the Benelux and neighbouring regions have been discussed in the Working Group on Climate Change Adaptation. Heavy rainfall, heavy snowfall, more and longer heat waves and periods of drought, sea level rise and more flooding will have important consequences for the energy systems in the Benelux region. The demand for energy will change radically, e.g. there will be an increased demand for electricity in the summer and a decrease in the demand for gas and fuel oil in the winter. Making the energy system resilient requires investment in the longer term and is very important if the economy and society are to continue to function. That is why it is imperative that the Benelux countries work together to maintain the resilience of the energy system and to anticipate the possible improvements needed (Benelux, 2016).

Water sector

Mainstreaming of adaptation is advanced in the water sector but mainly in relation to water quantity (floods and to some extent droughts) and less so when it comes to the key objective of protecting ecological status, as defined in the Water Framework Directive (EU, 2000) (see also Box 1.2).

When it comes to flooding, over half of the MSs considered climate change at the preliminary flood risk assessments and flood hazard and risk maps steps. From the flood risk management plans (FRMPs) assessed and from MSs' reporting, 24 of the 26 MSs ⁽³¹⁾ considered at least some aspects and 10 provided evidence that climate change impacts were considered. Fourteen MSs discussed future climate scenarios in their FRMPs. Less than half refer to the NASs prepared by MSs under the EU adaptation strategy. In about a quarter of MSs all FRMPs assessed referred to such national strategies; in a few more MSs some, but not all, FRMPs assessed included such references (EC, 2019h).

No less than 24 MSs provided evidence of having started to take account of climate change impacts already from the first cycle. Fourteen MSs have made specific links between their FRMPs and their national CCA strategies. More than half of the MSs have included measures to raise awareness of insurance schemes in their FRMPs, although insurance is not explicitly mentioned in the Floods Directive (EC, 2019b).

In the second round of FRMPs, by 2021, MSs will need to further refine and complement their analysis and set out the necessary measures. To support them in this process, the Commission's recommendations to all MSs (in addition to MS-specific comments) were to (1) clearly link the implementation of measures to the achievement of objectives so as to assess progress from the second cycle onwards; and (2) identify specific funding sources to secure the implementation of measures.

The European Commission recommends to MSs that the 2021 FRMPs should factor in the likely impact of climate change on the occurrence of flooding and adapt measures accordingly, making appropriate use of EU modelling tools such as those available through the Copernicus Climate Change Service (C3S), and consider to align their national climate change strategies and FRMPs and the measures included therein (EC, 2019h). Thus in the next step, mainstreaming and implementation efforts need to be more precise and made more explicit, based on the findings of the Commission's report.

Water is the most-cited pathway through which countries experience climate impacts and also the most-often prioritised sector through which countries seek to build resilience in their economies, their populations' livelihoods and their natural ecosystems (GWP, 2019). The guidance on addressing water in NAPs (GWP, 2019) calls for well-planned climate-responsive water management strategies and actions, which provide a significant opportunity to build resilience. This serves as a relevant contribution to mainstreaming climate change into water management planning and practice.

Health sector

In 2017, the World Health Organization Regional Office for Europe and the European Commission started a joint 18 month project to analyse developments in health policies to address adaptation to climate change in EU countries and to compile a selection of good practice case studies (Pagoda report; WHO Europe, 2018). Twenty out of the 28 EU Member States that participated in the Pagoda study ⁽³²⁾ reported that they had strengthened their public health capacities and their health systems to cope with impacts of climate change. Examples of strengthening infectious disease surveillance included increasing the frequency or number of sites of monitoring, expanding the list of notifiable infectious diseases, enhancing case definitions, updating protocols, initiating new monitoring for vectors and enhancing coordination between related institutions on infectious disease and vectors (WHO Europe, 2018).

In addition, 17 of the 20 responding countries have developed early warning systems for heat waves, 16 for flooding, 14 for cold spells, 13 for fires and nine for droughts. Heat waves, due to their growing frequency in recent years, are the only extreme weather event to have health response plans in 12 countries (WHO Europe, 2018).

Countries reported a wealth of activities on health system strengthening, with strong overall performance on early warning systems, infectious disease surveillance and implementation of the International Health Regulations 2005 (WHO, 2016). Certain important areas, however, remain lacking, such as developing integrated climate, environment and health surveillance or building climate-resilient health infrastructures (WHO Europe, 2018).

For example, Belgium set up a working group on exotic mosquitoes and other vectors, along with activity to strengthen vector surveillance. In 2016, the working group developed an active monitoring plan for exotic mosquitoes (WHO Europe, 2018, pp. 36 and 120).

⁽³¹⁾ Ireland and Greece failed to report their FRMPs to the Water Information System for Europe (WISE) in time for these to be assessed.

⁽³²⁾ Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Estonia, Finland, France, Germany, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Slovakia, Slovenia, Spain and Sweden.

Box 3.3 Early warning system in Bulgaria

In Bulgaria, a national early warning and disclosure system for executive bodies and the public provides warnings and informs citizens about impending or emerging disasters, including climate-related risks. It also serves as a platform for exchange of information and coordination of the activities of the executive authorities and the components of the joint rescue system in the event of impending or occurring disasters. The system comprises ministries and agencies, municipalities, commercial companies and sole traders, emergency medical care centres, other medical and health care establishments, non-profit legal entities including voluntary organisations, and the armed forces. A sound early warning system plays an important role in helping to adjust and revise adaptation implementation.

Source: WHO Europe (2018, p. 33).

Box 3.3 provides an example of the early warning system in Bulgaria, showing how this helps to further support climate resilience and how this knowledge supports further efforts to mainstream adaptation into other policy domains and supports its implementation.

Finance sector

Climate risks are currently not always adequately taken into account by the financial sector. The global increase in weather-related natural disasters means that insurance companies need to prepare for higher costs. Banks will also be exposed to greater losses due to the lower profitability of companies most exposed to climate change or highly dependent on dwindling natural resources. In Europe, average annual economic losses ⁽³³⁾ in the EEA member countries varied from EUR 7.4 billion over the period 1980-1989, to EUR 13.4 billion (1990-1999) and EUR 14.0 billion (2000-2009). Between 2010 and 2017, average annual losses were around EUR 13.0 billion. This high variability makes the analysis of historical trends difficult, as the choice of years heavily influences the trend. The distribution of weather- and climate-related losses among the 33 EEA member countries is uneven. The highest overall economic losses in absolute terms (in order of rank) were registered in Germany, Italy and France. The highest losses per capita were recorded in Switzerland, Denmark and Austria, while those per square kilometre were recorded in Switzerland, Luxembourg and Germany. The greatest shares of total losses in terms of cumulative gross domestic product (GDP) were registered in Croatia, Czechia and Hungary (EEA, 2019d).

The European Commission is currently assessing the insurance protection gap in Europe and will publish its observations when the EU adaptation strategy is updated.

Other environmental issues are increasingly acknowledged as threatening current business models. The green taxonomy of the Technical Expert Group (TEG) on sustainable finance is

discussed further in Section 3.3. By establishing clear criteria for investment that is considered 'green', this work is seeking to mainstream considerations of climate risk and vulnerability across decision-making in the financial sector.

3.1.2 Interreg regions, macro-regions and conventions

The European transnational regions that are 'hot spots' in terms of climate change impacts are the Northern Periphery and Arctic, South West Europe and the Mediterranean (including large parts of the Adriatic-Ionian and Balkan-Mediterranean regions), as well as the mountainous part of the Alpine Space. The European landscape of transboundary regions, macro-regions, river basin treaties and conventions is complex. Although EU macro-regional strategies have so far been established for only four transnational regions, the current European territorial cooperation programme has established funding programmes for 12 transnational Interreg regions as part of the three pillars of the EU's economic, social and territorial development as pursued by the EU cohesion policy. Some of the 12 transnational regions partially or totally overlap with EU macro-regional strategies and/or with other relevant cooperation initiatives, such as river basin conventions or sea and other territorial conventions.

In combination with the progress reporting of the Water Framework Directive and Floods Directive this creates a complex environment for monitoring and evaluating collaboration on CCA. The overview *Adaptation policies and knowledge base in transnational regions in Europe* (ETC/CCA, 2018a) concludes that the Interreg B programmes, EU macro-regional strategies and international conventions are addressing climate change and adaptation in their priorities or mainstreaming objectives. They demonstrate that policy awareness of the need for adaptation at transnational level is well established in the cooperation structures and their policy documents. In addition, the Interreg projects are found to have played a significant role in:

⁽³³⁾ All at euro 2017 prices.

- developing the knowledge base and tools that are needed to support CCA actions;
- improving awareness raising and capacity building;
- promoting agenda setting, inception and exploration of adaptation policies; and
- piloting CCA initiatives in many countries.

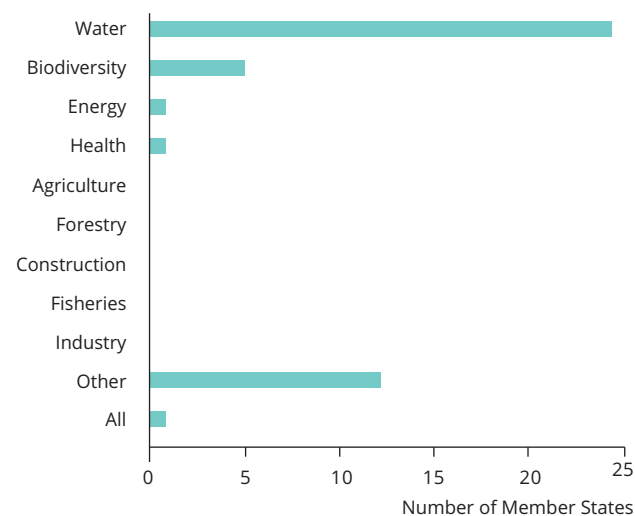
Web-based adaptation platforms, knowledge centres and networks are, for instance, active and operating in the North Sea, Northern Periphery and Arctic, Baltic Sea, Danube, Alpine Space, Central Europe, Adriatic-Ionian, Balkan-Mediterranean and the Pyrenees area of South West Europe. Most transnational projects focus on soft and facilitating actions (see Section 3.2) and are not expected to directly implement concrete measures on the ground. Evidence of the practical application of knowledge and products generated by projects appears limited (ETC/CCA, 2018a).

Regarding transboundary cooperation and risks, the evaluation of the EU adaptation strategy (EC, 2018b) highlights that in nearly all MSs transboundary cooperation is planned to address common challenges with relevant countries, and 24 out of 28 MSs state that climate risks/vulnerability assessments consider transboundary risks when relevant. Only four countries do not address transnational risks — of which two are islands (Cyprus, Malta). Based on the evaluation in the country fiches (EC, 2018a), the awareness of transboundary climate change challenges is high among the EU countries and the need for transboundary collaboration is acknowledged. Based on the data on transboundary collaboration, the European Commission concluded that the EU adaptation strategy has stimulated some actions on cross-border climate risks between MSs, in particular in river basins and Alpine areas but that further action is needed (EC, 2018b).

All but one MS integrated transboundary cooperation to address common challenges with relevant countries, almost invariably with regard to water, and more occasionally with regard to biodiversity, energy, health and 'other' issues, including mountain ranges (see Figure 3.2). The extent of transboundary cooperation and whether it is driven by the NAS/NAP varies between MSs, with 15 of the MSs having addressed this dimension in the NAS/NAP. Other drivers include international initiatives (e.g. the International Commission for the Protection of the Danube River and the Alpine Convention), and EU initiatives (e.g. EU macro-regional strategies) and projects (EC, 2018b).

The Floods Directive (FD) (EU, 2007) and the Water Framework Directive (WFD) (EU, 2000) have been particularly effective in promoting transboundary cooperation in the water sector.

Figure 3.2 Sectoral transboundary cooperation on adaptation issues



Note: Data for 28 EU Member States only.

Source: EC (2018b).

European and pan-European early warning and detection systems for weather-driven natural disasters existed, such as the European Flood Awareness System (EFAS), the European Forest Fire Information System (EFFIS) and the European Drought Observatory (EDO) and are continuously being developed⁽³⁴⁾. In addition, there are some policy initiatives in which imminent mainstreaming is taking place, such as invasive alien species, green infrastructure, land as a resource, a new EU forest strategy, coastal zone management and Natura 2000 (EC, 2018b).

To further progress on the implementation of the FD, coordination between MSs in a transboundary river basin is needed, including cooperation with third countries.

When looking into transboundary collaboration under the WFD, it became clear that, compared with the first cycle, governance structures were more formalised, international river basin management plans (RBMPs) were increasingly developed and the comparability of findings was improved as was the compatibility of approaches in response to pressures (EC, 2019h).

A positive development that can be highlighted is that, where coordination structures are established under the FD, the development of an international FRMP led invariably to common objectives for flood risk management and, in almost all cases, to the definition of a number of coordinated measures. Extensive public consultation took place for some of the basins where a river commission has been established, such as in the Danube, the Rhine, the Elbe and the Odra; considering

⁽³⁴⁾ EFAS: <https://www.efas.eu>; EFFIS: <https://effis.jrc.ec.europa.eu>; EDO: <https://edo.jrc.ec.europa.eu>

climate change at the basin level is more developed where a river commission is tasked with coordination (EC, 2019h).

Monitoring and evaluation of the state and effectiveness of transboundary CCA is beyond the scope of this report. It will be a complex challenge, because of the overlap between plans and reporting for the Interreg regions, macro-regions, transboundary river basins, the FD and the WFD and many bi- and multilateral conventions, each with its own context, scope, mandate and reporting mechanisms. Providing coherent and phase-specific information across the MSs' climate adaptation reports and EU-level progress reports on the WFD, FD, Interreg regions and macro-regions will be required to allow meaningful analyses of the progress of transboundary climate adaptation at regional and national levels.

3.1.3 *Mainstreaming through impact assessment regulation*

At the European level, directives for environmental impact assessment (EIA) (EU, 2014) and strategic environmental assessment (SEA) (EU, 2001) are commonly used instruments for assessing the environmental impacts on projects (EIA), programmes and plans (SEA) in all EU MSs. Fifteen EU MSs report that key planning policies consider climate impacts and some MSs also included climate change consideration in their legislation on SEAs. In addition, guidance documents for considering climate change in SEA processes were reported by Ireland (O'Mahony, 2015; Cian O'Mahony, 2019) and Slovenia (ARSO, 2019), but are not yet fully fledged in practice.

Half of the MSs have made little or no progress, as yet, in making procedures or guidelines available to assess the potential impact of climate change on major projects or

programmes and to facilitate the choice of alternative options (e.g. green infrastructure). Of the 28 EU MSs, 21 reported that adaptation is included in national EIA frameworks. Several MSs, such as Austria, Belgium, Ireland and Poland, developed guidelines on how climate impacts and adaptation can be best integrated into EIA and/or project development (EC, 2018b).

The example of guidelines and a support tool for reflecting on climate change impacts, vulnerability and adaptation efforts in the Austrian EIA process is provided in Box 3.4.

Joint Assistance to Support Projects in European Regions (Jaspers) is a technical assistance partnership between the European Commission, the European Investment Bank (EIB) and the European Bank for Reconstruction and Development (EBRD) and an important instrument of the EU cohesion policy. Its purpose is to promote the efficient use of EU structural funds, thereby stimulating future investment. The Knowledge and Learning Centre has developed a guidance document, which describes the process of managing climate adaptation considerations throughout the development of a project (Jaspers, 2017). Several projects funded by the Commission and/or the EIB follow the guidance document for project development and design (climate change risk and vulnerability assessment), which is a relevant contribution to mainstreaming adaptation into investment projects, which are in most cases subject to an EIA (EIB, 2020). Box 3.5 provides an overview of transport infrastructure projects and reflects upon the experience gained during Jaspers projects.

Besides environment related policies (e.g. EIA and SEA), direct adoption of CCA aspects in sector policies (e.g. considering climate change impacts within FRMPs, spatial planning or disaster risk management strategies or modifying the building codes) is more direct evidence of mainstreaming.

Box 3.4 Adaptation in the Austrian environmental impact assessment process

In Austria, an environmental impact assessment (EIA) climate-fit portal (UVPklimafit Infoportal) was created to support project developers, consultants and competent authorities with knowledge on the impacts of climate change on different infrastructure types and environmental issues.

The UVPklimafit Infoportal helps to anticipate the consequences of climate change in the design and development of major infrastructure projects (which are often subject to EIA). By adapting projects to the consequences of climate change, subsequent costs and negative effects on people, society and the environment can be reduced. It guides users through assessing potential future concern about the project and its environmental issues, depending on the location and the specific geographical/topographical conditions.

For a number of project types, the information portal provides a specific overview (project data fact sheets) of possible climate change-related changes. The possible impact of the project's environmental issues on the consequences of climate change can be estimated using fact sheets (basic information). The portal also offers aids for climate-appropriate adaptation of measures.

Sources: UVPklimafit (2020), Dallhammer et al. (2015) and Jiricka-Pürner et al. (2018, 2019).

Box 3.5 Climate change adaptation, vulnerability and risk assessments for transport infrastructure projects based on a Jaspers project's experience

During the EU programming period 2014-2020, projects funded from European structural and investment funds had to demonstrate their resilience by means of climate change adaptation (CCA) vulnerability and risk assessments. This is part of the requirements for climate change considerations (adaptation and mitigation, disaster resilience). Guidance material was prepared to help Member States. The roots of the methodology are in the *Guidelines for project managers: Making vulnerable investments climate resilient* (EC, 2013g). Based on this methodology, in June 2017, in collaboration with the Commission Directorates-General for Regional and Urban Policy and Climate Action (DG CLIMA), Jaspers prepared a guidance note, *The basics of climate change adaptation, vulnerability and risk assessment* (Jaspers, 2017). This explains the process of managing climate adaptation considerations throughout the project development cycle. It involves identifying climate hazards to which the project is vulnerable, assessing the level of risk and, if necessary, considering adaptation measures to reduce that risk to an acceptable level.

Jaspers independent quality review team reviews project compliance with the CCA requirements stemming from the European Structural and Investment Funds Regulations 2014-2020. The lessons learned from the review work carried out demonstrated that:

- Knowledge of the relevant climate change policies and objectives, notably European and national adaptation strategies as well as their linkages to the projects, was not sufficient even if the respective EU regulations did refer to Europe 2020 — the European strategy for smart, sustainable and inclusive growth, and to the national and regional adaptation strategies. However, as more projects were applying the Jaspers and DG CLIMA Guidelines (EC, 2013g, 2016a), an increase in the acknowledgement of the adaptation strategies was observed.
- Progress is noted in the quality and depth of CCA vulnerability and risk assessments performed. DG CLIMA guidelines and guidance note (EC, 2013b, 2013g) and Jaspers services played a relevant role.
- The revised Environmental Impact Assessment (EIA) Directive (EU, 2014) demanded new projects (as of 2017) to incorporate assessment of the impact of the project on climate and the vulnerability of the project to climate change. Although it is still too early to present the results, it is already clear that the practice of CCA assessment within EIAs needs to improve further and additional guidance would be helpful.
- There is a relatively long path ahead to ensure the effective consideration of CCA issues in option analysis (the transport sector in particular is relying on several cases on historical option analysis), different entry points for assessments via approval procedures, assessment methodologies, design and construction standards and others.

Sources: Personal communications from Ausra Jurkeviciute and Ismini Kyriazopoulou, Jaspers Network (<http://www.jaspersnetwork.org>) and Jaspers (<https://jaspers.eib.org>).

3.1.4 Mainstreaming in the private sector

A report on the insurance of weather and climate-related disaster risk (Ramboll Environment and IVM, 2017) states that, in the private property and agricultural sectors of the 12 EU countries assessed, there is a lack of focus on risk reduction. This is highly visible because of the low insurance penetration rates in private property markets, which is explained by the fact that households do not fully acknowledge the benefits of being insured against extreme weather or that their willingness to pay is lower than the premiums charged.

A main recommendation arising from this study is that countries create a national platform that fosters public and private partnerships to develop risk reduction strategies. The study also concludes that countries with higher penetration rates and lower risks are the ones that support collaboration

between the public and private sectors. One example that is being put forward is that of a public-private partnership, with a contract between the insurance sector and the government, whereby each group/partner takes action that maintains the provision of insurance coverage (Ramboll Environment and IVM, 2017).

A study from the International Risk Governance Centre draws lessons from insurance in critical infrastructure resilience such as 'although resilience is an emerging field of interest in Critical Infrastructure (CI) and insurance, at some point in time, market standards will have to be established for the definition of resilience, for the methods of assessment and monitoring, and for the implementation of resilience frameworks in the market' (Florin and Sachs, 2019). This reinforces the relevance of standards (see Section 3.2.3), as the report also states that 'cost-benefit analyses of investments in resilience

require reliable and comparable price tags, based on some standard' (Florin and Sachs, 2019). Furthermore, continuous improvements are needed, such as 'resilience-based strategies should also foster changes in the corporate culture and governance to enable ongoing improvements, for example via resilience monitoring requirements and regular scenario exercises' (Florin and Sachs, 2019).

Box 3.6 provides an example of a public-private partnership, namely the catastrophic loss insurance pool, which, based on the study, has been successfully implemented in Denmark.

3.2 Overview and examples of supporting conditions for implementation

Although the ways in which national adaptation policies, strategies and plans are put into action vary across countries, and implementation of adaptation actions is shaped by a multitude of context-specific factors, certain enabling factors that are common to different local implementations can be identified. To implement adaptation actions, several supporting or enabling conditions are needed. Table 3.2 presents several enabling factors for implementing adaptation policies.

Box 3.6 Denmark public-private partnership — catastrophic loss insurance pool

Disaster insurance pools extend the risk absorption capacity of the insurance market. Pools provide coverage against aggregate exposures and risks that are uninsurable. Since 1999, Denmark has experienced high costs in relation to weather-related damage, amounting to at least DKK 35 billion (~ EUR 7.7 billion). This increase has encouraged greater public-private cooperation and new management mechanisms.

Denmark has an independent council, the Danish Storm Council, established in pursuance of the Danish act relating to storm surges and windfall. This intergovernmental body decides, based on scientific evidence from technical experts, whether a storm event may be considered an event involving public compensation for damage costs. If a storm is considered a 1 in 20-year event, the Storm Council may liberate funds based on individual requests from private estate owners.

The Storm Council handles cases involving compensation following flooding from waterways and lakes as well as subsidies for reforestation after windfall. It also supervises and considers complaints about insurance companies' processing of storm surge cases. Its members represent insurance companies, citizens, municipalities and ministries.

The Storm Council covers damage through the public storm surge scheme. The scheme is financed by an annual tax of ~ EUR 7 included in the insured's fire insurance policy (which is mandatory for property owners). Insurance companies manage compensation payments on behalf of the Storm Council. Should there, however, be a disagreement between the insurance holder and the insurance company, the Storm Council may intervene.

Sources: Danish Storm Council (2020), EC (2013e) and Ramboll Environment and IVM (2017).

Table 3.2 Enabling factors for the implementation of adaptation policies

Enabling factor	Description
Knowledge and information	- Knowledge and information on the effects of climate change and on adaptation needs and adaptation options and their costs and benefits - Standards and guidance for supporting the implementation of actions
Actor profiles	Characteristics and abilities of actors involved, such as perceptions of risk or leadership qualities (especially at an early stage when a clear mandate is lacking)
Local context	Natural and socio-economic conditions that affect the need for and/or ability of actors to act
Supporting institutional context	- Coordination structures and networks - Horizontal and vertical integration of adaptation into institutional frameworks and processes
Resources	Funding/finance and other resources (personnel, expertise, time) for implementation
Supporting regulatory framework	- At multiple levels of governance (links with accountability) - Clear goals and targets
Public support	Awareness of the need to act upon climate risks

Source: Adapted from Russel et al. (2018).

Table 3.2 shows that monitoring and reporting of each of these enablers for implementation is unlikely to be in place for every adaptation action, but examples of good practice are emerging. Where possible, these examples have been highlighted throughout the report.

One enabling or supporting factor already mentioned in Chapter 2 is mainstreaming, which requires a supporting regulatory framework as well as other enabling factors described below. Other enabling conditions relate to, for example, stakeholder involvement throughout the planning, implementation, monitoring and evaluation phases. Stakeholder involvement can also be seen as being more the consequence of several enabling factors rather than an enabling factor as such. These enabling factors ensure, on the one hand, sound implementation but, on the other, acceptance of the need to adapt and smooth implementation. In the following sections, some supporting conditions are described in more detail.

3.2.1 Stakeholder involvement increases social capacity for implementing adaptation

Implementing adaptation policies requires the inclusion of climate variability and climate risks and integration of adaptation perspectives into a broad range of sectoral policies, planning and measures at different levels and in different areas (see Section 3.1). Such complex policy contexts that combine several sources of knowledge and expertise, including scientific and local knowledge, can foster relevant, reliable and legitimate knowledge and identify innovative and effective actions (e.g. Edelenbos et al., 2011; Polk, 2015).

Stakeholder involvement increases the legitimacy of national policies, enhancing trust between policymakers and practitioners and thus the likelihood of successful implementation of adaptation decisions. In addition, adaptation policies and strategies must have a clear framework for engaging private stakeholders, including a statement of where accountability and responsibility for adaptation actions lies.

Various phases of the adaptation cycle, including implementation, call for involving the target populations, e.g. through participative workshops, building awareness, capability and capacity, partnerships and empowerment. In a participatory implementation of adaptation, actors have different roles, premises and power positions but, at the same time, joint opportunities to learn from each other's knowledge and experience and build shared understanding of the issue and its solutions. Participatory approaches enhance the engagement and ownership of all actors to implement adaptation practices and may foster their collaborative capacity to tackle emerging challenges together. This

capacity building calls for strategic planning and support. The findings demonstrate the importance of financial carrots and conditions embedded within policies as incentives for sectoral stakeholders to engage with the adaptation processes (Sanderson et al., 2018) (see also Section 3.3 Financing adaptation).

