



Climate change adaptation of major infrastructure projects

A stock-taking of available resources to assist the development of climate resilient infrastructure

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Note for the readers of the printed version: the present report and its accompanying country reports link to a large number of resources via hyperlinks, which by nature are only active in the electronic version. In order to find the identified resources, an online search will usually deliver the right result; but otherwise it is also possible to make use of Annex II where all the identified resources and their hyperlinks are presented.

Executive Summary

Policy and legislative context

To keep climate change below dangerous levels, the international community agrees that rise of the average global temperature must be limited to no more than 2°C with an aim to 1.5°C above the pre-industrial temperatures. The EU is therefore working to reduce its emissions, to encourage other major polluters to take strong action, and to address the unavoidable impacts of a changing climate. The EU Strategy on Adaptation to Climate Change¹ sets out actions for promoting adaptation within the EU, and, among other actions, it encourages all EU countries to adopt comprehensive adaptation strategies; provides funding to support capacity building and step up adaptation action in Europe; addresses knowledge gaps on adaptation; mainstreams adaptation by integrating it into EU policies and legislation; and ensures more resilient infrastructure.

Climate change adaptation considerations have been included in the preparation and approval process of European Structural and Investment Funds² (ESIF) major projects³ (i.e. projects having a total eligible cost exceeding €50 million, or €75 million in the case of transport projects) and this has contributed to climate-proofing such projects. The European Structural and Investment Funds promote eleven Thematic Objectives, of which Thematic Objective 5 is '*Promoting climate change adaptation, risk prevention and management*'.

The Common Provisions Regulation (Regulation (EU) No 1303/2013⁴) sets the overall funds framework, and states that for a major project to be approved, the managing authority needs to ensure the availability of an analysis of the environmental impact, taking into account climate change adaptation and mitigation needs, and disaster resilience⁵. National and/or regional risk assessments for disaster risk management are a precondition (ex-ante conditionality) for funding under Thematic Objective 5, and national climate change adaptation strategies and related climate vulnerability assessments are required, where appropriate, to inform national risk assessments.

In addition, the Common Provision Regulation for ESI Funds requires Member States to "take into consideration the climate change mitigation and adaptation potential of investments made with the support of the ESI Funds, in accordance its Article 8, and ensure that they are resilient to the impact of climate change and natural disasters such as increased risks of flooding, droughts, heat waves, forest fires and extreme weather events. Moreover, Managing authorities shall undertake actions throughout the programme lifecycle, to avoid or reduce environmentally harmful effects of interventions and ensure results in net social, environment and climate benefits."⁶

¹ The EU Adaptation Strategy is undergoing evaluation at the time of writing of this study https://ec.europa.eu/clima/policies/adaptation/what_en

² The European Structural and Investment Funds comprise a family of five funds: the European Regional Development Fund (ERDF) and European Territorial Cooperation goal (ETC, which falls under ERDF); the Cohesion Fund (CF); the European Social Fund (ESF); the European Agricultural Fund for Rural Development (EAFRD); and the European Maritime and Fisheries Fund (EMFF).

³ a major project is defined as an operation comprising a series of works, activities or services intended in itself to accomplish an indivisible task of a precise economic or technical nature which has clearly identified goals and for which the total eligible cost exceeds EUR 50 000 000 and in the case of operations contributing to the thematic objective under point (7) of the first paragraph of Article 9 of 1303/2013, where the total eligible cost exceeds EUR 75 000 000. Financial instruments are not considered to be major projects. This definition is found in Article 100 of the Common Provisions Regulation (EU) No 1303/2013,

⁴ The full name of the regulation is: Regulation (EU) No 1303/2013 of the European Parliament and of the Council of 17 December 2013 laying down common provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund and laying down general provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund and the European Maritime and Fisheries Fund and repealing Council Regulation (EC) No 1083/2006

⁵ According to Article 101 (f) of the Common Provisions Regulation (EU Regulation 1303/2013)

⁶ Common Provisions Regulation (EU) No 1303/2013, point 5.2 of Annex I

It has to be noted that that the EU's major projects legislation for the 2014-2020 programming period is the first to define specific climate change related requirements. Insofar as the information requirements for major projects are concerned, the [Commission Implementing Regulation \(EU\) 2015/207](#) lays down detailed rules for implementing the Common Provisions Regulation. In the case of EU-funded major projects, Section F (Environmental Impact) of the Major Project Application Form includes a section F. 8 on "Climate change adaptation and mitigation, and disaster resilience", where it is requested to explain how the project contributes to climate change targets; how climate change related risks, adaptation and mitigation considerations, and disaster resilience have been taken into account; and what measures have been adopted to ensure resilience to current climate variability and future climate change within the project.

Overall Findings

This study reviewed the availability of resource materials that can support infrastructure project developers to take into account climate change adaptation. It provides an overall stock-taking of available resources that contribute to the preparedness of all Member States with regards to applying the climate change requirements of the European Structural and Investment Funds programming period 2014-2020. Finally, it identifies some of the ongoing good practices of Member States in adapting to climate change.

The present project commenced on January 13th 2017, compiled a large number of available resources until the end of the same year, and was completed by June 2018. The study focused exclusively on climate adaptation resources, projects, practice and literature, and their supporting institutional structures. It did not engage with the examination of climate mitigation, which is receiving extensive coverage as topics of other relevant EU studies.

Types of available resources

Seven different categories have been identified to map resources available at the EU, Member State and local level.

- **System and Legal Framework** – The institutional and legal framework adopted by formal authorities across the EU is used to deliver their primary responsibilities for climate adaptation, infrastructure, and the management of European Structural and Investment Funds. The overarching policy on adaptation is the 2013 EU Strategy on Adaptation to Climate Change, which, for infrastructure, has led to the inclusion of relevant considerations in the Common Provisions Regulation (No 1303/2013). This Regulation sets the overall ESIF² framework and the requirements for major projects to ensure the availability of an analysis of the environmental impact, taking into account climate change adaptation and mitigation needs, and disaster resilience. In this direction, the Implementing Regulation (EU) 2015/207 sets a number of specific requirements for major projects that need to be met by project developers. The main EU body responsible for climate adaptation is DG CLIMA, while other essential and supporting functions are performed by DG REGIO (Cohesion policy, ESIF), DG ENV (green infrastructure, LIFE), DG RTD, DG ECHO, DG DEVCO, and the European Environment Agency. On the availability of funds, the EIB has committed itself to climate mainstreaming and climate is a major consideration for financing. The Climate-ADAPT website provides links to the relevant EU policy documents and websites for information on the legal framework for EU Member States. 25 Member States have completed, and three are in the process of adopting their climate adaptation strategy. In addition to this, action plans have been or are currently being developed, and all are establishing working groups, monitor mechanisms and cooperation committees between various institutions and stakeholders at a national level. Key documents and policies setting out climate adaptation strategies are intended to be updated regularly. Revision of

the national legislation to transpose the revised Environmental Impact Assessment (EIA) Directive⁷, including the climate adaptation requirements, has been completed in 23 MSs, and is currently underway in five MSs⁸. Examples of robust institutions for climate change adaptation include [Local Government Denmark](#), the [Evaluation of the Implementation of Finland's Strategy for Adaptation to Climate Change](#) and [Strategies of the 16 Bundesländer](#). The adoption of legal obligation can support the adaptation of a given sector, for instance the revised Electricity Market Act (Finland) requires Distribution System Operators to improve their distribution networks' resilience against extreme