Efforts and capacity building to involve stakeholders in the development and planning phases of adaptation policy create the foundation for stakeholder involvement during the implementation phase. Currently, stakeholder involvement in the implementation phase is substantially less well developed than it is in the planning phase (see section 2.3). This was also confirmed in the evaluation of the EU adaptation strategy, as only 13 MSs involved stakeholders in implementing adaptation policies and measures (EC, 2018b).

In general, stakeholder involvement in implementation is centred on sharing information, whereas active involvement and inclusive partnerships are relatively rare. Nonetheless, forms of deeper involvement are typically more inclusive when actualised, involving stakeholders from different sectors. The examples in Box 3.7 provide experience from the Netherlands of stakeholder involvement in implementing ecosystem-based adaptation measures.

3.2.2 Climate services provide knowledge for implementing adaptation

Climate innovation and piloted climate services* produce action-oriented knowledge that galvanises adaptation and transformational change (Brooks, 2013; Lourenço et al., 2015) while unlocking Europe's competitiveness and economic growth induced by innovation (EC, 2015). Governments, businesses and civic society have committed to work together to deliver positive transformative adaptation.



WORKING DEFINITION

Climate services have been defined in many ways (Hewitt et al., 2012; Perrels et al., 2013; Vaughan and Dessai, 2014). The EU Roadmap (Street et al., 2015) portrays them as 'transformation of climate-related data — together with other relevant information — into customised products such as projections, forecasts, information, trends, economic analysis, assessments (including technology assessment), counselling on best practices, development and evaluation of solutions and any other service in relation to climate that may be of use for the society at large'.

Box 3.7 Stakeholder involvement in ecosystem-based adaptation in the Netherlands

Ecosystem-based adaptation (EbA) is a prime example of a policy context that requires broad multi-sectoral cooperation (see Section 1.3). EbA calls for identification and evaluation of different types of benefits, innovative and cooperative finance options and scalability from small-scale experiments to large-scale concepts of sustainable infrastructure and development. Therefore, succeeding in making the implementation inclusive is an essential factor for successful EbA.

An example of EbA is the Dutch Room for the River programme, completed in 2018. The goal was to give the river more room to allow higher water levels to be managed. At more than 30 locations, measures were taken to give the river space to flood safely. Moreover, the measures were designed in such a way that they improved the quality of the immediate surroundings. Other examples of EbA can be found in the EU policy document on natural water retention measures (CIS WFD Working Group Programme of Measures, 2014) and the platform Natural Water Retention Measures (<http://nwrwm.eu>).

One of the forerunners of implementing EbA in a participatory manner, which has a strong component of stakeholder involvement, is the Netherlands and its national Delta programme. The Delta programme aims to take a comprehensive approach to water management and flood prevention that combines conventional hard infrastructure solutions and EbA, involving a mixture of beach nourishment, dune replenishment and planting vegetation to stabilise the newly replenished beach and dunes, giving room on the land back to the water. The programme's overall aim is to keep the Netherlands a good, safe and attractive place to live and work. The programme is undertaken by the central government, water boards, provinces and municipalities working together. Investments in flood protection and water security have received broad local support.

The special working group supporting the adaptive delta management strategy is the Signal Group, which explores climate, economic and societal trends and dynamics and new knowledge and insights relevant to the Delta programme. The Signal Group is composed of experts from several authoritative institutes that are of relevance to the Delta programme: the Royal Netherlands Meteorological Institute (KNMI), the Netherlands Environmental Assessment Agency (PBL), Deltares, Wageningen University & Research, Rijkswaterstaat-Water, Traffic and Environment and Statistics Netherlands.

One of the Signal Group's subjects is sea level rise. In recent years there have been signs that, over the course of this century, the sea level may rise at a pace faster than that assumed in the Delta scenarios. The potential impact of such an acceleration on the Delta programme was explored. Subsequently, the Minister of Infrastructure and Water Management and the Delta programme's Commissioner jointly took the initiative of launching a multi-year Sea Level Rise Knowledge programme. This programme is intended to provide greater insight into the probability of an accelerated rise in sea level and into its potential impact on the water takings and spatial planning, and to indicate options for anticipating such developments.

Sources: Delta Programme Commissioner (2020) and Rijkswaterstaat (2020).

Climate services help individuals and organisations to make risk-informed decisions. Historical climate records, catalogues of extreme events, reanalyses, forecasts, projections and indices used in outlooks, early warnings, vulnerability and risk assessments enable higher agricultural productivity, more efficient use and allocation of water, greater financial security and returns on investments, more reliable access to and production of renewable energy, and more effective protection of vulnerable communities and ecosystems.

Climate services are knowledge-intensive business services that employ advanced technological and professional knowledge. What characterises climate services is that both users and purveyors play a vital role in co-designing and co-producing the service solutions, ideally in a genuine and mutually beneficial

partnership inspiring trust and users' satisfaction. Climate services generate private and collective benefits. Private benefits materialise through cost reduction, increased yields and incomes, better informed planning and protection against unforeseen events, and the potential for new entrepreneurial ventures. Collective benefits are embedded in greater water, energy and food security, enhanced resilience, increased adaptive capacity, and innovation-friendly policy and business environments.

Over past decades, climate services have grown in numbers, quality and sophistication, stimulated by efforts under the World Meteorological Organization's Global Framework for Climate Services, and the Climate Services Partnership. The EU has made large investments in frontline systems enabling

modern meteorological services under the Copernicus Earth observation programme (previously Global Monitoring for Environment and Security, GMES) as a contribution to the Europe 2020 strategy for smart, sustainable and inclusive growth (EC, 2010). The Copernicus Climate Change Service (C3S) is one of six services in the Copernicus service component, designed to deliver knowledge to support adaptation and mitigation policies.

Research has proved climate services to be useful in supporting decision-making in agriculture (Lechthaler and Vinogradova, 2016; Li et al., 2017), urban planning (Jones et al., 2017; Lindberg et al., 2018), health (Goddard et al., 2010; Bruno Soares et al., 2018) and tourism (Scott and Lemieux, 2010; Scott et al., 2011) among others. The total investments made in developing a new generation of climate services directly or indirectly funded by Horizon 2020 ⁽²⁵⁾ amount to nearly EUR 100 million.

An analysis of the climate services market in Europe (Street et al., 2015) in the past revealed relatively modest uptake of previously developed services (WMO, 2015). Previous work has highlighted poor agreement on best practices, definitions and methods, offering the opportunity to establish a holistic framework in this emerging field (Vaughan et al., 2018). Surveys among users and stakeholders revealed a poor connection between providers and users (Bowyer et al., 2015; Brasseur and Gallardo, 2016). Improved management of and access to information, through well-designed climate data centres, and the search for alternative services, e.g. through brokerage and coaching, can overcome these barriers. Diffusion of climate services can be fuelled by investing in capacity building, transfer of knowledge and interdisciplinary curricula. Tailor-made and effective communication is often indicated as one of the major challenges for developing a climate services market (Street, 2016; Vaughan et al., 2016).

As a part of the European Research and Innovation Roadmap (EC, 2015), the European Commission promoted a comprehensive analysis and evaluation of the market potential of climate services. The EU-MACS project (Cordis, 2019b) focused on drivers of and barriers to innovation and uptake of climate services, assessed diffusion gaps and untapped potential, and identified ways to encourage demand for and supply of market solutions matching users' knowledge needs. Sustainable finance driving green growth and risk-informed investments, cities as laboratories of climate action, and tourism with multiple spin-off effects on economies served as pilots for the in-depth assessment. The MARCO project (Cordis, 2019c) completed a market analysis and forecast market growth until 2030.

Climate services may support policy and decision-making on both CCA and DRR. Improved alignment of demand-led climate service products requires decision-makers from both communities to have stronger linkages with each other, as well as with the providers of climate information and knowledge and intermediate providers of climate services, such as national meteorological organisations. The DRR community has a long history of making use of hydro-meteorological services, but there are opportunities to better integrate uncertainty associated with future climate variability and change (Street et al., 2019).

3.2.3 *Standards as a specific form of supporting knowledge and a soft form of regulation*

Another enabling factor for implementing adaptation regards the role of standards and to a certain extent guidance. Standards are important and can help in systematising, designing and focusing monitoring and reporting, and perhaps evaluation. They develop over time and so does their implementation. Diverse standards and guidance documents are currently under development at the International Organization for Standardization (ISO) or the European Committee for Standardization/European Committee for Electrotechnical Standardization (CEN-CENELEC).

Standards are developed collaboratively by experts around the world help to improve regulation. They provide guidance to businesses, public and private sector organisations and policymakers to support their efforts to address the implications of climate change.

Currently, the infrastructure of the priority sectors (construction, transport and energy) are the focus. The existing standards are being revised and new standards are being drafted to reduce the vulnerability of the infrastructure to climate change impacts. These standards will represent best practice examples of how to address climate change adaptation in the area of standards in other sectors. The work of the standard writers is supported by climate change experts and a specific guide — CEN-CENELEC's *Guide for addressing climate change adaptation in standards* (CEN-CENELEC, 2016) — helping standard writers address the implications of climate change in standards. There is a specific CEN-CENELEC Coordination Group on Adaptation to Climate Change for adapting existing standards.

ISO 14090 (ISO, 2019) provides principles, requirements and guidelines for organisations on CCA. It includes the whole cycle of adaptation from pre-planning to monitoring, evaluation, reporting and communication. As well as using indicators for

⁽²⁵⁾ Horizon 2020 is the biggest EU research and innovation programme ever with nearly EUR 80 billion of funding available over 7 years (2014-2020) (<https://ec.europa.eu/programmes/horizon2020>).

monitoring climate impacts, indicators will also be used for monitoring and evaluation. Besides an implementation plan, it is envisaged that organisations will prepare a monitoring and evaluation plan and a reporting and communication plan. The monitoring and evaluation plan will assess progress against the implementation plan. Monitoring and evaluation informs the organisation about the progress of its CCA efforts and helps to inform adaptive management. The quantitative and qualitative indicators that are used for monitoring need to be described, as does the method used. The organisation can prepare a CCA communication for external use, supported by a CCA report that presents the organisation's efforts and their impact and the opportunities arising, the methods used, adaptation actions taken and the monitoring and evaluation plan, and the results.

ISO 14090 can support private sector organisations to prepare for CCA, deal with the impacts, and identify and seize opportunities that may arise to build climate resilience. MRE helps to further increase organisations' adaptation efforts. ISO 14090 has now become a European standard (CEN, 2020).

Other relevant upcoming ISO standards that might support the implementation of adaptation are:

- ISO 14091 'Adaptation to climate change — Vulnerability, impacts and risk assessment' (ISO, 2020a), developed jointly with CEN and expected in 2020.
 - This document provides guidance for assessing the risks related to the potential impacts of climate change. It explains vulnerability and describes how to develop and implement a sound risk assessment in the context of climate change. It can be used for assessing both present and future climate change risks.
 - Risk assessment according to this document provides a basis for climate change adaptation planning, implementation and monitoring and evaluation for any organisation, regardless of size, type or nature.
- ISO 14092, including 'guidance on adaptation planning for organizations including local governments and communities' (ISO, 2020b).

In addition to standards addressing CCA in general, the revision of asset-specific standards (e.g. those on building ventilation systems) also have the potential to support CCA. However, an assessment of their revision timelines and their potential is outside the scope of this report.

3.3 Financing adaptation

3.3.1 Overview of financing adaptation implementation

European heads of state and government have taken up the European Commission's suggestion that at least 20 % of the entire EU budget for the period 2014-2020 be spent on climate-related actions. Climate action had to be integrated into all the major EU policies. However, for the period 2021-2027, the Commission proposes to set a more ambitious goal for climate mainstreaming across all EU programmes, with a target of 25 % of EU expenditure contributing to climate objectives. This is estimated to be around EUR 320 billion or a combined increase of more than 50 % compared with the budget for climate mainstreaming for 2014-2020 (EC, 2018c, 2019d).

The European Green Deal investment plan envisages mobilising at least EUR 1 trillion of sustainable investment over the next decade ⁽³⁶⁾. In addition to the EU's long-term budget, the investment plan will bring in additional private funding through leveraging the EU's budget guarantee under the InvestEU programme. The EIB will become the EU's climate bank and has announced that it will gradually increase the share of its finance dedicated to climate action and environmental sustainability to reach 50 % of its operations in 2025. Cooperation with other financial institutions will be crucial. While this contribution shows the EU's commitment to funding the European Green Deal (EC, 2019d), it will on its own not be sufficient to unlock the necessary investment. Sizeable contributions will be needed from national budgets and the private sector.

The EU action plan on financing sustainable growth (EC, 2018d) noted that Europe has to close a yearly investment gap of almost EUR 180 billion to achieve EU climate and energy targets by 2030. The EIB has estimated that the overall gap in investment in transport, energy and resource management infrastructures has reached a yearly figure of EUR 270 billion.

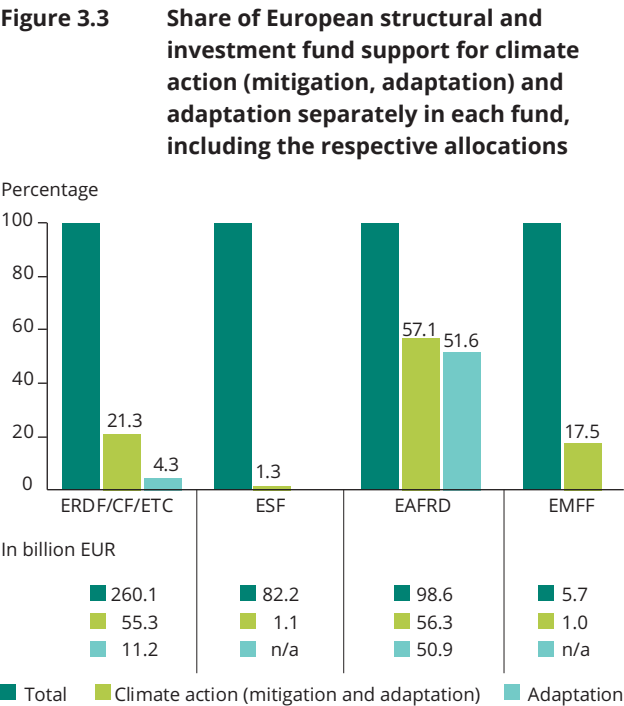
Consistent funding resources are available for implementing adaptation actions to increase climate resilience in vulnerable sectors and in cross-cutting ways (e.g. national scenarios and climate services, capacity building, websites) in only nine EU MSs ⁽³⁷⁾, but adaptation is financed in at least some sectors in all except one of the other MSs. The lack of funding that is specifically labelled for adaptation is also reflected in the fact that only 14 MSs include budget allocations in their NAS or NAP (EC, 2018b).

⁽³⁶⁾ In addition to the EU spending related to climate action and environmental policy, the Sustainable Europe investment plan also covers the amounts used under the Just Transition Mechanism, which will help the worst affected regions going through the transition.

⁽³⁷⁾ Denmark, Estonia, Germany, France, Lithuania, Portugal, Romania, Spain and Sweden.

The share of European structural and investment funds' support for climate action to mainstream funding for climate action in 2014-2020 is given in Figure 3.3. While there is direct funding for adaptation that can be tracked through certain funds (e.g. the European Regional Development Fund), indirect contributions from the European Social Fund and the European Maritime and Fisheries Fund, for example, cannot be tracked (COWI, 2017).

In order to begin to understand investment flows, the EEA commissioned the first stocktaking exercise of its kind, involving its European Environment Information and Observation Network (Eionet) in helping assess the current state of play on domestic climate finance tracking of public and private financial flows across Europe. On adaptation, the work noted that data on finance for climate adaptation (see Map 3.1) is generally less readily available than finance information for climate mitigation, reflecting the more dispersed and integrated character of adaptation measures. Benchmark examples at the MSs level include Czechia and Estonia, where information exists covering detailed total investment needs associated with their established NAPs. Estonia and Germany are also best practice examples, having data available on planned climate adaptation expenditure (EEA, 2017c). A more comprehensive overview beyond 2017 is not yet available.

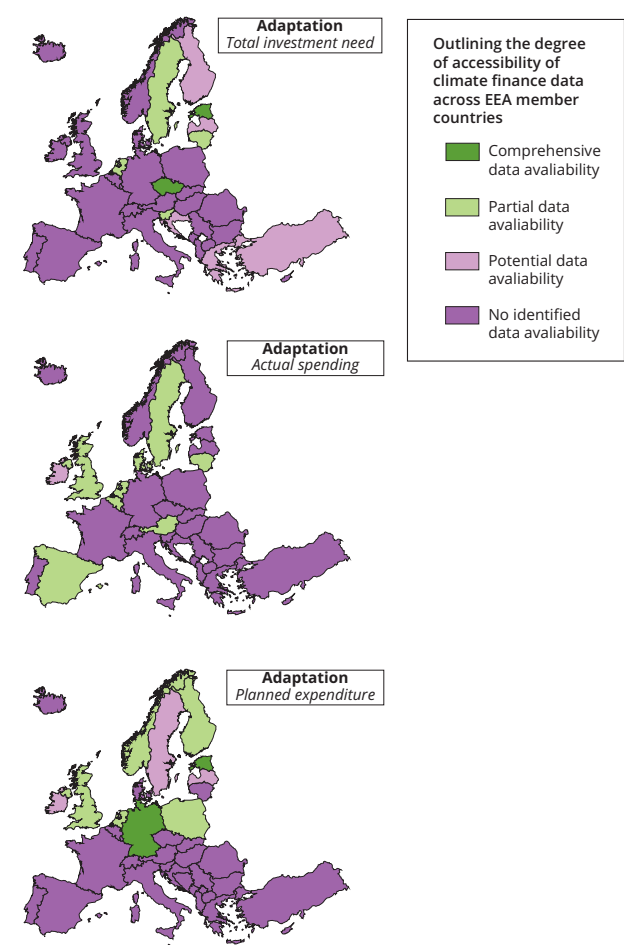


Note: ERDF/CF/ETC, European Regional Development Fund/ Cohesion Fund/European Territorial Cooperation (Interreg); ESF, European Social Fund; EAFRD, European Agricultural Fund for Rural Development; EMFF, European Maritime and Fisheries Fund.

Source: COWI (2017).

EU MSs reporting on adaptation in 2019 under the Monitoring Mechanism Regulation (EU, 2013b) highlights the European structural and investment funds (2014-2020), revenue from the sales of emissions trading permits and various forms of allocation of national budgets as the key funding instruments to support the implementation of adaptation actions. In no MSs are all three sources combined, and in the majority of cases it could be that identified national sources of funding remain the main source.

Map 3.1 Degree of accessibility of climate finance data across EEA member countries



Notes: Data were collected in 2016 from an Eionet questionnaire. While there is little evidence that a lack of information for most countries is no longer true, the situation for individual countries might have changed since 2016, in particular for the planned expenditure and especially if a NAP (or revised NAP) has been adopted since then. Examples are Czechia (where the planned expenditure is available in detail at the end of the NAP, adopted in 2017) and Lithuania (yearly evaluation of actual spending to update planned expenditure).

Source: EEA (2017c).

The evaluation of the EU adaptation strategy calls for a strategy that may be able to deliver more in the future in certain areas, including using private investment in adaptation (EC, 2018e). Public resources will not be sufficient to secure a climate-resilient economy. To attract private finance as well, the action plan for financing sustainable growth aims to provide clarity on whether or not investments contribute to climate adaptation through a taxonomy of environmentally sustainable investments. However, for adaptation this is not a straightforward exercise (TEG, 2020a, 2020b). Together with the investment support provided under the InvestEU programme, a taxonomy for sustainable investments opens up avenues to direct the private sector towards climate-resilient businesses and to build a pipeline of targeted adaptation projects. Ideally, this would be accompanied by the development of tools such as technical standards on climate resilience and cost-benefit analyses that highlight the economic advantages of adaptation (EC, 2018e).

France's law on energy transition for green growth (see Box 3.8), for example, has led to an improved acknowledgement of climate risks by investors.

The TEG on sustainable finance has produced a technical report on the EU taxonomy (TEG, 2020a). The annex of the *Taxonomy report* (TEG, 2020b) includes a section on CCA, which suggests that investors should look for the implementation of three principles to understand whether an activity makes a substantial contribution to CCA. They are reflected in screening criteria:

- Principle 1. The economic activity must reduce all material physical climate risks to that activity to the extent possible and on a best effort basis.
- Principle 2. The economic activity and its adaptation measures do not adversely affect the adaptation efforts of other people, nature or assets.
- Principle 3. The reduction in physical climate risks can be measured (TEG, 2020b, p. 391-392).

The criteria have several sub criteria, and specific criteria have been defined for those economic activities enabling adaptation.

Box 3.8 France's law on energy transition for green growth

Article 173 of this law came into force at the beginning of 2016 and strengthened mandatory carbon disclosure requirements for listed companies and introduced carbon reporting for institutional investors, defined as asset owners and investment managers. It requires (PRI/UNEP FI/UN Global Compact, 2016):

1. Listed companies shall disclose in their annual reports:
 - financial risks related to the effects of climate change;
 - the measures adopted by the company to reduce them;
 - the consequences of climate change on the company's activities and of the use of goods and services it produces.
2. Banks and credit providers shall disclose in their annual reports:
 - a. the risk of excessive leverage (not carbon-specific) and the risks exposed by regular stress tests (the government will submit a report to Parliament on the implementation of regular stress tests reflecting the risks associated with climate change by 31 December 2016).
3. Institutional investors shall disclose in their annual reports:
 - a. information on how environmental, social and governance (ESG) criteria are considered in their investment decisions;
 - b. how their policies align with the national strategy for energy and ecological transition.

Investors must report on a 'comply or explain' basis, meaning that they have to provide an explanation if they do not comply with any of the requirements above.

A review of the implementation concluded that investors appear to have progressed further in their acknowledgement of climate risks than of other ESG risks. However, they seem to be at only the initial stages of implementing risk management measures. Only a few investors have assessed their exposure to climate risks. Measures need to be taken to improve the understanding of the correlation between portfolio carbon footprint and climate risk management (EY, 2017).

Some adaptation activities were examined to demonstrate the substantial contribution of criteria for CCA in different sectors. The examples included a range of more asset-based and more service-oriented sectors, economic activities that need to adapt and enabling activities. After completing the 'do not significant harm' assessment, in which all five other environmental objectives of the taxonomy are screened, activities making a substantial contribution to CCA can be added to the taxonomy list.

In terms of monitoring the adaptation effects of public investment, the following key reasons for undertaking monitoring and evaluation of an adaptation intervention were identified (Moloney et al., 2020):

- evaluate the effectiveness of interventions;
- assess the efficiency of resource allocation;
- understand the implications of actions for equity;
- provide accountability;
- assess the outcomes;
- improve learning;
- improve future actions; or
- compare interventions.

The *Synthesis report on adaptation actions* (Climate Chance and Comité 21, 2019) states that monitoring, reporting and verification (MRV) mechanisms group together a set of rules and procedures for flow accounting methods. The use of indicators is necessary to evaluate financing and its impacts in terms of adaptation, but these are often too far-reaching and not easy to handle. Silent adaptation, which includes all adaptation actions that are not recognised as such, is not quantified and it is difficult to evaluate the adaptation 'part' in some projects.

In addition, international funds, such as the World Bank-administered Climate Investment Fund and its pilot programme for climate resilience (PPCR) uses monitoring and reporting frameworks, which are based on principles such as country ownership, stakeholder engagement, using quantitative and qualitative methods and ensuring learning by doing. The PPCR monitoring and reporting system is one of the first of its type for assessing adaptation finance at an aggregated level. Fostering a programmatic approach to climate action planning, it uses the monitoring and reporting systems to assess adaptation progress and ensure learning and accountability (Rai et al., 2019).

According to a 2018 Organisation for Economic Co-operation and Development report on climate finance, developed countries increased climate financing of developing economies, including for adaptation, from USD 7.8 billion in 2013 to USD 12.9 billion in 2017 (OECD, 2018a). It values bilateral financing from developed countries intended for adaptation at USD 4.7 billion in 2013 and at USD 5.6 billion in 2017, representing 21 % of bilateral financing. Multilateral financing for adaptation (attributed to developed countries) increased from 20 % in 2013 to 27 % in 2017. Not included in this is the category of transversal projects, which relate to both adaptation and mitigation and which would slightly increase the amount for adaptation. The first report of the Global Commission on Adaptation highlights the economic benefit of investing in adaptation (GCA, 2019). Thus, MRE systems become even more relevant in ensuring that the investments are increasing climate resilience and effective adaptation.

3.3.2 *Financing ecosystem-based adaptation measures*

Ecosystem-based adaptation (EbA) is a prime example of an adaptation approach that is multifunctional and therefore typically requires cross-sectoral, cross-departmental planning and implementation procedures (see Section 1.3). Furthermore, various funds have to be acquired and directed towards their respective investments. These principles can be useful to apply in all implementation action, but in EbA implementation they have a profound importance. The benefits of EbA are wide-ranging and manifold and therefore typically concern wider stakeholder groups than do the costs of EbA.

In general, EEA member countries have included EbA in assessments of adaptation options and their implementation in various manners — some have invested in it through multiple-level strategies and plans and in some it has remained an issue that only very limited groups or sectors give little attention to. Implementation of EbA on a large scale is at the experimental stage. To be able to monitor and evaluate its effectiveness and proper implementation methods in detail, the scale of the measures should be increased in a controlled manner. The MRE of financing specifically for EbA in EEA member countries is not particularly well developed. There are examples from specific sectoral projects, for example on natural water retention measures (CIS WFD Working Group Programme of Measures, 2014). Increasing monitoring and evaluation of EbA before and beyond the project implementation phase will help to identify benefits and potential trade-offs. This information improves actions that aim to increase the provision of ecosystem services (Kabisch et al., 2017) and creates justification and criteria for funding.

Implementation of EbA depends profoundly on the availability of supporting financial resources. Public finance for EbA is available at European and national levels, but regional and local budgets also have a key role. The focus has traditionally been on sectors such as water, agriculture and environment, but there is scope to extend this to infrastructure spending (moving from grey towards green, blue and hybrid infrastructural solutions), social protection and well-being (UNDP, 2015).

As public funding alone will not be sufficient to meet adaptation goals, private finance options have been developed and are used for EbA (EC, 2019g). Private investment can be attracted, for example, through payments for ecosystem services, product labelling and certification, bio-carbon markets or biodiversity compensation funds (CIS WFD Working Group Programme of Measures, 2014). Such financing mechanisms can offer a private source of otherwise public compensation payments and can provide land users with an alternative or complementary source of income. One of the new mechanisms for financing EbA emphasises the insurance value of ecosystems (see Box 3.9).

To bring public and private financing sources together and maximise investment, mainstreaming EbA into government policies and budgeting processes at national level can have a far-reaching impact on financing EbA in the long run. The precise mix of funding sources and overall size of investment are, however, highly local context specific and there is no one-size-fits-all or optimum solution. Creating incentives not just for private land users through price mechanisms such as taxes and cap-and-trade-based mechanisms for development rights and encouraging nature-centred investment behaviour in public authorities may constitute a fully functioning but not yet well-known addition to the adaptation policy mix (Droste et al., 2017). For example, by integrating an ecological indicator into the fiscal transfer system, a financial aspect comes into play that may encourage investment in EbA. Another new financial support mechanism is being made available through financial instrument support via the EIB Natural Capital Finance Facility, which supports projects delivering on biodiversity and climate adaptation through tailored loans and investments, backed by an EU guarantee (see Box 3.10).

Box 3.9 Relevance of insurance value of ecosystems in financing ecosystem-based adaptation

Insurance mechanisms related to disaster risks are an important instrument in a comprehensive climate change risk management system, as uninsured losses expose vulnerable populations to more insecurity (GIZ, 2018). As ecosystems can buffer against sudden adverse events and incremental deterioration and losses, ecosystem-based adaptation (EbA) can offer powerful benefits to reduce the vulnerability of communities and to increase their overall resilience. For example, diverse tree species and age structures in managed forest can reduce pest outbreaks, and vegetation cover in public parks reduces surface water run-off and thus flood risk (Paavola and Primmer, 2019). Although the insurance value of ecosystems has been acknowledged in the literature and in policy agendas, the governance of its provision remains to be established and put into practice (Paavola and Primmer, 2019).

Taking the positive impacts of EbA measures into account when exploring the use of insurance schemes to increase financial protection could allow the provider of the policies to lower the expected levels of loss of the underlying risk (GIZ, 2018). Insurers could therefore individualise pricing by offering discounts to customers and communities who invest in EbA-based self-protection and hence lower their risk rates. Subsequently, tailored insurance schemes present the opportunity to encourage private and public investment in adaptation measures. However, insurance value is typically a public good, and organising markets for its provision may entail high transaction costs due to the number of parties involved and the difficulty of determining units of objects of transactions and monitoring their delivery (Paavola and Primmer, 2019). Furthermore, to enhance the application of insurance value-based approaches in financing EbA, the cost-benefit and risk calculations have to be developed to capture the value.

As index-based insurance solutions require only the chosen variables to be monitored, they can therefore dramatically lower the transaction costs (GIZ, 2018). EbA relying on index-based insurance financing can be flexibly applied from the micro-level (e.g. individual farmers and households) through the meso-level (e.g. agricultural suppliers and farmer associations) and to the macro-level (e.g. relief agencies). Another potential example of insurance-based financing of EbA is catastrophe bonds, such as national green bonds, which are rising in popularity, partly as they provide long-term protection against risks that, for example, municipal governments seek and insurance companies have failed to provide (GIZ, 2018).

Box 3.10 Greece: Athens green infrastructure for urban resilience

The example of Athens is the first operation under the Natural Capital Finance Facility (NCFF) of the European Investment Bank (EIB) integrating nature-based solutions in a city. A EUR 5 million NCFF loan will finance and support integrating green components into the restoration of public squares and streets, creating green corridors between different greened areas and contributing to the natural restoration of Athens' second landmark hill after the Acropolis, Lycabettus hill.

The 2030 Athens resilience strategy is structured into four pillars (i.e. open, green, proactive and vibrant city) and the NCFF framework loan will in particular support the 'green pillar' of the strategy, with the objective of realising nature-based solutions for climate change adaptation. The projects will comprise green and blue infrastructure projects (e.g. parks, greening public spaces, green corridors, roofs) and other measures improving the functioning of urban ecosystems. In addition to improving resilience to the impact of climate change, these projects are expected to deliver air quality benefits, positive impacts on biodiversity, positive economic impacts on neighbourhoods and properties in the vicinity and enhanced social inclusion. In addition, there will be a component in the project providing technical assistance to the city of Athens, supporting the preparation, implementation and monitoring of the NCFF's objectives and the green pillar of the 2030 Athens resilience strategy.

Source: EIB (2019).

There are a few websites that are compiling, updating and using catalogues of successful and exemplary EbA such as Urban Nature Atlas (<https://naturvation.eu/atlas>), the European Natural Water Retention Measures platform (<http://nwrm.eu>) and the Oppla case studies platform (<https://oppla.eu>). They provide inspiration and it is to be expected that they will develop even further (see also EEA, forthcoming).

3.4 Lessons learned and key challenges for implementing adaptation

Less than half of EU MSs have addressed climate change in relation to many aspects of implementation and review, including consideration of climate change in disaster risk plans (9), land use planning (15), major projects (13), and national (11), sectoral (14) and sub-national (9) monitoring and reporting. And, as regards monitoring and reporting, only five MSs have started to develop and use a comprehensive set of process or outcome-based indicators to monitor implementation of adaptation strategies and plans (EC, 2018b). This highlights that the EU adaptation strategy has been less effective in promoting implementation and MRE. The following three main areas summarise the lessons learned and key challenges for successful implementation of adaptation actions.

Planning, including mainstreaming and enabling conditions

Mainstreaming has progressed at various governance levels and sectors through the integration of CCA into sectoral policies, strategies, plans, programmes and projects. Lessons learned indicate that the mainstreaming process and its formats need to be fit for purpose and there is no need for standardisation (see Table 3.1). Mainstreaming processes are also mostly non-hierarchical, voluntary and require the cooperation of multiple actors across scales; thus, stakeholder engagement and the co-production of adaptation policy and action during the planning phase is key for successful implementation. It is also key that the attractiveness of adaptation solutions to other sectors is of high importance and this motivates them to participate in horizontal governance processes, displaying the benefits and creating ownership of the adaptation policy and actions to support implementation. However, to increase resilience and adaptive capacity, mainstreaming and supporting, as well as enabling, conditions need to be tracked and evaluated in terms of their effectiveness and efficiency.

One example of mainstreaming is the recommendation from the European Commission to MSs on the second FRMPs in 2021. The likely impact of climate change on the occurrence of flooding should be factored in and measures adapted accordingly. Thus, in the next step, mainstreaming of and implementation efforts related to CCA need to become more precise and be made more explicit.

Several examples of supporting conditions have been identified. Although the framing conditions for developing adaptation policy have been identified (e.g. on standards and guidance), their monitoring and implementation remains more limited and in some cases difficult. Improved MRE of enabling/supporting conditions will help policy formulation.

Securing funding for real adaptation action

Financial support is key in enabling adaptation action. MSs can allocate budget to synergic or mutually supportive measures, exploiting the leverage to act within existing and already working European and national funding provisions (Russel et al., 2018). This resembles green budgeting (Russel et al., 2014). It requires, however, that countries and regions do not only refer generally to CCA in their sectoral and development plans and programmes but also ensure through, for instance, selection criteria that a sufficient share of the project's budget is dedicated to adaptation action. This is the only way to ensure that CCA concerns become truly integrated into the entire process of expenditure planning, implementation, reporting and periodic evaluation. Public resources and private investment are needed to secure a climate-resilient economy, and MRE and the tracking of financial flows for CCA action is needed. At the EU level, the Green Deal projects substantially increased budgets for climate (including CCA) action for the next decade compared with the period 2014-2020 (EC, 2019d, 2020a).

To better assess the effectiveness of adaptation measures, further development of current methodologies and mechanisms is needed and it needs to be taken seriously.

Documentation of the impacts of implemented policies

Only by basing learning on sound documentation of processes and the impact of implemented policy can we ensure that we are learning from experience. There is a growing emphasis on ensuring that learning is placed at the heart of MRE. CCA has progressed and, while many European countries have undertaken adaptation policy planning, only a modest number have begun to implement it in a structured way. Consequently, knowledge and experience of how best to adapt to climate change, how vulnerability can be most effectively reduced and resilience enhanced, what the characteristics of a well-adapted society might be, and what level of adaptive capacity is needed are still underdeveloped. In particular, the impact of policies implemented in diverse sectors and fields is not yet well documented or researched, with the exception of a few front-runners. It is critical that we learn what works well, in which circumstances and for what reasons. Countries need to make full use of the knowledge gained through MRE and further foster the exchange of knowledge. Collaboration with those that have gained more experience and can share lessons will be important. This need is heightened, given the scale of the likely impacts of climate change and, considering the limitations on effectively controlling global greenhouse gas emissions, the consequent level of adaptation investment likely to be required. MRE has the potential to be a key means of enhancing our learning and informing more effective adaptation policy and practice.



4 Approaches to monitoring, reporting and evaluation

Key messages

- Monitoring, reporting and evaluation (MRE) of adaptation can support the process across all levels of governance. The scope and objectives of MRE, however, vary from the international to the national and further to the local level. Indicators are a key way to connect levels and seek synergies, but they are not necessarily directly transferable across levels and policy domains.
- There is considerable demand for supporting the development of adaptation indicators, and the first sets of national-level adaptation indicators are operational in Europe. These indicators support mainly monitoring of adaptation, and experience of their use in evaluation is still limited.
- Evaluation of adaptation policies and their implementation benefits from the use of mixed methods, whereby quantitative and qualitative information and evidence from multiple sources, such as indicator data and stakeholder views, are combined.
- Although experience of tracking progress has accumulated, there is a need to move beyond tracking processes towards understanding the outcomes and impacts of policies and actions.
- Stakeholder engagement is crucial for MRE, on the one hand, to receive relevant quantitative and qualitative data for monitoring the process and its progress but also, on the other hand, for interpreting the available data and deriving relevant messages from it.
- Evaluation needs to be a specific and separate effort to put the emphasis on getting deeper insights into some elements and into progress from these insights, feeding back into revising adaptation policy. Only a limited number of countries have gained deeper insights through evaluation.

As implementation of adaptation policies and plans is highly context specific, monitoring and evaluation needs to recognise a variety of factors that determine if and how progress is made towards adaptation policy goals and objectives. Ultimately, evaluations of adaptation policies help to establish how adaptation actions affect our capacity to prepare for and respond to emerging climate risks. Given the complexity caused by long time-frames and uncertainties associated with climate impacts and risks, along with broader societal developments, it is critical that we improve our understanding of what works, under what conditions and why.

This chapter looks in detail at the multiple purposes that monitoring, reporting and evaluation (MRE) serves and provides an overview of the role of indicators in tracking the progress of adaptation. However, indicators alone cannot offer comprehensive and sufficient understanding of the progress and effects of the adaptation policies and measures implemented. The chapter also looks at the mix of methods that can be applied to support salient evaluations of adaptation policies.

4.1 Monitoring, reporting and evaluation serve multiple purposes

Efforts to monitor and evaluate adaptation generally serve both learning and accountability (Vallejo, 2017). For European countries, tracking and reporting adaptation policy progress and effectiveness, and enhancing learning and accountability have been identified as the main purposes of national MRE systems (EEA, 2015b). As national MRE systems are tailored to specific conditions and priorities, their specific purposes and objectives vary across countries.

In the early stages of implementing adaptation policies, efforts typically focus on monitoring and evaluating processes set by adaptation policies (What is being done?). Procedural aspects may include, for instance, coordination mechanisms being put in place, research and communication activities, or involving stakeholders in adaptation processes. As experience of implementing adaptation actions accrues, it becomes increasingly important to also understand the effects and outcomes of such processes and the associated adaptation actions (What difference does it make to our vulnerabilities and risks?). A key question, regardless of how far a country has progressed in its national adaptation work, is how knowledge generated by MRE is being used to inform adaptation policy and practice.

4.1.1 *Monitoring, reporting and evaluation can support adaptation governance across multiple levels*

Monitoring and evaluation of adaptation is needed simultaneously at multiple governance levels from the international through to the local. The aims and objectives, available data sources and suitable methodologies vary across the governance levels. Although this report focuses on national adaptation policies, there are clear linkages to and possible synergies with MRE at other governance levels.

European and international efforts to understand progress in adaptation rely on national-level information to aggregate broader overviews. Adaptation reporting processes at the global and European levels are summarised in Table 1.1 and Section 1.4. At the European level, in addition to adaptation-specific reporting processes, there are other thematic and/or sector-specific reporting processes, in which elements of reporting are also relevant for tracking climate change adaptation (CCA). These include reporting processes linked to the Floods Directive (EU, 2007; CIS WFD, 2009, 2013) or rescEU (EU, 2019b; EC, 2019a), for instance.

At the international level, commitment to the 2030 Agenda for Sustainable Development and complementary multilateral frameworks, including the Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR) and the Paris Agreement on Climate Change, has galvanised the pursuit of policy coherence (Mysiak et al., 2018). Monitoring progress of these frameworks is a key area in which the potential for synergies has been identified. While maintaining the autonomy of each of the post-2015 frameworks, improved coherence of actions and coordinated monitoring of their progress can save money and time, enhance efficiency and enable further actions (Adaptation Committee, 2018). Improving the connectivity and coordination of national-level indicators between disaster risk reduction, climate change adaptation and sustainable development can also improve the efficiency of data collection and build up a more comprehensive view of progress.

The United Nations Framework Convention for Climate Change (UNFCCC) Adaptation Committee and the United Nations Office for Disaster Risk Reduction (UNDRR, formerly the United Nations International Strategy for Disaster Reduction) jointly explored the relation between national goals and indicators for adaptation and those for sustainable development and disaster risk reduction. Reporting of national progress made towards achieving the Sustainable Development Goals (SDGs) and the SFDRR has been substantiated through indicators and guidelines. Progress in achieving the SFDRR targets is monitored and assessed by means of 38 indicators, some of which are also used to report on progress on the SDGs. In a recent analysis of the synergies between these indicators, a set of 20 indicators from the global SDG and SFDRR indicators were found to be of relevance for adaptation (see Table 3.3 in ETC/CCA, 2018b). These indicators can be found under different SDGs (and not only under SDG 13, Climate action) and under different global targets of the SFDRR.

Local-level MRE can generate significant inputs to the national level, as aggregation of information from the sub-national level on progress in adaptation is of interest to national MRE processes. Evidence of formal requirements for local-level adaptation MRE is scarce, although elements related to adaptation may be included in broader reporting associated with local-level decision-making. However, MRE activities connected to local-level adaptation plans are also interesting from the perspective of national-level MRE.

4.2 Indicators aim to track adaptation progress

The particular purpose of an MRE system for adaptation often influences the overall approach and the methods applied. Countries frequently acknowledge the benefits of setting up flexible systems that combine both qualitative and quantitative information from multiple sources to provide robust, consistent and contextualised descriptions of adaptation progress. In terms of methods for MRE, countries continually express high levels of interest in including indicators in their MRE systems for CCA (ETC/CCA, 2018b).

The high level of interest in using and developing adaptation indicators may result from the multitude of purposes that indicators can serve. In addition to tracking the progress of the implementation of adaptation policies, indicators can help to monitor spending related to adaptation. As a way of summarising information, indicators can also support effective communication of information to policymakers and practitioners alike (ETC/ACC, 2009).

Recent efforts to analyse national adaptation indicators used by European countries (ETC/CCA, 2018b) revealed that only a limited number of countries have operational adaptation indicator sets. It is important to acknowledge that selecting and developing indicators for adaptation can be a complex task. The full development and use of indicators is constrained by barriers (Mitchell et al., 2016). Challenges are linked to long time-frames and uncertainties inherent to CCA, establishing measurable targets and objectives and setting baselines for and constraints on data and resources (EEA, 2015b).

The *Adaptation gap report 2017* looked at the status of and ways forward for assessing and tracking progress on adaptation at a global level to support the post-Paris Agreement process. The report provided insights into the current state of knowledge on methodologies, indicators and metrics for tracking adaptation and evaluating its progress at a global level. It highlighted the opportunities to learn from efforts countries are currently making to implement national monitoring and evaluation systems for adaptation and the need to develop indicators that capture context-specific aspects and support evaluative metrics for qualitative assessment (UN Environment DTU Partnership 2017).

European countries' early experiences of developing national adaptation indicator sets illustrate that the process of developing and agreeing on a suitable set of indicators can be time consuming and require significant efforts to engage stakeholders. Indicator development is essentially an iterative process, affected by the needs for which they are developed, the views and capacities of the stakeholder involved and the

availability of data. Some countries (e.g. Germany and the United Kingdom) have already revised their indicator sets based on experience of applying them. Likewise, Austria has identified a likely need to revise criteria (similar to indicators) for the next reporting round. In Finland, the agreed set of adaptation indicators was much more limited than the potential set of indicators explored in the process of developing them. This was largely because many indicators were not immediately suitable for use as part of a set of adaptation indicators and needed further development (ETC/CCA, 2018b). The Finnish example highlights a common challenge resulting from the inevitable use of proxy indicators. Given the lack of resources for developing new indicators for the purposes of tracking adaptation, countries often rely on indicators developed for other sectoral or thematic purposes such as biodiversity monitoring or monitoring the implementation of flood risk management. Such indicators, when interpreted from an adaptation perspective, and possibly supplemented with additional information, may serve the purpose of tracking adaptation in addition to their original purpose. This emphasises the need for careful interpretation of indicator information, especially where they are applied to explain processes for which they were not originally designed.

A guidebook on monitoring and evaluation of ecosystem-based adaptation (EbA) interventions (GIZ et al., 2020) distinguishes four steps:

1. developing a results framework;
2. defining indicators, baselines and targets;
3. putting the monitoring and evaluation system into practice; and
4. using and communicating the results.

Throughout the various steps of the adaptation policy cycle, the MRE phase should be kept in mind. This report stresses the importance of stakeholder involvement and the use of indicators as proxies for different sub-processes that, when explained in their context, help to understand the progress made, keeping in mind that they do not cover all dimensions.

4.2.1 First sets of national-level adaptation indicators are operational in Europe

A recent assessment revealed that, within Europe, only a handful of countries have an operational set of indicators for adaptation in place (i.e. Austria, Finland, Germany, United Kingdom), while an additional number of countries are developing indicators for adaptation (ETC/CCA, 2018b). These

early experiences of developing national adaptation indicator sets offer some insights into their potential and pitfalls. The ETC/CCA (2018b) report is accompanied by tables in an online database ⁽³⁸⁾, putting all the available national systems in a common structure that can be searched by the reader to compare approaches.

In almost all cases in which national adaptation indicator sets are currently operational, they are primarily used for monitoring adaptation policies and reporting on progress rather than for evaluating adaptation policies and measures. Ideally, monitoring adaptation policies more regularly would build a foundation for periodic evaluations of the impacts and outcomes of policy interventions. It thus appears that there is unused potential for using adaptation indicators to evaluate adaptation policy. Especially as more experience of implementing adaptation policies accumulates, indicator time series can be a key source of information in assessing how risks, vulnerabilities and adaptive capacities are changing.

The indicator sets show high levels of variation in the numbers of indicators included and in the scope and focus of indicators. Indicators may be focused on a single sector or may be broader and cover multiple sectors. Likewise, high levels of variation were observed in the range of impacts addressed by the indicators. For instance, generally indicators linked to the precipitation-related impacts were less common than those linked to the temperature-related impacts of climate change. It is also common for indicators to cover multiple impacts of climate change. All indicator sets included different types of indicators, but overall very few commonalities could be observed across the five national adaptation indicator sets. The indicator sets essentially reflect countries' national adaptation priorities and different geographical and socio-economic contexts. This underlines the challenges linked to any attempts to develop adaptation indicators in supranational contexts, as adaptation is highly context specific.

Assessment of the early experiences of developing and applying national adaptation indicator sets in Europe (ETC/CCA, 2018b) also offered some reflections on the limitations of using indicators as a method overall. Understanding such limitations is important to overcome them and benefit from the full potential of indicators for tracking adaptation progress. Firstly, the experiences highlight the need to supplement indicators (especially quantitative, but also qualitative) with narratives to support their interpretation. Although indicators — especially those that are highly sensitive — have the potential to show changes in the variables they monitor, they generally have very limited power to explain why such changes happen. Secondly, indicators commonly lack features enabling interactivity or the collection of user feedback. While much attention has been paid to engaging experts in developing indicators, less

attention has been paid to engaging end users. The more purposes indicators are expected to serve beyond standard performance-based thinking and comparability across locations, especially for learning and more reflection-focused purposes, the more valuable such features can become in ensuring their usefulness for end users. Furthermore, adaptation indicators, like indicators and monitoring efforts in any other field, are subject to political volatilities and associated changes in resource allocation.

4.2.2 *Composite indices support comparison through aggregation of information*

Composite indices translate many-sided indicators of progress into statistical measures of overall performance, building upon frameworks that determine how individual indicators are selected, combined and weighted, based on their importance. Composite indices support analysis of disaster- and climate change-related risks and/or progress in mitigating and adapting to climate change.

Developed by the Inter-Agency Standing Committee ⁽³⁹⁾ and the European Commission Joint Research Centre (JRC, 2014), the Index for Risk Management (Marin-Ferrer et al., 2017) offers open source risk profiles for humanitarian crises and disasters. The index combines various indicators of hazard and exposure, vulnerability and coping capacity. Risk profiles support decision-making in crisis response, recovery, prevention and preparedness by humanitarian and development agencies. The Global Climate Risk Index (Eckstein et al., 2019) analyses to what extent countries have been affected by extreme weather- and climate-related events.

Composite indices are widely used to measure and compare the performance of regions and nations with respect to other capabilities such as innovation and competitiveness. Lassa et al. (2019) analysed political commitment to reduce risks from disasters and changing climate. The indicators employed include investment in early warning systems, fiscal allocation for risk mitigation, awareness raising and promotion, and incentives for stakeholders to participate in managing risks.

In recent years several indicator-based frameworks for adaptation analysis have been developed and tested (Lesnikowski et al., 2015). The Notre Dame Global Adaptation Index (ND-GAIN) is an index developed by the University of Notre Dame and the Global Adaptation Institute. ND-GAIN measures climate vulnerability and adaptation readiness based on two dimensions (vulnerability to climate disruptions and readiness to leverage private and public sector investment for adaptive actions) and 45 core indicators.

⁽³⁸⁾ https://www.eionet.europa.eu/etcs/etc-cca/products/etc-cca-reports/tp_3-2018/annex_tp_3-2018.xlsx

⁽³⁹⁾ <https://interagencystandingcommittee.org>

A synthesis and summary of frameworks for the MRE of CCA and resilience interventions, with a specific focus on international development projects and programmes, concluded that earlier frameworks were often modelled on disaster risk reduction (DRR) efforts, albeit with important modifications to reflect longer time-frames and greater uncertainty. Over time there has been an evolution in thinking about CCA, moving from resilience through adaptability to transformation (Bours et al., 2014).

Indices such as ND-GAIN measure readiness and capacity for adaptation rather than directly measuring the progress made in implementing adaptation practices. To our knowledge, there are very few indices that have been designed to measure the efficacy of adaptation actions and practices.

For instance, Lesnikowski et al. (2015) introduced a systematic monitoring and evaluation approach to measure adaptation actions being undertaken by 117 parties to the UNFCCC with the goal of establishing a baseline for global trends in adaptation. Their monitoring and evaluation framework is based on an index called the Adaptation Initiatives Index, which ranks countries based on the range of adaptation actions reported through national communications. The index includes 12 indicators, namely country, communication number, reporting year, action title, vulnerability, level of action, type of action, status of action, implementation approach, actor participation, sector participation and vulnerable group.

Scotland's centre of expertise on climate change research and policy (CXC, 2020) published over 100 indicators measuring and monitoring progress in building a 'climate-ready Scotland'. The indicators are categorised under (1) **risk/opportunity** and impact indicators related to the expected impacts of climate change, disaggregated by sector and region, and (2) **action** indicators, which evaluate the work being done (e.g. water leakage and losses, number of registrations for flood warnings/alerts and uptake of energy efficiency measures). The indicators are multidisciplinary and cross-sectoral and designed for a wide range of government policy teams, agencies, non-governmental organisations (NGOs), local authorities, planners and others working towards a climate-resilient Scotland.

Composite indices make it possible to evaluate the progress of adaptation and measure gains in terms of adaptive capacity and resilience (Mathew et al., 2016; CoastAdapt, 2018; Environment and Climate Change Canada, 2018). However, several challenges still need to be overcome (Dilling et al., 2019):

- There is neither an unambiguous definition of adaptation nor a single unit of analysis. Climate change adaptation serves different purposes and is carried out at different scales and in different economic sectors.
- Assessment of successful adaptation may stem from differing perceptions of what constitutes risk and whether (or how) climate risks should be mitigated or prevented.
- A global stocktaking process for climate change adaptation is driven by those with the capacity to participate at the national and international levels and thus likely to obscure the views of local, less powerful stakeholders and especially vulnerable groups.

4.3 Evaluations of adaptation policies require mixed methods

Beyond monitoring the implementation of adaptation policies and regularly reporting on progress, there is also a need to periodically evaluate, in a more holistic manner, whether progress is being made in the right direction. Policy evaluations support the revision of policies by providing insights into what is working and what changes might be needed.

As noted above, there is limited evidence of the use of indicators as part of adaptation policy evaluations in Europe. Furthermore, the limitations linked to adaptation indicators highlight the need for additional evidence to establish a sufficient understanding of what difference is being made. Experiences of recent policy evaluation efforts in Finland (Box 4.1) and Switzerland (Box 4.2) illustrate different methods and approaches in more detail, and below we give some brief examples of approaches elsewhere in Europe.

Box 4.1 Mid-term evaluation of the Finnish national adaptation plan employed evidence from a range of sources

In Finland's recent mid-term evaluation of its national adaptation plan (NAP, 2018-2019), evidence was collected from a range of actors using multiple methods. Engaging stakeholders across sectors and administrative levels provided important inputs to the evaluation process.

The evaluation process focused first on collecting data on the implementation of measures from key actors involved in the NAP's implementation. Information on implemented and ongoing measures was used as an input to sectoral focus group interviews with policymakers, alongside the results of the latest national weather and climate risk assessment. Partly in parallel, stakeholders beyond the national government were engaged in a series of regional stakeholder workshops and a national online survey. Five regional stakeholder workshops were organised jointly with those responsible for preparing regional risk assessments, with the aim of strengthening coordination across adaptation and disaster risk reduction networks and activities. In practice, rescue services and preparedness featured as a theme in all five workshops, while the other themes covered in the workshops reflected the sectoral priorities of the different regions. Another key source of stakeholders' views was a national survey that covered 15 sectors. The survey data complemented information collected in the regional workshops.

The different types of evidence collected for the evaluation (implementation status of measures, group interviews with government actors, regional stakeholder workshops and survey data) were evaluated against a set of criteria. These covered aspects of the implementation process as well as effectiveness. The analysis also focused on identifying areas and topics to be prioritised during the remaining years of the NAP's implementation period (until the end of 2022).

Limitations observed and lessons learned for future evaluations:

- Continuous monitoring of implementation is crucial for policy evaluations. Monitoring of the NAP's implementation had not been carried out annually as set out in the NAP. This increased the burden of the mid-term evaluation, as the evaluation team needed to start with collecting basic information on the NAP's implementation.
- The evaluation focused on a relatively short implementation period (mostly 2015-2017), which made applying evaluation criteria focused on the NAP's effectiveness challenging. Although these criteria could not be fully assessed in the mid-term evaluation, the experience gave useful indications of gaps in data availability and methodological applicability that can be addressed before the final evaluation of the NAP (expected in 2021/2022).
- Stakeholder engagement processes, in particular the regional workshops, were highly appreciated by those participating. In addition to providing insights into how the implementation of adaptation policies is progressing at the regional level and what gaps there are, the workshops also highlighted the value of strengthening regional networks on adaptation issues. In particular, improving coordination across adaptation and disaster risk management communities at the level of practical implementation proved valuable.

The mid-term evaluation showed that awareness of climate risks has increased since previous evaluations, especially among government actors. Implementation of adaptation actions has also increased, but significant variations remain across sectors. The evaluation also indicated that awareness of the NAP is not very widespread, which begs the question of the degree to which it has been driving adaptation action especially at the regional and local levels. The target of evaluation has changed from the national adaptation strategy to the NAP, and as a result the evaluation approach differed methodologically from that of previous evaluations. This limits the degree to which conclusions can be drawn over a longer time perspective.

Source: Mäkinen et al. (2019a) — a version in English is under preparation.

Box 4.2 Switzerland's monitoring, reporting and evaluation system and its evaluation

The Swiss adaptation strategy provides a framework for coordination at the federal level. In the first part of the strategy (FOEN, 2012), the objectives, challenges and fields of action for adapting to climate change are identified. The second part comprises an action plan with 63 adaptation measures (FOEN, 2014). Following the adoption of the action plan by the Federal Council, the Federal Office for the Environment (FOEN) was mandated to report to the Federal Council on the progress made, and the effects achieved, by the end of 2017.

An impact model (see Figure 4.1) forms the basis of the Swiss national monitoring, reporting and evaluation (MRE) system. The model consists of five evaluation 'objects' (concept, implementation, output, outcome and impact) and sets out the logic underpinning the flow from one object to another. A similar approach was used to evaluate the German adaptation strategy 2018/2019 (Kind et al., 2019). Furthermore, the model distinguishes between the strategic level (setting up a coordination framework for adaptation) and the operational level (implementing adaptation measures).

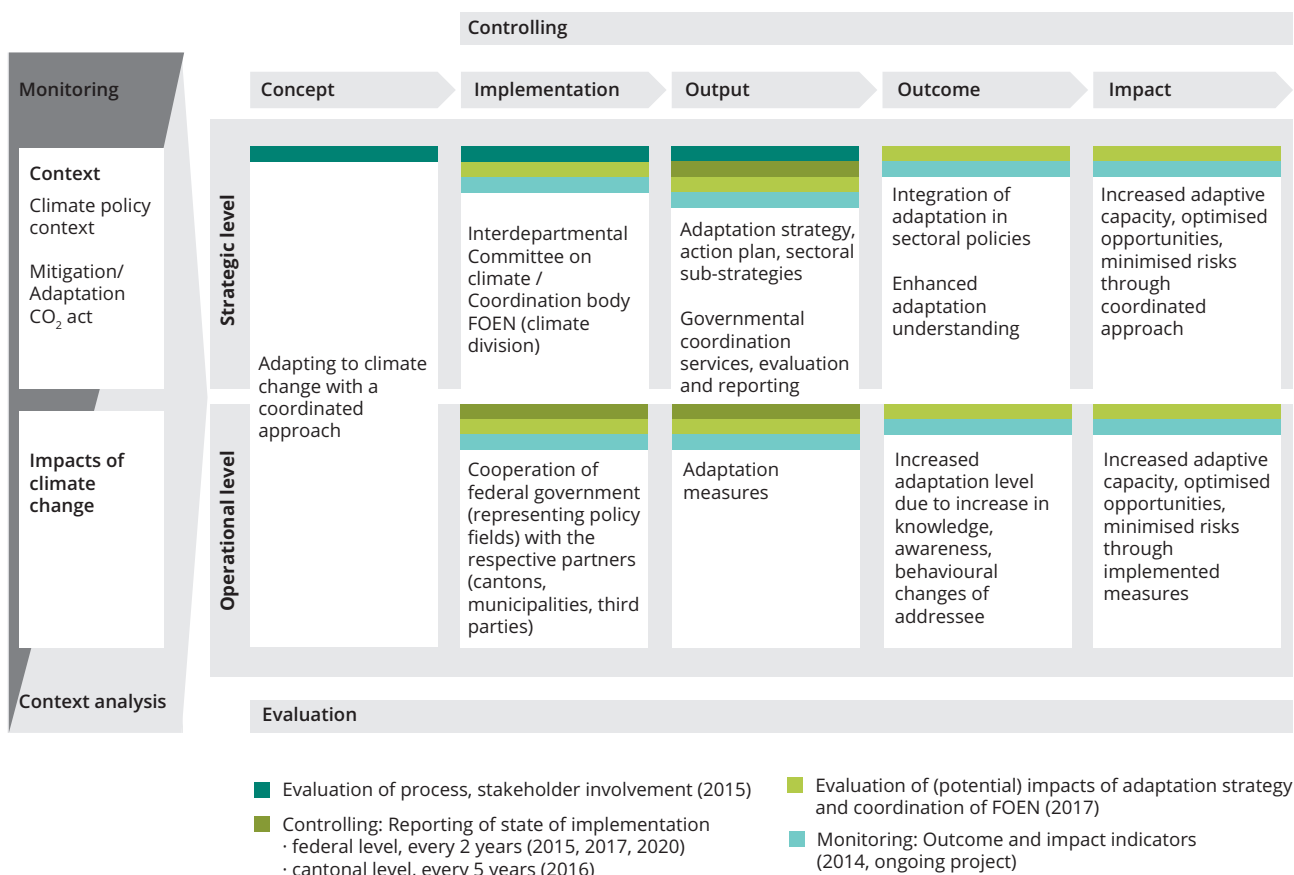
The aim of the evaluation of the Swiss adaptation strategy in 2017 was to give further information on the progress made and the effects achieved. Hence, it shows the added value of the adaptation strategy and its coordination by FOEN, expressed in increased adaptive capacity, minimised risks and seized opportunities. The evaluation focuses on three case studies of climate-related cross-sectoral challenges: greater heat stress in cities, increasing levels of summer drought and the rising snowline.

The reasons for selecting these topics were their relevance, the different levels of complexity of the three case studies and the availability of data. For each cross-sectoral challenge evaluated, a detailed impact model with the objects to be evaluated was developed (Figure 4.2).

The approach is illustrated for the cross-sectoral challenge of greater heat stress in cities and agglomerations. Minimising the risks posed by this challenge means, among other things, reducing mortality due to heat waves and increasing well-being (**goals**). To achieve these goals, adaptation measures such as information about behaviour during heat waves, suitable for target groups (**activities**), have to be distributed to cantons (**outcome**), e.g. by the Federal Office of Public Health (**implementation, output**). The cantons are informed and spread the information further to other stakeholders, such as hospitals, doctors and finally patients (**outcome**). Informed stakeholders change their behaviour and decrease mortality due to decreases in heat waves and increase their well-being; hence, the risk is reduced and the adaptive capacity increased (**impact**). For each evaluation object, the FOEN has applied criteria such as clarity, coherence, stakeholder involvement and potential impacts when determining the object.

Various obstacles and limitations were faced when evaluating the Swiss adaptation strategy, e.g. due to the short time span of implementation, the impacts are often not yet visible. Therefore, the evaluation focuses on potential impacts. It analyses whether the measures are set up in a way that the impacts can be potentially achieved, e.g. targets are defined, the target groups are determined and suitable communication channels are chosen.

The adaptation policy is mainly **qualitative**, and barely any **quantitative goals** are set. To identify the impacts achieved by implementing adaptation measures is challenging. The logic model and the focus on cross-sectoral challenges in the evaluation help to overcome the difficulty of having qualitative goals, of proving **causality** between the measures implemented and the reduced risks and **complexity** of the adaptation policy.

Box 4.2 Switzerland's monitoring, reporting and evaluation system and its evaluation (cont.)
Figure 4.1 Impact model of Switzerland's adaptation strategy


Source: FOEN (2014).

Figure 4.2 Impact model of cross-sectoral challenge: greater heat stress in cities and agglomerations

Strategic goals: - Increase adaptive capacity - Seize opportunities - Minimise risks		
Goals	Goals: Reduced mortality due to heat waves, increased well-being	<i>Clarity, coherence, completeness of goals</i>
Activities	Activities: Information about heat waves, suitable for target group.	
Implementation	Implementation: Federal Office of Public Health (FOPH)	<i>Responsibility, stakeholder involvement, resources, coordination by FOEN</i>
Output Measures	Output: Measure to deal with the challenges of heat waves	<i>State of implementation</i>
Outcome Government - Cantons - Other	Federal level: FOPH develops and distributes information to cantons Cantons: are informed and distribute information to other stakeholders (hospitals, doctors, etc.)	<i>Increased adaptive capacity</i>
Impact	Impact: Reduced heat mortality, reduced health problems, ensured well-being	<i>(potential) impacts of implementation of measures, optimisation needs, added value of coordination by FOEN</i>

Source: FOEN (2014).

The report *Methodology for the evaluation of the German adaptation strategy* presents the concept for the evaluation and further development of the German adaptation strategy, describes the survey instruments to be used and gives a detailed description of how the concept was developed (Kind et al., 2019). The results of a related report (Gaus et al., 2019), based on document analysis, interviews and a Delphi survey, indicate that the German adaptation strategy has stimulated federal states and at least large municipalities to become active themselves in adapting to climate change.

Recommendations derived from the German evaluation report call for an increased use of legal and economic instruments to foster implementation of measures on different levels (e.g. using the EU financial framework) and strengthening participation and consultation, particularly for non-governmental actors. Furthermore, the report calls for evidence-based visions and objectives for action on CCA and effective analysis of measures and policy mixes to optimise the implementation of measures and updating of standards and technical rules, particularly to design more resilient infrastructures (Gaus et al., 2019).

The conclusions of the Spanish evaluation report also raise important methodological issues, such as allocating sufficient resources, the important role of advisory groups, the involvement and relevant insights of stakeholders and compliance with measures (MITECO, 2019). In terms of the achievements of the national adaptation plan (NAP), progress was made in impact and vulnerability assessment and in collective knowledge building, various tools for adaptation were developed and adaptation governance was improved. Nevertheless, challenges remain, such as a stronger focus on adaptation measures is needed and knowledge management can be further improved. There are emerging issues such as social vulnerabilities or spill-over effects that need to be reflected upon and finally a culture of adaptation is needed (Heras, 2019).

The policy study 'Keeping track on adaptation in the Dutch Delta' (Ligtvoet et al., 2016) calls for a reflexive monitoring and evaluation framework for the Dutch delta programme. Based on a reflexive approach (adaptive delta management), the report makes four recommendations:

1. reinforce the Delta programme's capacity to promote learning through collaboration in a participatory environment;
2. secure adaptive management for a timely response to changing circumstances;
3. create a basis for shared accountability to keep track of the implementation of the Delta programme; and

4. create a basis for trust and transparency by verifying where goals are being reached and where they may need to be revised, based on experience (Ligtvoet et al., 2016).

Experience from the Portuguese action plan for adaptation to climate change 2030, in terms of implementation and monitoring, states that climate change impacts need to be monitored and the risks mapped, and national and sub-national monitoring and evaluation systems need to be established. Various outcome indicators with targets for 2020 and 2030 were and are monitored, e.g. municipalities with adaptation plans, the efficiency of water use in agriculture or areas of mainland coastline that are critically eroded (Paulino et al., 2019). In addition, Portuguese lessons learned highlight that process indicators are important for monitoring progress in mainstreaming adaptation, but quantitative indicators are quite challenging, e.g. how far is the development related to adaptation measures or other factors? Ensuring coherence with other countries' MRE systems remains challenging, as national risks, priorities and targets are in part quite different because climate change impacts are regionally diverse. What remains a future challenge for adaptation MRE is the question of how to determine the effectiveness of adaptation activities (Paulino, 2019).

4.3.1 Stakeholder involvement is crucial for salient evaluation

Engagement of stakeholders in the earlier phases of the adaptation policy cycle has a significant impact on potential collaboration in monitoring and evaluation of national adaptation strategies and NAPs. In the MRE phase, effective stakeholder involvement and information can deliver effective mapping of the state of adaptation and highlight gaps in awareness and capabilities in different societal sectors, regions and communities. Stakeholder engagement throughout the policy cycle, including during evaluation, can increase motivation. Greater ownership and identification of and accounting for diverse relevant aspects has the potential to create a better overall picture than expert knowledge alone. Stakeholder involvement may also increase the reliability, acceptability and accountability of the monitoring and evaluation and enhance overall adaptation capacity and capabilities in stakeholder groups.

However, the use of stakeholder involvement in the adaptation policy cycle is often least in MRE (EEA, 2014a). The EEA member countries that have involved stakeholders in MRE often request information from stakeholders and evaluate whether stakeholder knowledge was used. However, those stakeholders are not asked how motivated they are and how they would evaluate their access to participating in and influencing the process. For salient evaluations, stakeholder engagement is crucial.

An example of stakeholder engagement in the mid-term evaluation of Finland's NAP is provided in Box 4.3.

As the success of adaptation is not univocal, MRE benefits from focusing on measuring capability that builds adaptive capacity and empowers communities in the face of climate change (Dilling et al., 2019). To conduct comprehensive evaluation, comprehensive metrics, including those relevant to local communities are needed. Certain international agreements, such as the United Nations SDGs, the SFDRR and the Convention on Biological Diversity, have already outlined the metrics of success that can support the building of adaptation capabilities.

While the focus of this report is on adaptation action linked to public policies, it must be noted that adaptation actions are also taken autonomously e.g. by various actors in the private sector. Engaging private sector stakeholders in monitoring and evaluation of adaptation can broaden the range of adaptation activities captured by MRE efforts and thus enrich the views generated. Monitoring and evaluation have the potential to support the connection between the public and private spheres of adaptation action.

4.3.2 *Peer reviews promote knowledge exchange and policy compliance*

Peer reviews as governance instruments are 'systematic assessments of the performance of a State by other States, with the ultimate goal of helping the reviewed State improve its policy-making, adopt best practices, and comply with established standards and principles' (Pagani, 2002). They are strongly characterised by elements of mutual learning, exchange of good practices and fostering cooperation across countries. While there is limited evidence of applying peer reviews in the field of NAPs, experience of their application is available from related policy fields, including evaluation of national sustainable development policies (ETC/CCA, 2017), disaster risk management policies ⁽⁴⁰⁾ and environmental performance ⁽⁴¹⁾.

The SFDRR called for peer reviews to understand disaster risks and to promote mutual learning. Peer review was already part of progress monitoring under the Hyogo Framework for Action 2005-2015 for building the resilience of nations and communities to disasters (UNISDR, 2007). Peer review processes on disaster risk management policies and operation foster cooperation and exchange of good practices, promote mutual learning across Europe and contribute to an integrated approach to disaster risk management. The strictly voluntary reviews are implemented by peers/experts from other countries examining the set-up and operation of risk management

Box 4.3 Engagement of stakeholders in the mid-term evaluation of Finland's adaptation plan

Stakeholder involvement in the mid-term evaluation of the Finnish national adaptation plan (NAP) consisted of five regional stakeholder events and a web-based survey. The aim of the stakeholder events was to map the state of and gaps in adaptation practices at regional level. Participants included stakeholders relevant to adaptation and selected local themes, representatives of rescue services, regional government agencies and research organisations. At the beginning of each event, the objectives of the mid-term evaluation were presented and a local representative was heard. After the presentations, there was a workshop phase, where participants discussed and assessed the state of adaptation in their field or sector. The regional stakeholder events were facilitated by representatives of the national ministry and environment research institute and, importantly, a professional environmental conflict mediator. The web-based survey served to map the wider state of adaptation: how the NAP has enhanced adaptation practices, what the state of adaptation is in different sectors and how it should be improved, how the stakeholders cooperate in adaptation, and how the actors should be supported in their adaptation activities. The results of the stakeholder involvement process were analysed and reported in detail as part of the national evaluation report.

Sources: Mäkinen et al. (2019a) and the Finnish country page on Climate-ADAPT (2020).

⁽⁴⁰⁾ The reports produced under the EU disaster risk management peer review programme are available at https://ec.europa.eu/echo/what-we-do/civil-protection/peer-review_en.

⁽⁴¹⁾ OECD country-related environmental performance reviews are available at <https://www.oecd.org/environment/country-reviews/find-a-review.htm> (status in March 2020).

practices in the reviewed country. The flexible focus of the reviews varies from general disaster risk management arrangements to specific aspects such as risk assessments, risk management capability or early warning systems.

Since 2012, the European Commission in collaboration with the Organisation for Economic Co-operation and Development (OECD) and the UNDRR have conducted reviews for Bulgaria, Cyprus, Estonia, Finland, Malta, North Macedonia, Poland, Turkey and the United Kingdom and a few non-EEA member countries. Other countries are undergoing review under the EU 2018-2019 programme, including Portugal and Serbia. It is envisaged that four more countries will be reviewed in 2020-2021. The OECD's own peer review programme of risk governance and management policies has addressed additional countries (e.g. Italy, Norway and Sweden) and sub-national regions (Île de France/Seine and Loire basins).

4.4 Lessons learned and key challenges for monitoring, reporting and evaluation

MRE schemes have progressed over recent years and provide feedback on adaptation progress and performance, i.e. whether the adaptation goals, targets and efforts are sufficient and how they contribute to reducing vulnerability to climate change. Until now, most countries have focused on monitoring progress in adaptation and fewer experiences of evaluating adaptation policy have been available to learn from.

Experience from other countries developing nationally determined indicators show that progress is taking place in developing a range of indicators that measure resilience, vulnerability and adaptive capacity. Countries can draw on that to assess their success in progressing towards their own adaptation goals (Rai et al., 2019).

Regular monitoring entails routine collection of data and information that allows basic tracking of progress and performance and can help to avoid/limit the risk of maladaptation. Monitoring can thus answer the question of whether we are heading in the right direction. Building long time series of data (Vallejo, 2017) is important to create the basis for joint learning and knowledge-based adaptation planning. So far, EEA member countries have not progressed much beyond tracking adaptation processes. Consequently, understanding the outcomes of adaptation policies is still limited. Tracking of processes is often available more immediately than evidence of outcomes and, as demonstrated by the countries' experiences described above, often not enough time has passed to enable the evaluation of policy outcomes. To understand more about the effects of adaptation policies and measures in reducing impacts and risk, longer experience of implementation is required. However, given the

nature of adaptation planning, which is based on conditional, uncertain or otherwise incomplete understanding of changing climate risks, MRE is also expected to continuously improve the existing knowledge on (expected and observed) climate change impacts and vulnerability, and/or help identify key challenges, opportunities and persistent knowledge gaps.

Reporting entails formalised processes for tracking progress. In addition to monitoring results, information collected in reporting processes can also support specific and periodic evaluations of policies. For example, the information collected from EU Member States in evaluating the EU adaptation strategy (country fiches and scoreboards) is one kind of common reporting scheme (EC, 2018a). Although the information collected provides an overview of progress made in the adaptation policy cycle, it does not assess if and how climate resilience has increased or how adaptive capacity has been built up.

Experience from the United Kingdom (Street and Jude, 2019) highlights an additional challenge of designing and enabling supportive monitoring and evaluation processes that go beyond the more traditional scorecard and benchmarking approaches of tracking progress. There is a need to reflect on and deliver the various value propositions, which really requires buy-in by those stakeholders involved in the reporting process to enable and build up the necessary capacity to support reporting processes through a cooperative approach that enables continuous learning and improvement. There is a clear lesson learned that reporting needs to add value both to those organisations reporting and to the government.

Evaluations are specific and separate efforts that seek deeper insights into some elements and progress from these insights, feeding back into the revision of adaptation policy. Recent efforts from Finland, Switzerland and the United Kingdom have aimed to provide deeper insights into why and how various effects come about. Experiences to date indicate that progress at the level of processes is relatively feasible and easy to detect in evaluations. More challenging dimensions of evaluation include the use of resources for adaptation action, the impacts of policies and actions on vulnerability, exposure and changes in adaptive capacity, and discovering the range of actions in all sectors and at all implementation levels, including sub-national and local levels.

There is no single unit of analysis available for adaptation, as it serves different purposes and is carried out at different scales and in different economic sectors. For international organisations and funds such as the Global Environmental Facility and Green Climate Fund, MRE provides important insights on where to focus investments and how to maximise the impacts.

Experiences from 'participatory monitoring and evaluation' in the Green Climate Fund identified stakeholder involvement as very important for full and effective project implementation (Mutimba, 2019) and concludes that broad stakeholder engagement and participation throughout the whole life cycle of activities is very important, as is gender inclusiveness and involving indigenous (local) people. Another key conclusion and recommendation is sharing knowledge of lessons and experiences and feeding these back into new activities and thus increasing learning over time.

At national, regional and local levels MRE provides insights into what has been achieved and how. At international level, MRE is instrumental for cross-comparison and achieving global goals, in addition to trans-national impact and effort sharing. For the latter purpose the only coherent source of information on CCA is the national communications made under the UNFCCC (see Table 1.1). The Katowice Climate package (UNFCCC, 2019a, 2019b) reinforced the mandate for nations to undertake and document adaptation progress. Still, given the many levels of adaptation tracking*, clear mechanisms and frameworks for governmental accountability and adaptation assessment remain methodologically elusive.

Assessing adaptation outcomes is challenging, given the long timescales, considerable and persistent uncertainty and counterfactual assessment of the impacts and benefits of adaptation. MRE employs indicators related to adaptation processes and inputs, outputs and outcomes. Outcome indicators address the overarching impact of adaptation action on vulnerability, adaptive capacity or resilience. It is relatively easier to describe the progress using process/input or output indicators, but MRE systems are expected to determine the progress that has been made towards outcomes.

When it comes to the programme and project levels, common challenges are a lack of standardised and 'best practice' methodologies and outcome indicators for adaptation interventions (Christiansen et al., 2016). In addition, the baseline data for adaptation interventions are challenging because of the dynamic nature of the adaptation process. Also challenging is the timing/time horizon of the benefits expected from adaptation interventions. As there is no standard metric for adaptation, which supports the tracking and aggregation of results across the different sectors and levels possible, only proxy indicators can support monitoring and evaluation at the moment. Finally, attributing the outcomes of MRE in terms of increased resilience and adaptive capacity due to investment in adaptation is another challenge (Christiansen et al., 2016).

Despite the multitude of MRE frameworks, the optimal way of organising knowledge and experience of how to adapt to climate change, and what the characteristics of a well-adapted society are, still need to be developed. Among process-oriented indicators, future frameworks should capture how decision-making on adaptation copes with unavoidable uncertainties. It is important to portray how the pace of anticipated and unanticipated environmental (including climate) and socio-economic changes, along with the assumptions underpinning the adaptation choices, are considered in policy- and decision-making. MRE frameworks need to find a balance between the need for detailed, meaningful and longitudinal data sources and the burden of reporting on governments at various levels. Consistent and systematic frameworks need to be flexible to capture the (evolving) diversity of the vulnerability contexts across Europe.

5 Conclusions and future directions

5.1 Overview of lessons learned

Monitoring, reporting and evaluation (MRE) is an essential part of a learning process for continuous improvement (Street and Jude, 2019) and making further progress on adaptation policies and actions. It enables the uptake of new information and lessons learned from many different fields in a comprehensive and holistic way and helps to shape the future direction of and further improve and progress adaptation policies and actions. It is the 'last' step of the adaptation policy cycle, based on the adaptation support tool (AST; see Figure 0.1). Nevertheless, MRE ideally accompanies each step of the adaptation policy cycle. All steps of the adaptation policy cycle need to be evaluated in terms of their methods and the effectiveness and efficiency of measures as well as their success in achieving the target.

MRE of adaptation can support adaptation across all levels of governance. The scope and objectives of MRE, however, vary from the international to the national and further to the local level ⁽⁴²⁾. Although experience on tracking progress has accumulated, there is a need to move beyond tracking processes (input and output) towards understanding the outcomes and impacts of policies and actions. As climate change adaptation (CCA) and the adaptation policy cycle are embedded in a socio-economic-ecological system that needs to be resilient, MRE also needs to take place in terms of learning over time and looking at the questions of whether we are doing the right things and doing them right.

The Monitoring Mechanism Regulation (MMR, Article 15) (EU, 2013b) requires Member States (MSs) to report on their adaptation activities to the European Commission, without setting a mandatory format for such reporting. The last reporting on adaptation took place in 2019 and the reporting guidance requests MSs to provide information on (EC, 2019e):

- the policy and legal framework (adaptation strategies and plans);
- information on impacts, vulnerability and adaptation (observations and projections, impact and vulnerability assessments, research and monitoring progress);

- priority sectors and adaptation action; and
- engaging stakeholders through participation and capacity building (governance and adaptation capacity, dissemination, education and training).

The information reported forms the basis of the country information available on the European CCA portal Climate-ADAPT (EEA, 2019c). This is broadly in line with the adaptation reporting requirements for the United Nations Framework Convention on Climate Change (UNFCCC) national communications.

EU MSs continue to monitor, report on and evaluate adaptation policies and options, following the adoption of the Paris Agreement, which created great momentum for action on climate change. The European Green Deal is now reviving that momentum. Tracking adaptation to climate change is crucial to improve understanding of how adaptation is taking place in practice and on the ground as well as to ensure policy-oriented learning.

5.1.1 National adaptation policies

By 2013, 21 EEA member countries had a national adaptation strategy (NAS) in place and nine countries a national adaptation plan (NAP). By the end of 2019, 30 NASs and 20 NAPs were in place. In April 2020, all EU MSs had a NAS and/or a NAP adopted. By the end of 2019, 11 EEA member countries had revised their national adaptation policy frameworks and several other countries have plans to revise their national adaptation policies and actions. It needs to be acknowledged that the global and European policy context has changed over recent years and CCA has become more relevant, next to climate change mitigation, in climate policy.

Notwithstanding the success in terms of numbers, to the extent that all EEA member countries except one have adaptation policies adopted, the ideas of what a NAS or NAP should cover remains underdeveloped. Consequently, there is a huge variety in level of detail and issues covered from country to country. In

⁽⁴²⁾ Because of the multi-level governance aspects and the involvement of many stakeholders, the 'R' in MRE refers not only to the reporting obligations of countries at the European and global levels but also to bringing together information that is monitored by various stakeholders in a useful format to support the evaluation of adaptation policies.

our understanding, a well-developed NAS articulates a vision of how to deal with the impacts of climate change over the next decades. It describes the horizontal and vertical coordination structures, identifying the various actors and areas of action. Compared with the NAS, the NAP then ideally has a shorter time horizon (roughly up to a decade). The NAP specifies how the NAS is implemented and by whom. The level of detail varies, taking into account the lifetime of the NAP and the specific national context. Both NAS and NAP ideally include when and how their success will be evaluated and what the monitoring and reporting needs are to allow the evaluation to be executed properly. The distinction between NAS and NAP is not made at the global level, where the content of both is merged into one document.

5.1.2 Stakeholder involvement

The greatest learning for all those involved occurs during the course of the evaluation itself through information and knowledge sharing and presentations and workshops as well as during the discussion of the findings. Thus, greater emphasis has to be placed on the provision of early feedback from stakeholders. It is therefore strongly recognised that the framework of evaluation lessons will need to be used in the context of interactive forms and formats of communication with diverse actors and stakeholders in the adaptation policy cycle to ensure that the evaluation lessons truly become 'lessons learned'.

Essentially the co-development and co-production of knowledge and various forms of stakeholder engagement have progressed in recent years, and participatory elements and approaches are common and very relevant elements of developing and implementing adaptation policy. Stakeholder engagement is crucial for MRE, on the one hand, to receive relevant quantitative and qualitative data for monitoring the process and progress and also, on the other hand, for interpreting the available data and deriving relevant messages from it. Thus, MRE is essential in contributing to further building up resilience and increasing adaptive capacity in EEA member countries.

Stakeholder engagement and thus the co-creation of adaptation policy throughout the strategy and planning process can help to ensure uptake from sectoral actors and thus strongly support implementation. This varies between statutory requirements (such as climate acts) and voluntary approaches, under which stakeholder engagement comes more strongly into play for implementing the measures envisaged in the climate adaptation action plans.

Notwithstanding the understanding of the importance of stakeholder involvement throughout the adaptation policy cycle, 26 EU MSs had processes in place for involving stakeholders in preparing adaptation policies, while only 13 MSs had these processes in place for involving stakeholders at national level in policy implementation and the review of

adaptation policies (EC, 2018b). It has been remarked that several countries are not evaluating their adaptation policies yet. The general conclusion of the 2014 report (EEA, 2014a) that stakeholder involvement is less developed in the implementation and evaluation phases (than in the policy development phase) and moves from active involvement (e.g. co-development) to more passive forms (e.g. consultation or providing information) seems to remain valid.

5.1.3 Monitoring, reporting and evaluation indicators and mixed methods

However, unlike mitigation, there is no universal unit of measurement for adaptation. The perceptions of effectiveness and even success vary. Focusing on national-level adaptation and measuring change in overall vulnerability may leave open the questions of 'vulnerability of whom?', 'to what?' and 'who decides?', which is likely to lead to the views of local, less powerful stakeholders and especially vulnerable groups being obscured (Dilling et al., 2019).

Indicators are a key way of connecting levels and seeking synergies, but they are not necessarily directly transferable across levels and policy domains. The first sets of national-level adaptation indicators are operational in Europe, but there is high demand for supporting the development of adaptation indicators. These indicators support mainly monitoring of adaptation, and experience of their use in evaluation is still limited.

Evaluation needs to be a specific and separate effort to put the emphasis on getting deeper insights into some elements and into progress from these insights, feeding back into revising adaptation policy. Only a limited number of countries gained deeper insights through evaluation. The target of the evaluation is very important — e.g. in the Finnish mid-term evaluation, the focus was on the NAP and more strictly its implementation, while in the final evaluation leading to policy updates the perspective can and perhaps should be much wider to allow the identification of new approaches that may be needed. Evaluating adaptation policies and their implementation benefits from the use of mixed methods, whereby quantitative and qualitative evidence are combined.

The first attempt to have common adaptation indicators was made using scoreboard and country fiches accompanying the evaluation of the EU adaptation strategy (EC, 2018a). However, the answers to various questions and sub-items mainly include output information and only a little about the outcome and impact of the national adaptation policies and their implementation and MRE schemes. The descriptive texts are not easily comparable across countries and the quantitative indicators are limited to binary yes/no/(maybe) questions.

The conclusions of Christiansen et al. (2016) illustrate the need to shift from trying to measure direct impacts of adaptation

interventions towards describing the contribution of a project or programme to a common objective. This reinforces the need for more explicit and clear objectives that can be more easily measured and monitored and towards which progress can be assessed.

5.1.4 Knowledge base

The knowledge base for developing adaptation policies has improved in recent years. The information from assessments of climate change impacts and vulnerability and our knowledge of climate impacts, vulnerability and risks has improved at various scales, national and European. In addition, information from related policy fields such as disaster risk reduction and related national risk assessments, have some parts in common, and synergies have been and can be capitalised on. Nevertheless, there is a clear need for more holistic and detailed risk assessments for, for example, compound and cascading hazards as well as transboundary and cross-border impacts and spill-over effects.

MRE is very relevant to documenting the impacts of implemented policies and has increased the available knowledge base and can ensure that learning loops are in place to further support implementation. MRE has the potential to be a key means of enhancing our learning and informing more effective adaptation policy and practice. Over time, there will be greater clarity over what works and what does not and help to avoid mal-adaptation. Increased coherence between CCA efforts and diverse related policy fields is visible as is more adaptation elements being integrated into other, e.g. sectoral, policies. Mainstreaming has progressed in many areas from water to agriculture, disaster risk reduction, biodiversity, forestry and other sectors at the European and national levels. Nevertheless, it remains challenging to monitor and evaluate beyond processes: the question remains, 'What difference is mainstreaming making?' Procedural mainstreaming (environmental impact assessment, strategic impact assessment, financial instruments) are important in enabling more action that supports adaptation, but ultimately mainstreaming in sector policies, plans and programmes (regulatory mainstreaming) is likely to have more of an impact on our abilities to manage climate risks and vulnerabilities.

Not only at the national but also at the transboundary level are CCA challenges highly relevant and are awareness-raising efforts and collaboration taking place. This is taking place in river basins (e.g. EU Water Framework Directive and Floods Directive), in the Interreg regions and EU macro-regions and

through various other sea or territorial conventions and mostly focuses on transnational collaboration. Projects within Europe focus on 'soft actions' and are not expected to directly implement concrete adaptation actions on the ground.

5.1.5 Adaptation finance

Financial support is key in enabling adaptation action. Public finance is increasingly being directed towards CCA (e.g. through the European structural funding programmes), but private sector finance is harder to identify. Public resources and private investment are needed to secure a climate-resilient economy. Awareness of the need for this to become operational needs to be raised. Tracking financial flows for CCA from both public and private sources is needed as well as the need for adaptation in monetary terms⁽⁴³⁾. These aspects are largely unknown at national level in most EEA member countries today. Most NAPs lack detail on the estimated resources needed to execute the described measures, and clarity on the origin of the financial resources.

The European Commission guidelines on climate-related reporting (EC, 2019f) do recognise that companies will benefit from better disclosure of climate-related information. The following improvements are envisaged, namely increased awareness and understanding of climate-related risks and opportunities, improved risk management, better informed decision-making and improved strategic planning, better and more constructive dialogue with stakeholders (e.g. investors and shareholders), an enhanced corporate reputation and a more diverse investor base.

To better assess the effectiveness of adaptation actions, further development of current methodologies and mechanisms is needed and needs to be taken seriously.

5.1.6 Ecosystem-based adaptation

EEA member countries have included ecosystem-based adaptation (EbA) in assessing and implementing adaptation options in various ways, but implementation of EbA on a large scale is at an experimental stage. There are examples from specific sectoral projects, for example on natural water retention measures. Nevertheless, increasing the monitoring and evaluation of EbA before and beyond the project implementation phase will help to identify benefits and potential trade-offs.

⁽⁴³⁾ Notwithstanding the need for tracking, it is also clear that, in the context of mainstreaming adaptation in sectoral policies or combined with other (environmental) objectives, it is sometimes difficult to delimit which funds have been spent specifically on adaptation measures. Being clear about what is counted and how this is done is necessary to avoid under- or overestimation of adaptation finance and essential when comparing sources.

5.2 The way forward

5.2.1 Reporting requirements

Reporting requirements are continuously developing as policy frameworks evolve. European reporting requirements for adaptation are being revised in response to the adoption of the Energy Union Governance Regulation (EU, 2018b). The entry into force of the Governance Regulation thus presents a key opportunity to improve the framework for MRE of CCA and to begin to put in place mechanisms to address the knowledge gaps that have been identified. The regulation's implementing act is expected to detail the reporting requirements for 2021 and onwards and will include all issues legally required by the Governance Regulation⁽⁴⁴⁾, as well as what is agreed in the Paris Rulebook on adaptation. The revision of the EU adaptation strategy, as envisaged in the European Green Deal, may also set targets and directions that are relevant for developing MRE frameworks.

The close connection of adaptation to disaster risk reduction and sustainable development underlines the need to follow how reporting frameworks linked to the Sendai Framework on Disaster Risk Reduction (SFDRR) and the Sustainable Development Goals (SDGs) develop and to seek synergies in reporting frameworks. Although some monitoring information can be useful and beneficial across policy fields and governance levels, the questions asked and the data collected are often not automatically transferable but demand careful consideration and interpretation when applied in new domains.

5.2.2 Monitoring reporting and evaluation methods and quality

Improving the quality of information delivered by MRE is also important for increasing the impact of the results of MRE. When better and more reliable information is available and communicated to decision-makers, the results of MRE can enhance the revision of policies and plans, provided that the political will to act on new information is there.

There are methodological limitations on assessing the increased resilience and adaptive capacity of the indicators and metrics that are currently being used for assessment. Further research and methodological improvements are needed.

On account of the cross-cutting nature of CCA and the importance of mainstreaming it across different sectors, searching for synergies with other communities and creating integrated visions and joint efforts is an (and perhaps the) effective and efficient way forward. Although the national

adaptation indicators should be based on specific evaluation questions for each NAS and NAP, one can imagine a small set of European adaptation indicators, e.g. indicators relevant for adaptation that are already prepared under the scope of the SFDRR or the SDGs. In addition, the use of Copernicus data and information can be explored in this context. As most of the indicators for the global frameworks are of a basic nature, they should not be seen as a replacement for, but as complementary to the national evaluations undertaken.

As already mentioned earlier, the target and focus and the target groups of the evaluation need to be clearly defined to measure the potential impact. This also helps to determine how a certain 'adaptation' policy and actions increase resilience and the adaptive capacity to climate risks. Continuous monitoring of implementation is crucial for policy evaluations. Because of the short time span of implementation, the impacts of adaptation policies and progress on implementing adaptation actions are often not yet visible.

The optimal way of organising knowledge and experience on how to adapt to climate change, and what the characteristics of a well-adapted society are, still need to be developed. As universal units to measure resilience and the impact of adaptation actions will never exist, working with quantitative information (which can be used as proxies for some aspects of adaptation) will always have to be combined with in-depth descriptive information.

5.2.3 Knowledge gaps

The need to better understand the economic impacts of climate change and indirect damage poses particular challenges for monitoring and evaluation. Information on the costs of climate change impacts and the costs of adaptation actions (structural/physical, social and institutional, as used by the IPCC (2014b)) requires systematic enhancement of data collection and reporting to enhance opportunities to assess the effectiveness and efficiency of adaptation. Systematic improvements are needed in tracking spending on adaptation at both the European and national levels, e.g. methodologies and ways to track investments and actions funded through European funds. In addition, environmental co-benefits other than those of adaptation exist and make tracking difficult. A potential way to overcome this challenge might be by developing 'key types of measures' (KTMs), which would enable standardised reporting by MSs to meet their reporting obligations. In addition, the role of standards (such as EN and ISO) and guidance can further support the implementation of adaptation actions. This has been thus far quite successful in other policy areas, such as in the Water Framework Directive

⁽⁴⁴⁾ Subject to change, as this is based on the draft implementing act (EC, 2020b) as it was presented during the feedback period 5.2.2020-4.3.2020 at: <https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12158-Structure-format-submission-process-and-review-of-climate-information-reported-under-Energy-Union-Governance>.

and in the Marine Strategy Framework Directive. The reduced level of detail of KTMs compared with that of dedicated national systems is compensated for by the increased level of comparability across countries.

5.2.4 *Adaptation finance*

The Technical Expert Group (TEG) on sustainable finance has been working on developing the EU taxonomy for climate change mitigation and adaptation. The TEG's final report on the EU taxonomy (TEG, 2020a) contains recommendations relating to the overarching design of the taxonomy, as well as guidance on how companies and financial institutions can make

disclosures using the taxonomy. The report is supplemented by a technical annex containing an updated list of technical screening criteria for economic activities that can substantially contribute to climate change mitigation or adaptation, including an assessment of significant harm to other environmental objectives. In addition, the TEG has prepared Excel tools to help users of the taxonomy to implement it in their own work.

The TEG's work is continuing, and the taxonomy will continue to develop but provides a useful framework for ongoing future assessments of the state of play of climate adaptation financing and for incorporating climate adaptation and environmental, social and governance criteria into corporate reporting and disclosure.





Abbreviations

Abbreviation	Name	Reference
7th EAP	Seventh Environment Action Programme	https://ec.europa.eu/environment/action-programme
AST	Adaptation Support Tool	https://climate-adapt.eea.europa.eu/knowledge/tools/adaptation-support-tool
CAP	Common agricultural policy	https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/cap-glance_en
CCA	Climate change adaptation	
CCC	Committee on Climate Change (UK)	https://www.theccc.org.uk
CCIV	Climate change impacts and vulnerability	
CEN-CENELEC	European Standardization Organisations: the European Committee for Standardization (CEN) and the European Committee for Electrotechnical Standardization (CENELEC)	https://www.cencenelec.eu/Pages/default.aspx
C3S	Copernicus Climate Change Service	https://climate.copernicus.eu
DG CLIMA	Directorate-General for Climate Action (of the European Commission)	https://ec.europa.eu/clima/index_en
DRMKC	Disaster Risk Management Knowledge Centre	https://drmkc.jrc.ec.europa.eu
DRR	Disaster risk reduction	
EbA	Ecosystem-based adaptation	
EC	European Commission	https://ec.europa.eu
EEA	European Environment Agency	https://www.eea.europa.eu
EIA	Environmental impact assessment	https://ec.europa.eu/environment/eia/eia-legalcontext.htm
Eionet	European Environment Information and Observation Network	https://www.eionet.europa.eu
EIB	European Investment Bank	https://www.eib.org/en/index.htm
ETC/CCA	European Topic Centre on Climate Change Impacts, Vulnerability and Adaptation	https://www.eionet.europa.eu/etcs/etc-cca
EU	European Union	https://europa.eu/european-union
EUFIWACC	EU financial institutions working group on climate change	
Euro-Cordex	Coordinated Downscaling Experiment — European Domain	https://www.euro-cordex.net
Eurostat	Statistical Office of the European Union	https://ec.europa.eu/eurostat/home?
FD	Floods Directive	https://ec.europa.eu/environment/water/flood_risk
FRMP	Flood risk management plan	
GDP	Gross domestic product	
ICT	Information and communication technology	
IPCC	Intergovernmental Panel on Climate Change	https://www.ipcc.ch
ISO	International Organization for Standardization	https://www.iso.org/home.html

Abbreviation	Name	Reference
Jaspers	Joint Assistance to Support Projects in European Regions	https://jaspers.eib.org
JRC	European Commission Directorate-General Joint Research Centre	https://ec.europa.eu/info/departments/joint-research-centre_en
KTM	Key type of measure	
MMR	Monitoring Mechanism Regulation	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013R0525
MRE	Monitoring, reporting and evaluation	
MS	EU Member State (one of the 28 countries in the EU from 1 July 2013 to 31 January 2020)	
NAP	National adaptation plan	
NAS	National adaptation strategy	
NBS/EApp	Nature-based solutions and ecosystem-based approaches	
NC7	Seventh National Communication	https://unfccc.int/NC7
NCFF	Natural Capital Finance Facility	https://www.eib.org/en/products/blending/ncff/index.htm
ND-GAIN	Notre Dame Global Adaptation Index	https://gain.nd.edu
NGO	Non-governmental organisation	
NICCAP	Northern Ireland climate change adaptation programme	https://www.climateinireland.org/NICCAP.php
NRA	National risk assessment	
OECD	Organisation for Economic Co-operation and Development	http://www.oecd.org
RAP	Regional adaptation plan	
RCP	Representative concentration pathway	
SAP	Sectoral adaptation plan	
SDGs	Sustainable Development Goals	https://sustainabledevelopment.un.org/sdgs
SEA	Strategic environmental assessment	https://ec.europa.eu/environment/eia/sea-legalcontext.htm
SFDRR	Sendai Framework for Disaster Risk Reduction	https://www.unisdr.org/we/coordinate/sendai-framework
TEG	Technical Expert Group (on sustainable finance)	https://ec.europa.eu/info/publications/sustainable-finance-technical-expert-group_en
WFD	Water Framework Directive	https://ec.europa.eu/environment/water/water-framework/index_en.html
WHO	World Health Organization	https://www.who.int
UN	United Nations	https://www.un.org
UNDRR	UN Office for Disaster Risk Reduction (previously known as United Nations International Strategy for Disaster reduction, UNISDR)	https://www.unisdr.org
UNFCCC	United Nations Framework Convention on Climate Change	https://unfccc.int

Glossary

- **Climate change impact and vulnerability (CCIV) assessments** refer to evidence-gathering activities that seek to assess climate change impacts, vulnerability and/or risks (see Box 1.1 for more information on related terminology). They have evolved over the years and so has their use in adaptation policy development. While the importance of CCIV assessments as information sources for developing adaptation policy is generally recognised, the exact nature of and reason for a CCIV assessment can vary greatly from country to country (EEA, 2018a, p. 41).
- **Climate services** have been defined in multiple ways (Hewitt et al., 2012; Perrels et al., 2013; Vaughan and Dessai, 2014). The EU Roadmap (Street et al., 2015) portrays them as 'transformation of climate-related data — together with other relevant information — into customised products such as projections, forecasts, information, trends, economic analysis, assessments (including technology assessment), counselling on best practices, development and evaluation of solutions and any other service in relation to climate that may be of use for the society at large'.
- **Ecosystem-based adaptation (EbA)** is the use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people to adapt to the adverse effects of climate change. As one of the possible elements of an overall adaptation strategy, ecosystem-based adaptation uses the sustainable management, conservation and restoration of ecosystems to provide services that enable people to adapt to the impacts of climate change. It aims to maintain and increase the resilience and reduce the vulnerability of ecosystems and people in the face of the adverse effects of climate change (IUCN, 2017).
- **Evaluation** classifies mainstreaming efforts, e.g. based on different kinds of criteria/indicators.
- **Horizontal coordination mechanisms** refer to institutions and processes in place to support the integration of adaptation into sector policies. It requires those responsible for different policy areas within an administrative level (e.g. national) to exchange information and adjust their activities to ensure that adaptation efforts result in coherent action to respond to the unavoidable impacts of and, where possible, to benefit from climate change (EEA, 2014a).
- **Impacts** are positive and negative, primary and secondary long-term effects produced by an intervention, directly or indirectly, intended or unintended (Simister, 2015).
- **Implementation** is defined as putting 'a public adaptation policy into effect' — converting adaptation options into action. Once policymakers decide on, formulate and adopt an adaptation policy, then it is implemented, i.e. activities identified in the policy document are translated into concrete actions. The IPCC (2014c, Chapter 15) identified the important role of monitoring and evaluation in informing implementation: 'implementing adaptation is a dynamic iterative learning process, and monitoring and evaluation help to adjust policy responses and actions to accommodate, for example, the availability of new information such as changes in climate and socio-economic conditions'.
- **Mainstreaming** climate change adaptation concerns into other policies can increase the effectiveness of reducing climate change impacts. The critical aspect of it is to develop sufficient awareness of decision-makers at all levels to minimise climate change impacts. Therefore, information on potential impacts needs to be available, so that decision-makers are aware of them and a wide range of stakeholders is involved in designing policy instruments (Climate Policy Info Hub, 2020).
- **Mixed methods** are a combination of quantitative and qualitative information and evidence from multiple sources such as indicator data and stakeholder views.
- **Monitoring** aims to map climate change impacts and adaptation efforts across stakeholders using criteria or indicators and showcases changes over time. Monitoring is usually undertaken on an on-going basis, while reporting and evaluation activities are typically only conducted at specific, usually strategic, points in time.
- A **national adaptation plan (NAP)** is a national document that articulates how a country's NAS is to be implemented (and by whom). In most cases, the NAP outlines a strategic planning process for implementing adaptation. It presents adaptation

measures in varying levels of detail, e.g. provides information on the goal of the measures and the next steps needed, assigns responsibilities to those involved, outlines the time-frame and deadlines, etc. (EEA, 2014a).

- A **national adaptation strategy** (NAS) is a national document that articulates a country's strategic vision with regard to adaptation to prepare the country for current and expected impacts of climate change. A NAS mostly summarises climate-related risks and vulnerabilities as well as identifying various stakeholders and sectors as areas of action. These strategies facilitate the process of coordinating the adaptation response at the horizontal and vertical levels as well as helping to raise awareness of adaptation among various stakeholders. A NAS usually provides the framework for adaptation, in which other governance approaches emerge. NASs are mainly designed by national governments and informed by the scientific community (based on Bauer et al., 2012; EEA, 2014a, 2018b; Grothmann, 2011).
- The **national risk assessment** (NRA) is based on the EU Civil Protection Mechanism, which obliges all EU Member States and participating countries to regularly assess risks that may create the need to request civil protection assistance from other Member States. In order to help countries with this task, the European Commission developed guidelines on risk assessment and mapping. In spite of these, the summaries of NRAs provided to the European Commission have presented several challenges related to the process and the content of the assessments (Poljanšek et al., 2019).
- **Nature-based solutions and ecosystem-based approaches (NBS/EbA)** are 'umbrella terms' to describe different policy areas working with nature to solve different but interlinked societal challenges related to climate change adaptation and disaster risk reduction. EbA fall under this umbrella and is mostly used in relation to climate change adaptation (policies) (EEA, forthcoming).
- **Outcomes/results** are the likely or achieved short- and medium-term effects of an intervention's outputs (Simister, 2015).
- **Outputs** are the products, capital goods and services that result from a development intervention; they may also include changes resulting from the intervention that are relevant to achieving outcomes (Simister, 2015).
- **RCP4.5 scenario**: intermediate stabilisation pathways in which radiative forcing is stabilised at approximately 4.5 W/m² after 2100 (the corresponding extended concentration pathways (ECPs) assuming constant concentrations after 2150) (IPCC, 2014a).
- **RCP8.5 scenario**: one high pathway for which radiative forcing reaches > 8.5 W/m² by 2100 and continues to rise for some amount of time (the corresponding ECP assuming constant emissions after 2100 and constant concentrations after 2250) (IPCC, 2014a).
- **Reporting** aims to showcase and present the monitoring results to a broader audience and make the experiences and lessons learned available for all kinds of stakeholders.
- **Stakeholder involvement and engagement** is used to describe any process that involves stakeholders in some form of collaborative effort directed towards a decision, which might involve future planning and/or behaviour change. The extent of this collaboration can vary from fairly brief and simple information provision, to more extensive and long-term relationships among participants (Gardner et al., 2009).
- (Adaptation) **tracking** refers to assessing progress on adaptation efforts over time and space and between and across populations and sectors.
- **Transnational** is used in this report for issues beyond the national boundaries of neighbouring EEA member countries.
- **Vertical coordination mechanisms** refer to institutions and processes in place to support integration of adaptation through multiple administrative levels within a country (i.e. national, provincial, regional, local/city level). This requires that information on and approaches to adaptation are transferred and exchanged effectively within each policy area from the national to the sub-national levels and vice versa (EEA, 2014a).

References

- Adaptation Committee, 2015, *Enhancing coherent action on adaptation 2012-2015: 2015 overview report*, United Nations Climate Change Secretariat, Bonn.
- Adaptation Committee, 2018, 'Expert meeting on national adaptation goals/indicators and their relationship with the Sustainable Development Goals and the Sendai Framework for Disaster Risk Reduction 24-25 July 2018, Tokyo, Japan (background document)', United Nations Framework Convention on Climate Change (UNFCCC) (https://unfccc.int/sites/default/files/resource/indicators_background_paper.pdf) accessed 7 November 2019.
- Arkema, K. K., et al., 2006, 'Marine ecosystem-based management: from characterization to implementation', *Frontiers in Ecology and the Environment* 4(10), pp. 525-532 (DOI: 10.1890/1540-9295(2006)4[525:MEMFCT]2.0.CO;2).
- ARSO, 2019, 'Navodilo izdelovalcem poročila o vplivih na okolje za obravnavo vidika podnebnih sprememb', Agencija Republike Slovenije Za Okolje (https://www.arso.gov.si/varstvo%20okolja/presoja%20vplivov%20na%20okolje/okoljevarstveno%20soglasje/Navodilo%20za%20PVO_podnebne%20spremembe_%20V8_na%20spletni%20ARSO_februar_2019.docx) accessed 5 February 2020.
- Bauer, A., et al., 2012, 'The governance of climate change adaptation in 10 OECD countries: challenges and approaches', *Journal of Environmental Policy & Planning* 14(3), pp. 279-304 (DOI: 10.1080/1523908X.2012.707406).
- BEH, 2017, *World risk report — Analysis and prospects 2017*, Bündnis Entwicklung Hilft, Berlin (<https://reliefweb.int/report/world/world-risk-report-2017>) accessed 13 April 2020.
- Benelux, 2016, 'Benelux Werkgroep Klimaatadaptatie & BEN!EX — Seminar 'Klimaat en Energie', resultaten / Benelux groupe de travail adaptation au changement climatique & BEN!EX — séminaire 'Climat et Energie', résultats', Benelux Energie Expertise Netwerk / Réseau Benelux d'Expertise Énergétique (<http://www.benelux.int/nl/benex/nieuws-evenementen/benelux-werkgroep-klimaatadaptat/>) accessed 17 January 2020.
- Benzie, M., et al., 2016, *Introducing the transnational climate impacts index: Indicators of country-level exposure — methodology report*, SEI Working Paper No No 2016-07, Stockholm
- Environment Institute, Stockholm, Sweden (<https://www.sei-international.org/publications?pid=2972>).
- Benzie, M., et al., 2019, 'Cross-border climate change impacts: implications for the European Union', *Regional Environmental Change* 19(3), pp. 763-776 (DOI: 10.1007/s10113-018-1436-1).
- Benzie, M. and Persson, Å., 2019, 'Governing borderless climate risks: moving beyond the territorial framing of adaptation', *International Environmental Agreements: Politics, Law and Economics* 19(4-5), pp. 369-393 (DOI: 10.1007/s10784-019-09441-y).
- Berrang-Ford, L., et al., 2019, 'Tracking global climate change adaptation among governments', *Nature Climate Change* 9(6), pp. 440-449 (DOI: 10.1038/s41558-019-0490-0).
- Bours, D., et al., 2014, *Monitoring and evaluation for climate change adaptation and resilience: A synthesis of tools, frameworks and approaches*, SEA Change Community of Practice and UK Climates Impact Programme, Phnom Penh, Cambodia, and Oxford, UK (<http://www.ukcip.org.uk/wp-content/PDFs/SEA-Change-UKCIP-MandE-review-2nd-edition.pdf>) accessed 28 October 2015.
- Bowyer, P., et al., 2015, 'The role of climate services in adapting to climate variability and change', in: Leal Filho, W. (ed.), *Handbook of climate change adaptation*, Springer Berlin Heidelberg, Berlin, Heidelberg, pp. 533-550.
- Brasseur, G. P. and Gallardo, L., 2016, 'Climate services: lessons learned and future prospects', *Earth's Future* 4(3), pp. 79-89 (DOI: 10.1002/2015EF000338).
- Brooks, M. S., 2013, 'Accelerating innovation in climate services: the 3 Es for climate service providers', *Bulletin of the American Meteorological Society* 94(6), pp. 807-819 (DOI: 10.1175/BAMS-D-12-00087.1).
- Bruno Soares, M., et al., 2018, 'Sectoral use of climate information in Europe: a synoptic overview', *Climate Services* 9, pp. 5-20 (DOI: 10.1016/j.cliser.2017.06.001).
- Bundesministerium Landwirtschaft, Regionen und Tourismus, 2019, 'Fortschrittsbericht zur Klimawandelanpassung' (https://www.bmlrt.gv.at/umwelt/klimaschutz/klimapolitik_national/)

anpassungsstrategie/Fortschrittsbericht.html) accessed 4 February 2020.

Buth, M., et al., 2017, *Guidelines for climate impact and vulnerability assessments. Recommendations of the interministerial working group on adaptation to climate change of the German federal government*, German Environment Agency (<https://www.umweltbundesamt.de/en/publikationen/guidelines-for-climate-impact-vulnerability>) accessed 9 June 2020.

C3S, 2019, 'Copernicus Climate Change Service' (<https://climate.copernicus.eu/>) accessed 13 November 2019.

Casado-Asensio, J. and Steurer, R., 2014, 'Integrated strategies on sustainable development, climate change mitigation and adaptation in Western Europe: communication rather than coordination', *Journal of Public Policy* 34(3), pp. 437-473 (DOI: 10.1017/S0143814X13000287).

CCC, 2017, *2017 Report to Parliament — Progress in preparing for climate change*, Committee on Climate Change (<https://www.theccc.org.uk/publication/2017-report-to-parliament-progress-in-preparing-for-climate-change/>) accessed 19 December 2017.

CCC, 2019, *2019 Report to Parliament — Progress in preparing for climate change*, Committee on Climate Change (<https://www.theccc.org.uk/publication/progress-in-preparing-for-climate-change-2019-progress-report-to-parliament/>) accessed 4 February 2020.

CEN, 2020, 'CEN/SS S26 — Environmental management', European Committee for Standardization (https://standards.cen.eu/dyn/www/f?p=204:110:0:::FSP_PROJECT,FSP_ORG_ID:66475,6339&cs=1B1A12000C6A4C2D1A328A181DE928578) accessed 2 May 2020.

CEN-CENELEC, 2016, *Guide for addressing climate change adaptation in standards*, Guide 32, European Committee for Standardization and European Committee for Electrotechnical Standardization (ftp://ftp.cencenelec.eu/EN/EuropeanStandardization/Guides/32_CENCLCGuide32.pdf) accessed 10 February 2020.

CEN-CENELEC, 2020, 'Climate change adaptation', European Committees for Standardization (<https://www.cencenelec.eu/standards/Sectorsold/ClimateChange/Pages/default.aspx>) accessed 14 April 2020.

Chen, C., et al., 2015, *University of Notre Dame Global Adaptation Index: Country index technical report*, University of Notre Dame (https://gain.nd.edu/assets/254377/nd_gain_technical_document_2015.pdf) accessed 21 January 2020.

Christiansen, L., et al., 2016, *Monitoring & evaluation for climate change adaptation: A summary of key challenges and emerging practice. Understanding, discussing and exemplifying the key challenges of M&E for adaptation*, Working Paper 1, UNEP DTU

Partnership, Copenhagen (https://backend.orbit.dtu.dk/ws/portalfiles/portal/157400902/MandE_challenge_guidance_note_01_07_16.pdf) accessed 3 May 2020.

CIS WFD, 2009, *Guidance document no 24 — River basin management in a changing climate*, Technical Report No 2009-040, Common Implementation Strategy for the Water Framework Directive (2000/60/EC) & European Communities (https://circabc.europa.eu/sd/a/a88369ef-df4d-43b1-8c8c-306ac7c2d6e1/Guidance%20document%20n%2024%20-%20River%20Basin%20Management%20in%20a%20Changing%20Climate_FINAL.pdf) accessed 23 June 2020.

CIS WFD, 2013, *Guidance document no 29 — Guidance for reporting under the Floods Directive (2007/60/EC): A compilation of reporting sheets adopted by Water Directors Common Implementation Strategy for the Water Framework Directive (2000/60/EC)*, Technical Report No 2013-071, Common Implementation Strategy for the Water Framework Directive (2000/60/EC) & European Communities (https://circabc.europa.eu/sd/a/acbcd98a-9540-480e-a876-420b7de64eba/Floods%20Reporting%20guidance%20-%20final_with%20revised%20paragraph%204.2.3.pdf) accessed 23 June 2020.

CIS WFD Working Group Programme of Measures, 2014, *EU policy document on natural water retention measures*, Technical Report No 2014-082, Common Implementation Strategy for the Water Framework Directive (2000/60/EC) & European Commission (Directorate-General for Environment) (<https://op.europa.eu/en/publication-detail/-/publication/64617091-8289-4841-b420-a377a270a8cf/language-en>) accessed 5 February 2020.

Climate Chance and Comité 21, 2019, *Adaptation book: Synthesis report on adaptation actions*, Global observatory on non-state climate action (<https://www.climate-chance.org/wp-content/uploads/2020/03/climate-chance-comite21-2019-adaptation-book-2019-synthesis-report-on-adaptation-action.pdf>) accessed 2 May 2020.

Climate Change Advisory Council, 2020, 'Other publications, submissions and correspondence' (<http://www.climatecouncil.ie/councilpublications/otherpublicationssubmissionsandcorrespondence/>) accessed 2 May 2020.

Climate Policy Info Hub, 2020, 'Mainstreaming Climate Change Adaptation in the EU' (<https://climatepolicyinfohub.eu/mainstreaming-climate-change-adaptation-eu>) accessed 4 February 2020.

Climate-ADAPT, 2020, 'Country profiles' (<https://climate-adapt.eea.europa.eu/countries-regions/countries>) accessed 10 June 2020.

CMCC, 2017, *Piano nazionale di adattamento ai cambiamenti climatici — PNACC [National plan for adaptation to climate change*

- PNACC], Centro Euro-Mediterraneo sui Cambiamenti Climatici (https://www.minambiente.it/sites/default/files/archivio_immagini/adattamenti_climatici/documento_pnacc_luglio_2017.pdf) accessed 20 January 2020.
- CoastAdapt, 2018, 'Monitoring and evaluation in climate change adaptation', National Climate Change Adaptation Research Facility (NCCARF) and the Australian Government Department of the Environment and Energy (<https://coastadapt.com.au/how-to-pages/monitoring-and-evaluation-climate-change-adaptation>) accessed 7 February 2020.
- Conde, C. and Lonsdale, K., 2015, *Stakeholder engagement in the adaptation process*, UNDP Adaptation Policy Framework Technical Paper 2 (original version 2004, updated 2015), United Nations Development Programme, New York.
- Cordis, 2019a, 'CAScading Climate risks: towards ADaptive and resilient European Societies | CASCADES Project | H2020', Cordis EU research results (<https://cordis.europa.eu/project/id/821010>) accessed 24 January 2020.
- Cordis, 2019b, 'European Market for Climate Services | EU-MACS Project | H2020', Cordis EU research results (<https://cordis.europa.eu/project/id/730500>) accessed 5 February 2020.
- Cordis, 2019c, 'MArket Research for a Climate Services Observatory | MARCO Project | H2020', Cordis EU research results (<https://cordis.europa.eu/project/id/730272>) accessed 5 February 2020.
- Cordis, 2019d, 'REmote Climate Effects and their Impact on European sustainability, Policy and Trade | RECEIPT Project | H2020', Cordis EU research results (<https://cordis.europa.eu/project/id/820712>) accessed 24 January 2020.
- COWI, 2017, *Mainstreaming of adaptation into the ESIF 2014-2020. Report for the European Commission Directorate-General for Climate Action*, Report No A34990 No A34990, COWI A/S, Kongens Lyngby, Denmark (https://ec.europa.eu/clima/sites/clima/files/budget/docs/report_mainstreaming_adaptation_en.pdf) accessed 5 February 2020.
- Curtin, R. and Pallezo, R., 2010, 'Understanding marine ecosystem based management: a literature review', *Marine Policy* 34(5), pp. 821-830 (DOI: 10.1016/j.marpol.2010.01.003).
- CXC, 2020, 'Indicators and trends', ClimateXChange (<https://www.climateexchange.org.uk/research/indicators-and-trends/>) accessed 7 February 2020.
- Dallhammer, E., et al., 2015, *Strategische Unterstützung bei der Projektplanung zur Berücksichtigung von Klimawandelfolgen — Endbericht zum Forschungsprojekt 'Environmental Impact Assessment Satisfying Adaptation Goals Evolving from Climate Change (ENVISAGE-CC)'*, BOKU-Met Report No 24, Institut für Meteorologie (https://www.klimawandelanpassung.at/fileadmin/inhalte/kwa/pdfs/Envisage_StrategischeUnterstuetzung_BOKU-Met_Report_24.pdf) accessed 4 February 2020.
- Danish Storm Council, 2020, 'Home page' (<https://www.danishstormcouncil.dk>) accessed 10 June 2020.
- Dazé, A., et al., 2016, *Vertical integration in national adaptation plan (NAP) processes: A guidance note for linking national and sub-national adaptation*, International Institute for Sustainable Development, Winnipeg (<http://www.napglobalnetwork.org/resource/vertical-integration-national-adaptation-plan-nap-processes/>) accessed 2 May 2020.
- Delta Programme Commissioner, 2020, 'Delta programme' (<https://english.deltacommissaris.nl/delta-programme>) accessed 10 June 2020.
- Deutsche Bundesregierung, 2015, 'Fortschrittsbericht zur Deutschen Anpassungsstrategie an den Klimawandel' (https://www.bmu.de/fileadmin/Daten_BMU/Download_PDF/Klimaschutz/klimawandel_das_fortschrittsbericht_bf.pdf) accessed 21 January 2020.
- Dilling, L., et al., 2019, 'Is adaptation success a flawed concept?', *Nature Climate Change* 9(8), pp. 572-574 (DOI: 10.1038/s41558-019-0539-0).
- DMI, 2019, 'Introduktion til Klimaatlas', Dansk Meteorologisk Institut (Danish Meteorological Institute) (<http://www.dmi.dk/klimaatlas/>) accessed 7 April 2020.
- Downing, C., 2017, *Assessing adaptation knowledge in Europe: Vulnerability to climate change*, Ecofys, UKCIP and SRUC by order of the European Commission (https://ec.europa.eu/clima/sites/clima/files/adaptation/what/docs/climate_change_vulnerability_en.pdf) accessed 24 January 2020.
- Droste, N., et al., 2017, 'Implementing nature-based solutions in urban areas: financing and governance aspects', in: *Nature-based solutions to climate change adaptation in urban areas — Linkages between science, policy and practice*, Theory and Practice of Urban Sustainability Transitions, Springer Open, Cham, Switzerland.
- Dupuis, J. and Biesbroek, R., 2013, 'Comparing apples and oranges: the dependent variable problem in comparing and evaluating climate change adaptation policies', *Global Environmental Change* 23(6), pp. 1476-1487 (DOI: 10.1016/j.gloenvcha.2013.07.022).
- EC, 2010, Communication from the Commission — Europe 2020 — A strategy for smart, sustainable and inclusive growth (COM(2010) 2020 final, Brussels, 3.3.2010).
- EC, 2012a, Communication from the Commission to the European Parliament, the Council, the European Economic

and Social Committee and the Committee of the Regions — Blueprint to Safeguard Europe's Water Resources (COM(2012) 673 final, Brussels, 14.11.2012).

EC, 2012b, *Map of national and international river basin districts*, European Commission Directorate-General for Environment (https://ec.europa.eu/environment/water/water-framework/facts_figures/pdf/River%20Basin%20Districts-2012.pdf) accessed 2 April 2020.

EC, 2013a, Commission Staff Working Document — Impact Assessment — Part 1 Accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions — An EU Strategy on adaptation to climate change (SWD(2013) 132 final, Brussels, 16 April 2013).

EC, 2013b, Commission Staff Working Document — Technical guidance on integrating climate change adaptation in programmes and investments of cohesion policy accompanying the document. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: An EU Strategy on adaptation to climate change (SWD(2013) 135 final, Brussels, 16 April 2013).

EC, 2013c, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions — An EU Strategy on adaptation to climate change (COM(2013) 216 final, Brussels, 16 April 2013).

EC, 2013d, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions — Green infrastructure (GI): enhancing Europe's natural capital (COM(2013) 249 final, Brussels, 6 May 2013).

EC, 2013e, Green Paper on the insurance of natural and man-made disasters (COM(2013) 213 final, Brussels, 16 April 2013).

EC, 2013f, Guidelines on climate change and Natura 2000 — Dealing with the impact of climate change, on the management of the Natura 2000 network of areas of high biodiversity value, European Commission Directorate-General for the Environment, Brussels (<http://ec.europa.eu/environment/nature/climatechange/pdf/Guidance%20document.pdf>) accessed 22 July 2015.

EC, 2013g, 'Non-paper — Guidelines for project managers: making vulnerable investments climate resilient', European Commission Directorate General for Climate Action (https://ec.europa.eu/clima/sites/clima/files/adaptation/what/docs/non_paper_guidelines_project_managers_en.pdf) accessed 5 February 2020.

EC, 2015, *A European research and innovation roadmap for climate services*, Publications Office of the European Union, Luxembourg (<https://publications.europa.eu/en/publication-detail/-/publication/73d73b26-4a3c-4c55-bd50-54fd22752a39>) accessed 28 February 2018.

EC, 2016a, *Climate change and major projects: Outline of the climate change related requirements and guidance for major projects in the 2014-2020 programming period — Ensuring resilience to the adverse impacts of climate change and reducing the emission of greenhouse gases*, Publications Office of the European Union, Luxembourg (https://ec.europa.eu/clima/sites/clima/files/docs/major_projects_en.pdf) accessed 17 January 2020.

EC, 2016b, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions — Next steps for a sustainable European future: European action for sustainability (COM(2016) 739 final, Brussels, 22 November 2016).

EC, 2016c, Communication from the Commission to the European Parliament, the European Council, the Council and the European Investment Bank on establishing a new Partnership Framework with third countries under the European Agenda on Migration (COM(2016) 385 final, Brussels, 7 June 2016).

EC, 2016d, 'Mainstreaming adaptation', European Commission Directorate-General for Climate Action (https://ec.europa.eu/clima/policies/adaptation/what/mainstreaming_en) accessed 17 January 2020.

EC, 2017a, *7th National Communication and 3rd Biennial Report from the European Union under the UN Framework Convention on Climate Change (UNFCCC) (required under the UNFCCC and the Kyoto Protocol)*, No C(2017)8511, European Commission, Brussels (http://unfccc.int/files/national_reports/annex_i_natcom/submitted_natcom/application/pdf/459381_european_union-nc7-br3-1-nc7_br3_combined_version.pdf) accessed 17 August 2018.

EC, 2017b, 'Better regulation toolbox', European Commission (https://ec.europa.eu/info/law/law-making-process/planning-and-proposing-law/better-regulation-why-and-how/better-regulation-guidelines-and-toolbox/better-regulation-toolbox_en) accessed 28 October 2019.

EC, 2017c, Commission Staff Working Document — Better Regulation Guidelines (SWD(2017) 350 final, Brussels, 7 July 2017).

EC, 2017d, Commission Staff Working Document — Overview of natural and man-made disaster risks the European Union may face (SWD(2017) 176 final, Brussels, 23 May 2017).

- EC, 2017e, *Revised adaptation scoreboard indicator list and methodology for assessing them*, European Commission Directorate-General for Climate Action (https://ec.europa.eu/clima/sites/clima/files/consultations/docs/0035/scoreboard_description_en.pdf) accessed 8 December 2017.
- EC, 2018a, Commission Staff Working Document — Adaptation preparedness scoreboard — country fiches accompanying the document The Commission to the European Parliament and the Council on the implementation of the EU Strategy on adaptation to climate change (SWD(2018) 460 final, Brussels, 12 November 2018).
- EC, 2018b, Commission Staff Working Document — Evaluation of the EU Strategy on adaptation to climate change — accompanying the document Report from the Commission to the European Parliament and the Council on the implementation of the EU Strategy on adaptation to climate change (SWD(2018) 461 final, Brussels, 12 November 2018).
- EC, 2018c, Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions — A modern budget for a Union that protects, empowers and defends: the Multiannual Financial Framework for 2021-2027 (COM(2018) 321 final, Brussels, 2 May 2018).
- EC, 2018d, Communication from the Commission to the European Parliament, the European Council, the European Central Bank, the European Economic and Social Committee and the Committee of the Regions — Action plan: financing sustainable growth (COM(2018) 097 final, Brussels, 8 March 2018).
- EC, 2018e, Report from the Commission to the European Parliament and the Council on the implementation of the EU Strategy on adaptation to climate change (COM(2018) 738 final).
- EC, 2019a, Commission Notice: Reporting Guidelines on Disaster Risk Management, Art. 6(1)d of Decision No 1313/2013/EU (2019/C 428/07) (2019/C 428/07, Brussels, 20 December 2019).
- EC, 2019b, Commission Staff Working Document — Fitness check of the Water Framework Directive, Groundwater Directive, Environmental Quality Standards Directive and Floods Directive (SWD(2019) 439 final, Brussels, 10 December 2019).
- EC, 2019c, Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions — Annex to The European Green Deal (COM(2019) 640 final, Brussels, 11 December 2019).
- EC, 2019d, Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions — The European Green Deal (COM(2019) 640 final, Brussels, 11 December 2019).
- EC, 2019e, 'Guidance on the second reporting period on national adaptation actions under Article 15 of the MMR (reporting by 15 March 2019)', European Commission Directorate-General for Climate Action (http://cdr.eionet.europa.eu/help/2019_MMR_reporting_guidance_adaptation.pdf) accessed 3 October 2019.
- EC, 2019f, *Guidelines on reporting climate-related information*, European Commission Directorate-General for Financial Stability, Financial Services and Capital Markets Union, Brussels (https://ec.europa.eu/finance/docs/policy/190618-climate-related-information-reporting-guidelines_en.pdf) accessed 2 May 2020.
- EC, 2019g, 'Investing in green infrastructure', European Commission Directorate-General for Environment (https://ec.europa.eu/environment/nature/ecosystems/investing/index_en.htm) accessed 5 February 2020.
- EC, 2019h, Report from the Commission to the European Parliament and Council on the implementation of the Water Framework Directive (2000/60/EC) and the Floods Directive (2007/60/EC) — Second river basin management plans — First flood risk management plans (COM(2019) 95 final).
- EC, 2020a, Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions — Sustainable Europe Investment Plan European Green Deal Investment Plan (COM(2020) 21 final, Brussels, 14 January 2020).
- EC, 2020b, Draft Commission Implementing Regulation on structure, format, submission processes and review of information reported by Member States pursuant to Regulation (EU) 2018/1999 of the European Parliament and of the Council and repealing Commission Implementing Regulation (EU) No 749/2014 and Annexes 1-25 (Ares(2020)742164).
- EC, 2020c, 'EU External Investment Plan', European Commission (https://ec.europa.eu/commission/eu-external-investment-plan_en) accessed 14 April 2020.
- EC and High Representative of the Union for Foreign Affairs and Security Policy, 2017, Joint Communication to the European Parliament and the Council: A strategic approach to resilience in the EU's external action (JOINT(2017) 21 final, Brussels, 7 June 2017).
- Eckstein, D., et al., 2019, *Global Climate Risk Index 2020 — Who suffers most from extreme weather events? Weather-related loss events in 2018 and 1999 to 2018*, Germanwatch, Bonn (<https://germanwatch.org/en/17307>) accessed 13 April 2020.

- Edelenbos, J., et al., 2011, 'Co-producing knowledge: joint knowledge production between experts, bureaucrats and stakeholders in Dutch water management projects', *Environmental Science & Policy* 14(6), pp. 675-684.
- Editorial, 2019, 'The CMIP6 landscape', *Nature Climate Change* 9(10), pp. 727-727 (DOI: 10.1038/s41558-019-0599-1).
- EEA, forthcoming, *Assessment on ecosystem-based approaches for climate change adaptation*, European Environment Agency (<https://www.eea.europa.eu/publications>).
- EEA, forthcoming, *Consequences of global climate change and their impacts on Europe — A view on agriculture commodities and migration flows*, European Environment Agency.
- EEA, 2012, *Water resources in Europe in the context of vulnerability*, EEA Report No 11/2012, European Environment Agency.
- EEA, 2014a, *National adaptation policy processes in European countries — 2014*, EEA Report No 4/2014, European Environment Agency (<http://www.eea.europa.eu/publications/national-adaptation-policy-processes>) accessed 11 June 2015.
- EEA, 2014b, *Public participation, contributing to better water management experiences from eight case studies across Europe*, EEA Report No 3/2014, European Environment Agency (<http://www.eea.europa.eu/publications/public-participation-contributing-to-better>) accessed 23 July 2015.
- EEA, 2015a, *Exploring nature-based solutions: the role of green infrastructure in mitigating the impacts of weather- and climate change-related natural hazards*, EEA Technical Report No 12/2015, European Environment Agency (<http://www.eea.europa.eu/publications/exploring-nature-based-solutions-2014>).
- EEA, 2015b, *National monitoring, reporting and evaluation of climate change adaptation in Europe*, EEA Technical Report No 20/2015, European Environment Agency (<http://www.eea.europa.eu/publications/national-monitoring-reporting-and-evaluation>).
- EEA, 2015c, *Overview of climate change adaptation platforms in Europe*, EEA Technical Report No 5/2015, European Environment Agency (<http://www.eea.europa.eu/publications/overview-of-climate-change-adaptation>) accessed 10 April 2019.
- EEA, 2015d, *Water-retention potential of Europe's forests*, EEA Technical Report No 13/2015, European Environment Agency (<http://www.eea.europa.eu/publications/water-retention-potential-of-forests>) accessed 6 November 2019.
- EEA, 2016, *European forest ecosystems — State and trends*, EEA Report No 5/2016, European Environment Agency.
- EEA, 2017a, *Climate change adaptation and disaster risk reduction in Europe: Enhancing coherence of the knowledge base, policies and practices*, EEA Report No 15/2017, European Environment Agency (<https://www.eea.europa.eu/publications/climate-change-adaptation-and-disaster>) accessed 10 April 2019.
- EEA, 2017b, *Climate change, impacts and vulnerability in Europe 2016 — An indicator-based report*, EEA Report No 1/2017, European Environment Agency (<https://www.eea.europa.eu/publications/climate-change-impacts-and-vulnerability-2016>) accessed 12 August 2019.
- EEA, 2017c, 'Financing Europe's low carbon, climate resilient future', European Environment Agency (<https://www.eea.europa.eu/themes/climate/financing-europe2019s-low-carbon-climate>) accessed 5 February 2020.
- EEA, 2018a, *National climate change vulnerability and risk assessments in Europe, 2018*, EEA Report No 1/2018, European Environment Agency (<https://www.eea.europa.eu/publications/national-climate-change-vulnerability-2018>) accessed 10 April 2019.
- EEA, 2018b, 'Number of countries that have adopted a climate change adaptation strategy/plan', European Environment Agency (<https://www.eea.europa.eu/airs/2018/environment-and-health/climate-change-adaptation-strategies>) accessed 7 January 2019.
- EEA, 2018c, *Sharing adaptation information across Europe*, EEA Report No 3/2018, European Environment Agency (<https://www.eea.europa.eu/publications/sharing-adaptation-information-across-europe>) accessed 17 August 2018.
- EEA, 2019a, *Adaptation challenges and opportunities for the European energy system: Building a climate-resilient low-carbon energy system*, EEA Report No 1/2019, European Environment Agency (<https://www.eea.europa.eu/publications/adaptation-in-energy-system>) accessed 4 December 2019.
- EEA, 2019b, *Climate change adaptation in the agriculture sector in Europe*, EEA Report No 4/2019, European Environment Agency.
- EEA, 2019c, 'Country profiles — Climate-ADAPT', European Environment Agency (<https://climate-adapt.eea.europa.eu/countries-regions/countries>) accessed 3 October 2019.
- EEA, 2019d, 'Economic losses from climate-related extremes in Europe (CSI 042/CLIM 039)', European Environment Agency (<https://www.eea.europa.eu/data-and-maps/indicators/direct-losses-from-weather-disasters-3/assessment-2>) accessed 9 April 2019.
- EEA, 2019e, *The European environment — State and outlook 2020: knowledge for transition to a sustainable Europe*, European Environment Agency (<https://www.eea.europa.eu/soer-2020>) accessed 9 December 2019.

- EEA, 2020, 'Why does Europe need to limit climate change and adapt to its impacts?', European Environment Agency (<https://www.eea.europa.eu/highlights/why-does-europe-need-to>) accessed 2 May 2020.
- EEAS, 2017, *Shared Vision, Common Action: A Stronger Europe — A global strategy for the European Union's foreign and security policy*, European External Action Service (https://eeas.europa.eu/regions/western-europe/17304/global-strategy-european-unions-foreign-and-security-policy_en) accessed 14 April 2020.
- EIB, 2019, 'Athens resilient city and natural capital (NCFP)', European Investment Bank (<https://www.eib.org/en/projects/pipelines/all/20180050>) accessed 5 February 2020.
- EIB, 2020, 'Climate action', European Investment Bank (<https://www.eib.org/en/about/priorities/climate-and-environment/climate-action/index.htm>) accessed 5 February 2020.
- Environment and Climate Change Canada, 2018, *Measuring progress on adaptation and climate resilience: Recommendations to the Government of Canada*, Environment and Climate Change Canada, Gatineau QC, Canada.
- Environment Department Cyprus, 2017, 'ΕΘΝΙΚΗ ΣΤΡΑΤΗΓΙΚΗ ΓΙΑ ΤΗΝ ΠΡΟΣΑΡΜΟΓΗ ΣΤΗΝ ΚΛΙΜΑΤΙΚΗ ΑΛΛΑΓΗ [National Strategy for Climate Change Adaptation]', Ministry for agriculture, rural development and the environment ([http://www.moa.gov.cy/moa/environment/environmentnew.nsf/All/C15CD89954708638C2257FF1003494BD/\\$file/%CE%95%CE%B8%CE%BD%CE%B9%CE%BA%CE%AE%20%CE%A3%CF%84%CF%81%CE%B1%CF%84%CE%B7%CE%B3%CE%B9%CE%BA%CE%AE%20%CE%B3%CE%B9%CE%B1%20%CF%84%CE%B7%CE%BD%20%CE%A0%CF%81%CE%BF%CF%83%CE%B1%CF%81%CE%BC%CE%BF%CE%B3%CE%AE%20%CF%83%CF%84%CE%B7%CE%BD%20%CE%9A%CE%BB%CE%B9%CE%BC%CE%B1%CF%84%CE%B9%CE%BA%CE%AE%20%CE%91%CE%BB%CE%BB%CE%B1%CE%B3%CE%AE.pdf](http://www.moa.gov.cy/moa/environment/environmentnew.nsf/All/C15CD89954708638C2257FF1003494BD/$file/%CE%95%CE%B8%CE%BD%CE%B9%CE%BA%CE%AE%20%CE%A3%CF%84%CF%81%CE%B1%CF%84%CE%B7%CE%B3%CE%B9%CE%BA%CE%AE%20%CE%B3%CE%B9%CE%B1%20%CF%84%CE%B7%CE%BD%20%CE%A0%CF%81%CE%BF%CF%83%CE%B1%CF%81%CE%BC%CE%BF%CE%B3%CE%AE%20%CF%83%CF%84%CE%B7%CE%BD%20%CE%9A%CE%BB%CE%B9%CE%BC%CE%B1%CF%84%CE%B9%CE%BA%CE%AE%20%CE%91%CE%BB%CE%BB%CE%B1%CE%B3%CE%AE.pdf)) accessed 20 January 2020.
- ETC/ACC, 2009, *Development of adaptation indicators*, ETC/ACC Technical Paper No 2009/6, European Topic Centre on Air and Climate Change (https://www.eionet.europa.eu/etcs/etc-cca/products/etc-cca-reports/etcacc_tp_2009_6_etccacc_tp_2009_6_adapt_ind-1) accessed 23 June 2020.
- ETC/CCA, 2017, *Monitoring, reporting and evaluation of national level adaptation in Europe: Lessons and experiences from other policy domains*, ETC/CCA Working Paper No 2017/1, European Topic Centre Climate Change Impacts, Vulnerability and Adaptation (https://www.eionet.europa.eu/etcs/etc-cca/products/etc-cca-reports/wp_1-2017) accessed 23 June 2020.
- ETC/CCA, 2018a, *Adaptation policies and knowledge base in transnational regions in Europe*, ETC/CCA Technical Paper No 2018/4, European Topic Centre Climate Change Impacts, Vulnerability and Adaptation (https://www.eionet.europa.eu/etcs/etc-cca/products/etc-cca-reports/tp_4-2018) accessed 4 February 2020.
- ETC/CCA, 2018b, *Indicators for adaptation to climate change at national level — Lessons from emerging practice in Europe*, ETC/CCA Technical Paper No 2018/3, European Topic Centre Climate Change Impacts, Vulnerability and Adaptation (https://www.eionet.europa.eu/etcs/etc-cca/products/etc-cca-reports/tp_3-2018) accessed 20 January 2020.
- EU, 1992, Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (OJ L 206, 22.7.1992, pp. 7-50).
- EU, 2000, Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (OJ L 327, 22.12.2000, pp. 1-73).
- EU, 2001, Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment (OJ L 197, 21.7.2001, pp. 30-37).
- EU, 2007, Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks (OJ L 288, 6.11.2007, pp. 27-34).
- EU, 2010, Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (codified version) (OJ L 20, 26.1.2010, pp. 7-25).
- EU, 2013a, Decision No 1386/2013/EU of the European Parliament and of the Council of 20 November 2013 on a general Union environment action programme to 2020 'Living well, within the limits of our planet' (OJ L 354, 28.12.2013, pp. 171-200).
- EU, 2013b, Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC (OJ L 165, 18.6.2013, pp. 13-40).
- EU, 2014, Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment (OJ L 124, 25.4.2014, pp. 1-18).
- EU, 2018a, 'Climate Diplomacy: Council adopts conclusions', European Council and Council of the EU (<http://www.consilium.europa.eu/en/press/press-releases/2018/02/26/climate-diplomacy-council-adopts-conclusions/>) accessed 14 April 2020.
- EU, 2018b, Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the

- Governance of the Energy Union and Climate Action (OJ L 328, 21.12.2018, pp. 1-77).
- EU, 2019a, '8th Environment Action Programme — Council adopts conclusions (press release)', Council of the EU (<http://www.consilium.europa.eu/en/press/press-releases/2019/10/04/8th-environmental-action-programme-council-adopts-conclusions/>) accessed 7 April 2020.
- EU, 2019b, Decision (EU) 2019/420 of the European Parliament and of the Council of 13 March 2019 amending Decision No 1313/2013/EU on a Union Civil Protection Mechanism (OJ L 77I, 20.3.2019, pp. 1-15).
- EU, 2020, 'Sustainable finance — Council adopts a unified EU classification system (press release)', Council of the EU (<http://www.consilium.europa.eu/en/press/press-releases/2020/04/15/sustainable-finance-council-adopts-a-unified-eu-classification-system/>) accessed 2 May 2020.
- EUFIWACC, 2016, *Integrating climate change information and adaptation in project development. Emerging experience from practitioners*, European Financing Institutions Working Group on Adaptation to Climate Change (<http://www.eib.org/attachments/press/integrating-climate-change-adaptation-in-project-development.pdf>).
- Eurostat, 2019a, 'Sustainable Development Goals — Overview' (<https://ec.europa.eu/eurostat/web/sdi>) accessed 7 October 2019.
- Eurostat, 2019b, *Sustainable development in the European Union — Monitoring report on progress towards the SDGs in an EU context*, European Union Statistical Office, Luxembourg.
- EY, 2017, *How have investors met their ESG and climate reporting requirements under Article 173-VI? Perspectives on the implementation of Article 173-VI of the French 'Energy Transition for Green Growth' law*, Ernst & Young et Associés, France ([https://www.ey.com/Publication/vwLUAssets/ey-how-have-investors-met-their-esg-and-climate-reporting-requirements-under-article-173-vi/\\$FILE/ey-how-have-investors-met-their-esg-and-climate-reporting-requirements-under-article-173-vi.pdf](https://www.ey.com/Publication/vwLUAssets/ey-how-have-investors-met-their-esg-and-climate-reporting-requirements-under-article-173-vi/$FILE/ey-how-have-investors-met-their-esg-and-climate-reporting-requirements-under-article-173-vi.pdf)) accessed 5 February 2020.
- Florin, M.-V. and Sachs, R., 2019, 'Critical infrastructure resilience: lessons from insurance', Infoscience (<https://infoscience.epfl.ch/record/273295>) accessed 2 May 2020.
- FOEN, 2012, *Anpassung an den Klimawandel in der Schweiz*, No UD-1055-D, Bundesamt für Umwelt (<https://www.bafu.admin.ch/bafu/de/home/themen/klima/publikationen-studien/publikationen/anpassung-klimawandel-schweiz-2012.html>) accessed 7 February 2020.
- FOEN, 2014, *Anpassung an den Klimawandel in der Schweiz*, No UD-1081-D, Bundesamt für Umwelt (<https://www.bafu.admin.ch/bafu/de/home/themen/klima/publikationen-studien/publikationen/anpassung-klimawandel-schweiz-2014.html>) accessed 7 February 2020.
- Forzieri, G., et al., 2016, 'Multi-hazard assessment in Europe under climate change', *Climatic Change* 137(1-2), pp. 105-119 (DOI: 10.1007/s10584-016-1661-x).
- Forzieri, G., et al., 2018, 'Escalating impacts of climate extremes on critical infrastructures in Europe', *Global Environmental Change* 48, pp. 97-107 (DOI: 10.1016/j.gloenvcha.2017.11.007).
- Gallina, V., et al., 2016, 'A review of multi-risk methodologies for natural hazards: consequences and challenges for a climate change impact assessment', *Journal of Environmental Management* 168, pp. 123-132 (DOI: 10.1016/j.jenvman.2015.11.011).
- Gardner, J., et al., 2009, *A framework for stakeholder engagement on climate adaptation*, Working Paper No 3, CSIRO Climate Adaptation National Research, Canberra (<http://www.csiro.au/resources/CAF-working-papers.html>) accessed 6 June 2015.
- Gaus, H., et al., 2019, *Politikanalyse zur Evaluation der Deutschen Anpassungsstrategie an den Klimawandel (DAS) — Evaluationsbericht*, No Forschungskennzahl 3717 48 199 0, Umweltbundesamt, Dessau-Roßlau (<https://www.umweltbundesamt.de/publikationen/politikanalyse-zur-evaluation-der-deutschen>) accessed 3 May 2020.
- GCA, 2019, *Adapt Now: A Global Call for Leadership on Climate Resilience*, Global Centre on Adaptation and World Resources Institute, Rotterdam, Netherlands, and Washington, DC (https://cdn.gca.org/assets/2019-09/GlobalCommission_Report_FINAL.pdf#page=64).
- Gill, J. C. and Malamud, B. D., 2014, 'Reviewing and visualizing the interactions of natural hazards', *Reviews of Geophysics* 52(4), pp. 680-722 (DOI: 10.1002/2013RG000445).
- GlZ, 2018, *Finance options and instruments for ecosystem-based adaptation. Overview and compilation of ten examples*, Deutsche Gesellschaft für Internationale Zusammenarbeit, Bonn.
- GlZ, et al., 2020, *Guidebook for monitoring and evaluating ecosystem-based adaptation interventions*, Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH, Bonn (https://www.adaptationcommunity.net/download/ME-Guidebook_EbA.pdf) accessed 4 May 2020.
- Goddard, L., et al., 2010, 'Providing seasonal-to-interannual climate information for risk management and decision-making', *Procedia Environmental Sciences* 1, pp. 81-101 (DOI: 10.1016/j.proenv.2010.09.007).
- Government of the Netherlands, 2013, 'Benelux countries and North Rhine-Westphalia to work together more closely'

- (<https://www.government.nl/latest/news/2013/07/18/benelux-countries-and-north-rhine-westphalia-to-work-together-more-closely>) accessed 7 February 2020.
- Grothmann, T., 2011, 'Governance recommendations for adaptation in European urban regions: results from five case studies and a european expert survey', in: Otto-Zimmermann, K. (ed.), *Resilient cities: Cities and adaptation to climate change — Proceedings of the Global Forum 2010*, Local Sustainability, Springer, Netherlands, pp. 167-175.
- GWP, 2019, *Addressing water in national adaptation plans: Water supplement to the UNFCCC NAP technical guidelines (2nd edition)*, Global Water Partnership, Stockholm (https://www4.unfccc.int/sites/NAPC/Documents/Supplements/GWP_NAP_Water_Supplement_May2019.pdf) accessed 17 January 2020.
- Hedlund, J., et al., 2018, 'Quantifying transnational climate impact exposure: new perspectives on the global distribution of climate risk', *Global Environmental Change* 52, pp. 75-85 (DOI: 10.1016/j.gloenvcha.2018.04.006).
- Hendel-Blackford, S., et al., 2017, *Assessing adaptation knowledge in Europe: Infrastructure resilience in the transport, energy and construction sectors*, Ecofys, UKCIP and SRUC by order of the European Commission (https://ec.europa.eu/clima/sites/clima/files/adaptation/what/docs/infrastructure_resilience_en.pdf) accessed 24 January 2020.
- Heras, F., 2019, 'ECCA Session SP043: Understanding practice, progress and lessons learned in adaptation — Approaches to monitoring, reporting and evaluation at national level and the way forward', presentation given at: European Climate Change Adaptation Conference 2019 (ECCA), Lisbon, Portugal, 30 May 2019.
- Hewitt, C., et al., 2012, 'The global framework for climate services', *Nature Climate Change* 2(12), pp. 831-832 (DOI: 10.1038/nclimate1745).
- Holling, C. S., 1978, *Adaptive environmental assessment and management*, John Wiley & Sons, Chichester, UK.
- IPBES, 2018, *The assessment report on land degradation and restoration*, Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn (<https://www.ipbes.net/assessment-reports/ldr>) accessed 20 March 2019.
- IPBES, 2019, *Global assessment report on biodiversity and ecosystem services*, Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn (<https://www.ipbes.net/global-assessment-report-biodiversity-ecosystem-services>) accessed 6 August 2019.
- IPCC, 2012, *Managing the risks of extreme events and disasters to advance climate change adaptation. Special report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, UK.
- IPCC, 2014a, 'Annex II: Glossary', in: Barros, V. R. et al. (eds), *Climate change 2014: impacts, adaptation, and vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, pp. 1757-1776.
- IPCC, 2014b, *Climate change 2014 — Synthesis report. Summary for policy makers. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Summary for policy makers, Intergovernmental Panel Climate Change, Geneva (http://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf) accessed 4 March 2016.
- IPCC, 2014c, *Climate Change 2014: Impacts, adaptation and vulnerability. — Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, UK.
- IPCC, 2018, *Global warming of 1.5 °C*, Intergovernmental Panel on Climate Change, Geneva (<http://www.ipcc.ch/report/sr15/>) accessed 10 November 2018.
- ISO, 2019, *Adaptation to climate change — Principles, requirements and guidelines (ISO 14090:2019)*.
- ISO, 2020a, *Adaptation to climate change — Guidelines on vulnerability, impacts and risk assessment (under development) (ISO/DIS 14091)*.
- ISO, 2020b, *GHG Management & related activities: requirement & guidance of adaptation planning for organizations including local governments and communities (under development) (ISO/CD TS 14092)*.
- ISPRA, 2014, *Planning for adaptation to climate change — Guidelines for municipalities*, Life Project No LIFE08 ENV/IT/000436 Adapting to Climate change in Time (ACT), Institute for Environmental Protection and Research (<https://base-adaptation.eu/sites/default/files/306-guidelinesversionefinale20.pdf>) accessed 29 July 2019.
- IUCN, 2017, 'Ecosystem based adaptation and mitigation', International Union for Conservation of Nature (<https://www.iucn.org/commissions/commission-ecosystem-management/our-work/cems-thematic-groups/ecosystem-based-adaptation-and-mitigation>) accessed 7 April 2020.
- Jacob, D., et al., 2013, 'Euro-Cordex: new high-resolution climate change projections for European impact research', *Regional Environmental Change* 14(2), pp. 563-578 (DOI: 10.1007/s10113-013-0499-2).

- Jaspers, 2017, *The basics of climate change adaptation vulnerability and risk assessment*, Jaspers Guidance Note, European Investment Bank, Luxembourg (<http://www.jaspersnetwork.org/plugins/servlet/documentRepository/displayDocumentDetails?documentId=381>) accessed 4 February 2020.
- Jiricka-Pürner, A., et al., 2018, 'Climate change adaptation and EIA in Austria and Germany: current consideration and potential future entry points', *Environmental Impact Assessment Review* 71, pp. 26-40 (DOI: 10.1016/j.eiar.2018.04.002).
- Jiricka-Pürner, A., et al., 2019, 'Mainstreaming climate change adaptation in infrastructure planning — lessons learned from knowledge transfer and communication', in: Leal Filho, W. et al. (eds), *Addressing the challenges in communicating climate change across various audiences*, Springer International Publishing, Cham, Switzerland, pp. 399-416.
- Jones, L., et al., 2017, 'Constraining and enabling factors to using long-term climate information in decision-making', *Climate Policy* 17(5), pp. 551-572 (DOI: 10.1080/14693062.2016.1191008).
- JRC, 2014, 'Index for Risk Management — INFORM', EU Science Hub — European Commission (<https://ec.europa.eu/jrc/en/scientific-tool/index-risk-management-inform>) accessed 7 February 2020.
- Kabisch, N., et al., eds., 2017, *Nature-based solutions to climate change adaptation in urban areas: Linkages between science, policy and practice*, Springer International Publishing, Cham, Switzerland.
- Kappes, M. S., et al., 2012, 'Challenges of analyzing multi-hazard risk: a review', *Natural Hazards* 64(2), pp. 1925-1958 (DOI: 10.1007/s11069-012-0294-2).
- Kind, C., et al., 2019, *Methodology for the evaluation of the German adaptation strategy*, Project number 3715 41 106 0, German Environment Agency, Dessau-Roßlau (<https://www.umweltbundesamt.de/publikationen/politikanalyse-zur-evaluation-der-deutschen>) accessed 2 May 2020.
- Kronberger-Kießwetter, B., et al., 2015, *Anpassung An Den Klimawandel In Österreich Fortschrittsbericht (Vom Ministerrat am 29 September 2015 beschlossen)*, Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft, Vienna (https://www.bmlrt.gv.at/dam/jcr:affd5225-8d2b-4772-9977-da229f5b5690/Fortschrittsbericht-Final_v17_2015-12-02_klein.pdf) accessed 4 February 2020.
- Lassa, J. A., et al., 2019, 'Measuring political will: an index of commitment to disaster risk reduction', *International Journal of Disaster Risk Reduction* 34, pp. 64-74 (DOI: 10.1016/j.ijdr.2018.11.006).
- Lechthaler, F. and Vinogradova, A., 2016, *The climate challenge for agriculture and the value of climate services: Application to coffee-farming in Peru*, Economics Working Paper Series No Working Paper 16/231, Center of Economic Research at ETH Zurich (<https://cer.ethz.ch/content/dam/ethz/special-interest/mtec/cer-eth/cer-eth-dam/documents/working-papers/WP-16-231.pdf>) accessed 7 November 2019.
- Lesnikowski, A. C., et al., 2015, 'How are we adapting to climate change? A global assessment', *Mitigation and Adaptation Strategies for Global Change* 20(2), pp. 277-293 (DOI: 10.1007/s11027-013-9491-x).
- Lexer, W. and Buschmann, D., 2018, *Case study reports on the mainstreaming of climate adaptation: Country report Austria*, Interreg Alpine Space — GoApply — Multidimensional Governance of Climate Change Adaptation in Policy Making and Practice, Environment Agency Austria (Umweltbundesamt), Vienna (https://www.alpine-space.eu/projects/goapply/results/goapply_d.t2.1.1_wp2_case-study-reports_austria_uba-at_dec-2018.pdf) accessed 14 January 2020.
- Li, Y., et al., 2017, 'A coupled human-natural system to assess the operational value of weather and climate services for agriculture', *Hydrology and Earth System Sciences* 21(9), pp. 4693-4709 (DOI: 10.5194/hess-21-4693-2017).
- Ligtvoet, W., et al., 2016, *Keeping track of adaptation in the Dutch Delta: Design of a reflexive monitoring and evaluation framework for the Delta Programme*, Policy Study No 2557, Netherlands Environment Assessment Agency, The Hague (<https://www.pbl.nl/en/publications/keeping-track-of-adaptation-in-the-dutch-delta>) accessed 3 May 2020.
- Lindberg, F., et al., 2018, 'Urban Multi-scale Environmental Predictor (UMEP): an integrated tool for city-based climate services', *Environmental Modelling & Software* 99, pp. 70-87 (DOI: 10.1016/j.envsoft.2017.09.020).
- Lourenço, T. C., et al., 2015, 'The rise of demand-driven climate services', *Nature Climate Change* 6(1), pp. 13-14 (DOI: 10.1038/nclimate2836).
- Mäkinen, K., et al., 2019a, *Kansallisen ilmastonmuutokseen sopeutumissuunnitelman 2022 toimeenpanon väliarviointi [Interim review of the implementation of the National Climate Change Adaptation Plan 2020]*, No 2019:11, Ministry of Agriculture and Forestry, Helsinki (<http://urn.fi/URN:ISBN:978-952-366-000-7>) accessed 14 April 2020.
- Mäkinen, K., et al., 2019b, 'Understanding practice, progress and lessons learned in adaptation – approaches to monitoring, reporting and evaluation at national level and the way forward — ECCA Session SP043', ECCA 2019 — 4th European Climate Change Adaptation Conference (<https://www.ecca2019.eu/understanding-practice-progress-and-lessons-learned-in-adaptation-d-approaches-to-monitoring-reporting-and-evaluation-at-national-level-and-the-way-forward/>) accessed 23 January 2020.

- Marin-Ferrer, M., et al., 2017, *Index for Risk Management INFORM: Concept and methodology report*, JRC Science for Policy Report, European Commission Joint Research Centre, Ispra, Italy (<https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/inform-index-risk-management-concept-and-methodology-version-2017>) accessed 7 February 2020.
- Mathew, S., et al., 2016, *Methods for evaluating the results of monitoring adaptation projects and programs*, CoastAdapt, National Climate Change Adaptation Research Facility, Gold Coast (https://coastadapt.com.au/sites/default/files/factsheets/T4M4_3_Methods%20of%20evaluation.pdf) accessed 7 February 2020.
- McVittie, A., et al., 2017, *Assessing adaptation knowledge in europe: Ecosystem-based adaptation*, Ecofys, UKCIP and SRUC by order of the European Commission (https://ec.europa.eu/clima/sites/clima/files/adaptation/what/docs/ecosystem_based_adaptation_en.pdf) accessed 24 January 2020.
- MetOffice, 2020, 'About UKCP18', UKCP18 (<https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/about>) accessed 20 January 2020.
- Ministarstvo Zdravstva, 2017, 'Protokol o postupanju preporuke za zaštitu od vrućine [Protocol on the procedure and recommendations for heat protection]', Ministarstvo Zdravstva [Republic of Croatia — Ministry of Health] (<https://zdravlje.gov.hr/UserDocImages/2017%20programi%20i%20projekti/PROTOKOL%20-%20VRU%C4%86INA.pdf>) accessed 13 January 2020.
- Mitchell, C. L., et al., 2016, '(Mis)communicating climate change? Why online adaptation databases may fail to catalyze adaptation action', *Wiley Interdisciplinary Reviews: Climate Change* 7(4), pp. 600-613 (DOI: 10.1002/wcc.401).
- MITECO, 2019, 'Evaluation Report of the Spanish National Climate Change Adaptation Plan: executive summary', Ministerio para la Transición Ecológica (https://www.miteco.gob.es/es/cambio-climatico/temas/impactos-vulnerabilidad-y-adaptacion/executivesummary_informeevaluacionpnacc_tcm30-499189.pdf) accessed 3 May 2020.
- Moloney, S., et al., 2020, 'Tracking progress on climate change: developing a tool for monitoring and evaluation for local governments', conference paper presented at: Climate Adaptation 2018 — Learn, collaborate, act, Melbourne, 7-9 May, 9 May 2020.
- Mutimba, S., 2019, *Participatory monitoring & evaluation in the green climate fund — and how civil society can engage*, Policy Brief, Germanwatch, Care climate change and partners, Bonn (<https://www.germanwatch.org/en/16582>) accessed 3 May 2020.
- Mysiak, J., et al., 2018, 'Brief communication: Strengthening coherence between climate change adaptation and disaster risk reduction', *Natural Hazards and Earth System Sciences* 18(11), pp. 3137-3143 (DOI: 10.5194/nhess-18-3137-2018).
- MZOE, 2017, *Jačanje kapaciteta Ministarstva zaštite okoliša i energetike za prilagodbu klimatskim promjenama te priprema Nacrta Strategije prilagodbe klimatskim promjenama: Izveštaj o procijenjenim utjecajima i ranjivosti na klimatske promjene po pojedinim sektorima [Strengthening the capacity of the Ministry of Environment and Energy for adaptation and drafting a Climate Change Adaptation Strategy — Impact assessment report: vulnerabilities to climate change by individual sectors]*, Ministarstvo zaštite okoliša i energetike (Ministry of Environment and Energy), Zagreb, Croatia (<http://prilagodba-klimi.hr/wp-content/uploads/docs/Procjena-ranjivosti-na-klimatske-promjene.pdf>) accessed 13 January 2020.
- MZOE, 2020, 'Hrvatski sabor usvojio Strategiju prilagodbe klimatskim promjenama [The Croatian Parliament adopts a Climate Change Adaptation Strategy]', Republika Hrvatska — Ministarstvo zaštite okoliša i energetike [Republic of Croatia — Ministry of Environment and Energy] (<https://mzoe.gov.hr/vijesti/hrvatski-sabor-usvojio-strategiju-prilagodbe-klimatskim-promjenama/5837>) accessed 2 May 2020.
- Nationale klimaatcommissie, 2016, 'Belgische Nationaal Adaptatieplan 2017-2020 [Belgian national climate change adaptation plan 2017-2020]', Federale overheidsdienst Volksgezondheid, Veiligheid van de Voedselketen en Leefmilieu (https://www.klimaat.be/files/6714/9880/5758/NAP_NL.pdf) accessed 13 January 2020.
- OECD, 2012, *Disaster risk assessment and risk financing. A G20/OECD methodological framework*, Organisation for Economic Co-operation and Development, Paris (<https://www.oecd.org/gov/risk/G20disasterriskmanagement.pdf>) accessed 23 January 2020.
- OECD, 2018a, *Climate finance from developed to developing countries: 2013-17 public flows*, Technical Note, OECD Publishing, Paris (<http://www.oecd.org/environment/cc/climate-finance-2013-17.htm>) accessed 2 May 2020.
- OECD, 2018b, *National risk assessments: A cross country perspective*, OECD Publishing, Paris.
- O'Mahony, C., 2019, *Integrating climate change into strategic environmental assessment in Ireland — A guidance note (updated June 2019)*, Environmental Protection Agency, Wexford, Ireland (<http://www.epa.ie/pubs/advice/ea/EPA%20SEA-Climate-Factors-Guidance-Note.pdf>) accessed 14 April 2020.
- Paavola, J. and Primmer, E., 2019, 'Governing the provision of insurance value from ecosystems', *Ecological Economics* 164, p. 106346 (DOI: <https://doi.org/10.1016/j.ecolecon.2019.06.001>).

- Pagani, F., 2002, 'Peer review as a tool for co-operation and change: an analysis of an OECD working method', *African Security Review* 11(4), pp. 15-24 (DOI: 10.1080/10246029.2002.9628141).
- Palutikof, J. P., et al., 2019, 'Tracking the progress of climate change adaptation: an Australian case study', *Environmental Science & Policy* 101, pp. 126-135 (DOI: 10.1016/j.envsci.2019.07.018).
- Paulino, J., et al., 2019, 'Portuguese Action Plan for Adaptation to Climate Change 2030: Towards implementation and monitoring assessment (P-3AC)', conference paper presented at: European Climate Change Adaptation Conference 2019 (ECCA), Lisbon, Portugal, 30 May 2019.
- Paulino, J., 2019, 'Understanding practice, progress and lessons learned in adaptation — Approaches to monitoring, reporting and evaluation at national level and the way forward — ECCA Session SP043', presentation given at: European Climate Change Adaptation Conference 2019 (ECCA), Lisbon, Portugal, 30 May 2019.
- Perrels, A., et al., 2013, 'Socio-economic benefits of weather and climate services in Europe', *Advances in Science and Research* 10(1), pp. 65-70 (DOI: 10.5194/asr-10-65-2013).
- Poljanšek, K., et al., 2017, *Science for disaster risk management 2017: Knowing better and losing less*, EUR 28034 EN, Publications Office of the European Union, Luxembourg (<https://publications.europa.eu/en/publication-detail/-/publication/4bc0e055-3712-11e7-a08e-01aa75ed71a1/language-en>) accessed 23 January 2020.
- Poljanšek, K., et al., 2019, *Recommendations for national risk assessment for disaster risk management in EU*, Publications Office of the European Union, Luxembourg.
- Polk, M., 2015, 'Transdisciplinary co-production: designing and testing a transdisciplinary research framework for societal problem solving', *Futures* 65, pp. 110-122 (DOI: <https://doi.org/10.1016/j.futures.2014.11.001>).
- Price-Kelly, H., et al., 2017, 'Webinar | Vertical integration in NAP processes: linking national and sub-national adaptation', NAP Global Network (<http://www.napglobalnetwork.org/resource/webinar-vertical-integration-nap-processes-linking-national-sub-national-adaptation/>) accessed 2 May 2020.
- PRI/UNEP FI/UN Global Compact, 2016, French energy transition law. Global investor briefing, Principles for Responsible Investment Initiative, UNEP Finance Initiative and UN Global Compact (<https://www.unepfi.org/fileadmin/documents/PRI-FrenchEnergyTransitionLaw.pdf>) accessed 10 April 2019.
- Rai, N., et al., 2019, *Assessing adaptation results: Aligning national M&E systems and global results frameworks*, Issue Paper, International Institute for Environment and Development, London, UK (<https://pubs.iied.org/pdfs/10198IIED.pdf>) accessed 2 May 2020.
- Ramboll Environment and IVM, 2017, *Insurance of weather and climate-related disaster risk: An inventory and analysis of mechanisms to support damage prevention in the EU*, Publications Office of the European Union, Luxembourg (<https://publications.europa.eu/en/publication-detail/-/publication/4f366956-a19e-11e7-b92d-01aa75ed71a1>) accessed 5 February 2020.
- Rijkswaterstaat, 2020, 'Room for the River' (<https://www.rijkswaterstaat.nl/english/about-us/gems-of-rijkswaterstaat/room-for-the-river/index.aspx>) accessed 23 June 2020.
- RMI Belgium, 2020, 'CORDEX.be targets', CORDEX.be (<http://www.euro-cordex.be/meteo/view/en/29026726-Targets.html>) accessed 20 January 2020.
- Russel, D., et al., 2014, *Knowledge use, knowledge needs and policy integration in Member States*, Workpackage Deliverable No D2.2 (https://base-adaptation.eu/sites/default/files/BASE%20Deliverable_2_2.pdf) accessed 5 February 2020.
- Russel, D., et al., 2018, 'Analyzing the policy framework for climate change adaptation', in: *Adapting to climate change in Europe*, Elsevier, pp. 273-313.
- Rüttinger, L., et al., 2015, *A new climate for peace — Taking action on climate and fragility risks*, Adelphi, International Alert, Wilson Center and European Union Institute for Security Studies, Berlin (https://www.newclimateforpeace.org/sites/default/files/NewClimateForPeace_FullReport_small_0.pdf) accessed 23 June 2020.
- Sadegh, M., et al., 2018, 'Multihazard scenarios for analysis of compound extreme events', *Geophysical Research Letters* 45(11), pp. 5470-5480 (DOI: 10.1029/2018GL077317).
- Sanderson, H., et al., eds., 2018, *Adapting to climate change in Europe: Exploring sustainable pathways — from local measures to wider policies*, Elsevier, Waltham, MA.
- Schmidt-Traub, G., et al., 2015, *Indicators and a monitoring framework for the Sustainable Development Goals — Launching a data revolution for the SDGs (A report to the Secretary-General of the United Nations by the Leadership Council of the Sustainable Development Solutions Network)*, Sustainable Development Solutions Network (<https://sustainabledevelopment.un.org/content/documents/2013150612-FINAL-SDSN-Indicator-Report1.pdf>) accessed 8 March 2018.
- Scott, D., et al., 2011, 'Climate services to support sustainable tourism and adaptation to climate change', *Climate Research* 47(1), pp. 111-122 (DOI: 10.3354/cr00952).

- Scott, D. and Lemieux, C., 2010, 'Weather and climate information for tourism', *Procedia Environmental Sciences* 1, pp. 146-183 (DOI: 10.1016/j.proenv.2010.09.011).
- Simister, N., 2015, *Outputs, outcomes and impact*, INTRAC (<https://www.intrac.org/wpcms/wp-content/uploads/2016/06/Monitoring-and-Evaluation-Series-Outcomes-Outputs-and-Impact-7.pdf>) accessed 7 April 2020.
- Sperotto, A., et al., 2017, 'Reviewing Bayesian networks potentials for climate change impacts assessment and management: a multi-risk perspective', *Journal of Environmental Management* 202, pp. 320-331 (DOI: 10.1016/j.jenvman.2017.07.044).
- Street, R., et al., 2015, *A European research and innovation roadmap for climate services*, Publications Office of the European Union, Luxembourg.
- Street, R. B., 2016, 'Towards a leading role on climate services in Europe: a research and innovation roadmap', *Climate Services* 1, pp. 2-5 (DOI: 10.1016/j.cliser.2015.12.001).
- Street, R. B., et al., 2019, 'How could climate services support disaster risk reduction in the 21st century', *International Journal of Disaster Risk Reduction* 34, pp. 28-33 (DOI: 10.1016/j.ijdr.2018.12.001).
- Street, R. B. and Jude, S., 2019, 'Enhancing the value of adaptation reporting as a driver for action: lessons from the UK', *Climate Policy* 19(10), pp. 1340-1350 (DOI: 10.1080/14693062.2019.1652141).
- Swanson, D. and Bhadwal, S., eds., 2009, *Creating adaptive policies: A guide for policymaking in an uncertain world*, SAGE International Institute for Sustainable Development ; International Development Research Centre, Los Angeles, Winnipeg, Ottawa.
- TEG, 2020a, *Taxonomy: Final report of the Technical Expert Group on Sustainable Finance*, EU Technical Expert Group on Sustainable Finance, Brussels (https://ec.europa.eu/info/sites/info/files/business_economy_euro/banking_and_finance/documents/200309-sustainable-finance-teg-final-report-taxonomy_en.pdf) accessed 2 May 2020.
- TEG, 2020b, *Taxonomy report: Technical Annex — Updated methodology and updated technical screening criteria*, EU Technical Expert Group on Sustainable Finance, Brussels (https://ec.europa.eu/info/sites/info/files/business_economy_euro/banking_and_finance/documents/200309-sustainable-finance-teg-final-report-taxonomy-annexes_en.pdf) accessed 2 May 2020.
- Tobin, I., et al., 2018, 'Vulnerabilities and resilience of European power generation to 1.5 °C, 2 °C and 3 °C warming', *Environmental Research Letters* 13(4), p. 044024 (DOI: 10.1088/1748-9326/aab211).
- UN, 2015, Resolution adopted by the General Assembly on 25 September 2015 — Transforming our world: the 2030 Agenda for Sustainable Development (A/RES/70/1).
- UN, 2016, *Report of the open-ended intergovernmental expert working group on indicators and terminology relating to disaster risk reduction*, Seventy-first session. Agenda item 19 c). Sustainable development: disaster risk reduction No A/71/644, United Nations General Assembly, New York (http://www.preventionweb.net/files/50683_oiewgreportenglish.pdf) accessed 9 June 2020.
- UN, 2017a, Resolution adopted by the General Assembly on 6 July 2017 (A/RES/71/313).
- UN, 2017b, Resolution adopted by the General Assembly on 23 December 2016: 71/265 New Urban Agenda (A/RES/71/256).
- UN, 2017c, 'Sustainable development agenda', United Nations (<http://www.un.org/sustainabledevelopment/development-agenda/>) accessed 22 November 2017.
- UN, 2020, Annex — Global indicator framework for the Sustainable Development Goals and targets of the 2030 Agenda for Sustainable Development (A/RES/71/313 E/CN.3/2018/2 E/CN.3/2019/2 E/CN.3/2020/2).
- UN Environment DTU Partnership, 2017, *Adaptation gap report 2017*, United Nations Environment Programme, Nairobi, Kenya.
- UN Environment DTU Partnership, 2018, *Adaptation gap report 2018*, United Nations Environment Programme, Nairobi, Kenya.
- UNCBD, 1992, Convention on biological diversity.
- UNCBD, 2012a, 'TARGET 15 — Technical rationale extended (provided in document COP/10/INF/12/Rev.1)', Aichi Biodiversity Targets (<https://www.cbd.int/sp/targets/rationale/target-15/>) accessed 4 February 2020.
- UNCBD, 2012b, 'Technical rationale (provided in document COP/10/27/Add.1)', Aichi Biodiversity Targets (<https://www.cbd.int/sp/targets/rationale/>) accessed 4 February 2020.
- UNCCD, 2020, 'United Nations Convention to Combat Desertification' (<https://www.unccd.int/>) accessed 7 October 2019.
- UNDP, 2015, 'Making the case for policy change and financing for ecosystem-based adaptation — Global Ecosystem-based Adaptation in Mountains Programme (Learning Brief 4)', United Nations Development Programme (https://www.adaptation-undp.org/sites/default/files/downloads/undp_mt_eba_learning_brief_4_web_vs_12.01.16.pdf) accessed 5 February 2020.

- UNDRR, 2015, *Sendai Framework for Disaster Risk Reduction 2015-2030*, United Nations Office for Disaster Risk Reduction, Geneva (<http://www.unisdr.org/we/inform/publications/43291>) accessed 23 November 2017.
- UNDRR, 2020, 'Sendai Framework Monitor Home page', United Nations Office for Disaster Risk Reduction (<https://sendaimonitor.undrr.org/>) accessed 23 June 2020.
- UNFCCC, 2011, *Report of the Conference of the Parties on its sixteenth session, held in Cancun from 29 November to 10 December 2010*, No FCCC/CP/2010/7/Add.1, United Nations Framework Convention on Climate Change (<https://unfccc.int/resource/docs/2010/cop16/eng/07a01.pdf>) accessed 9 October 2019.
- UNFCCC, 2015, Paris Agreement (Decision 1/CP.21).
- UNFCCC, 2019a, Report of the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement on the third part of its first session, held in Katowice from 2 to 15 December 2018 — Addendum 1 — Part two: Action taken by the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement (FCCC/PA/CMA/2018/3/Add.1).
- UNFCCC, 2019b, Report of the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement on the third part of its first session, held in Katowice from 2 to 15 December 2018 - Addendum 2 - Part two: Action taken by the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement (FCCC/PA/CMA/2018/3/Add.2).
- UNFCCC, 2019c, 'What do adaptation to climate change and climate resilience mean?', United Nations Framework Convention on Climate Change (<https://unfccc.int/topics/adaptation-and-resilience/the-big-picture/what-do-adaptation-to-climate-change-and-climate-resilience-mean>) accessed 9 October 2019.
- UNISDR, 2007, *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters (Extract from the final report of the World Conference on Disaster Reduction (A/CONF.206/6))*, United Nations International Strategy for Disaster Reduction (https://www.unisdr.org/files/1037_hyogoframeworkforactionenglish.pdf) accessed 7 February 2020.
- UVPklimafit, 2020, 'UVPklimafit Infoportal', Umweltbundesamt (<http://uvpklimafit.boku.ac.at>) accessed 10 June 2020.
- Vallejo, L., 2017, *Insights from national adaptation monitoring and evaluation systems*, Climate Change Expert Group Paper No 2017(3), OECD and IEA (<http://www.oecd.org/environment/cc/Insights%20from%20national%20adaptation%20monitoring%20and%20evaluation%20systems.pdf>) accessed 23 November 2017.
- van den Hurk, B., et al., 2014, KNMI'14: *Climate change scenarios for the 21st century — A Netherlands perspective*, Scientific Report No KNMI WR 2014-01, Koninklijk Nederlands Meteorologisch Instituut, De Bilt (http://www.climatecenarios.nl/images/KNMI_WR_2014-01_version26May2014.pdf) accessed 20 January 2020.
- Van Eerd, M. C. J., et al., 2014, 'Exploring the prospects for cross-border climate change adaptation between North Rhine-Westphalia and the Netherlands', *Utrecht Law Review* 10(2), p. 91 (DOI: 10.18352/ulr.271).
- VARAM, 2020, 'Vides aizsardzības un reģionālās attīstības ministrija: Projekta ietvaros veikto pētījumu nodevumi 'risku un ievainojamības novērtēšanu un pielāgošanās pasākumu identificēšanu sešās jomās kā ainavu plānošana un tūrisms, bioloģiskā daudzveidība un ekosistēmu pakalpojumi, civilā aizsardzība un ārkārtas palīdzība, būvniecība un infrastruktūras plānošana, veselība un labklājība, lauksaimniecība un mežsaimniecība' [Ministry of Environmental Protection and Regional Development: Outcomes of research carried out within the framework of the project 'Research on risk and vulnerability assessment and identification of adaptation measures in six areas like landscape planning and tourism, biodiversity and ecosystem services, civil protection and emergency aid, construction and infrastructure planning, health and welfare, agriculture and forestry']' (http://www.varam.gov.lv/lat/publ/petijumi/petijumi_klimata_parmainu_joma/?doc=23668) accessed 13 January 2020.
- Vaughan, C., et al., 2016, 'Identifying research priorities to advance climate services', *Climate Services* 4, pp. 65-74 (DOI: 10.1016/j.cliser.2016.11.004).
- Vaughan, C., et al., 2018, 'Surveying climate services: what can we learn from a bird's-eye view?', *Weather, Climate, and Society* 10(2), pp. 373-395 (DOI: 10.1175/WCAS-D-17-0030.1).
- Vaughan, C. and Dessai, S., 2014, 'Climate services for society: origins, institutional arrangements, and design elements for an evaluation framework: climate services for society', *Wiley Interdisciplinary Reviews: Climate Change* 5(5), pp. 587-603 (DOI: 10.1002/wcc.290).
- Vonk, M., et al., 2015, *Worldwide climate effects: risks and opportunities for the Netherlands*, No 1412, PBL Netherlands Environmental Assessment Agency, Bilthoven, the Netherlands (<http://www.pbl.nl/en/publications/worldwide-climate-effects-risks-and-opportunities-for-the-netherlands>) accessed 23 January 2020.
- Walters, C. J., 1986, *Adaptive management of renewable resources*, Macmillan Publishers Ltd, Basingstoke, UK.
- Wamsler, C., 2017, 'Stakeholder involvement in strategic adaptation planning: transdisciplinarity and co-production at stake?', *Environmental Science & Policy* 75, pp. 148-157 (DOI: 10.1016/j.envsci.2017.03.016).

Wamsler, C. and Pauleit, S., 2016, 'Making headway in climate policy mainstreaming and ecosystem-based adaptation: two pioneering countries, different pathways, one goal', *Climatic Change* 137(1-2), pp. 71-87 (DOI: 10.1007/s10584-016-1660-y).

WHO, ed., 2016, *International Health Regulations* (2005), World Health Organization, Geneva.

WHO Europe, 2018, *Public health and climate adaptation policies in the European Union*, World Health Organization Regional Office for Europe, Copenhagen (http://www.euro.who.int/__data/assets/pdf_file/0010/386965/Pagoda-REPORT-final-published-2.pdf?ua=1) accessed 17 January 2020.

WMO, 2015, *Valuing weather and climate: Economic assessment of meteorological and hydrological services*, World Meteorological Organization, Geneva, Switzerland.

Zandvoort, M., et al., 2017, 'Adaptation pathways in planning for uncertain climate change: applications in Portugal, the Czech Republic and the Netherlands', *Environmental Science & Policy* 78, pp. 18-26 (DOI: 10.1016/j.envsci.2017.08.017).

Annex 1

Indicators relevant to climate impacts and adaptation in the Sustainable Development Goals

The 2030 Agenda for Sustainable Development (UN, 2015), adopted by all United Nations Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet, now and into the future. At its heart are the 17 Sustainable Development Goals (SDGs, see Figure A1.1), which are an urgent call for action by all countries — developed and developing — in a global partnership. They recognise that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality and spur economic growth — all while tackling climate change and working to preserve our oceans and forests. More information on the SDGs can be found on the United Nations website: <https://sustainabledevelopment.un.org/?menu=1300>.

Indicators relevant to climate impacts and adaptation are not only found in SDG 13, Climate action, but also in the SDGs 1, 2, 6, 11, 12, 13 and 15 (ETC/CCA, 2018b).

The following SDG indicators are relevant to climate impacts and adaptation (UN, 2017a, 2020):

- number of deaths, missing persons and directly affected persons attributed to disasters per 100 000 population (covered in SDGs 1.5.1, 11.5.1, 13.1.1);
- direct economic loss attributed to disasters in relation to gross domestic product (GDP) (covered in SDG 1.5.2);
- proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction (covered in SDGs 1.5.4, 13.1.2);
- proportion of agricultural area under productive and sustainable agriculture (covered in SDG 2.4.1);
- percentage of agricultural households using irrigation systems compared with all agricultural households (covered in SDG 2.4.2);
- extent to which (1) global citizenship education and (2) education for sustainable development are mainstreamed in (i) national education policies, (ii) curricula, (iii) teacher education and (iv) student assessment (covered in SDGs 4.7.1, 12.8.1, 13.3.1);

Figure A1.1 Sustainable Development Goals



Source: UN (2015).

- change in the efficiency of water use over time (covered in SDG 6.4.1);
- degree of integrated water resources management implemented (0-100) (covered in SDG 6.5.1);
- proportion of transboundary basin area with an operational arrangement for water cooperation (covered in SDG 6.5.2);
- direct economic loss in relation to global GDP, damage to critical infrastructure and number of disruptions to basic service, attributed to disasters (covered in SDG 11.5.2);
- number of countries that adopt and implement national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015-2030 (covered in SDG 13.1.2);
- number of countries with nationally determined contributions, long-term strategies, national adaptation plans and strategies as reported in adaptation communications and national communications (covered in SDG 13.2.1).

For further details, we refer readers to the global indicator framework adopted by the General Assembly (UN, 2017a), annual refinements contained in E/CN.3/2018/2 (Annex II), E/CN.3/2019/2 (Annex II) and 2020 comprehensive review changes (Annex II) and annual refinements (Annex III) contained in E/CN.3/2020/2 (codified in UN, 2020).



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Although the EU and all EU Member States have a dedicated climate adaptation policy, none of them can fully show whether we are becoming more resilient.

This report looks at how monitoring and reporting could feed into policy evaluation and inform future policies.

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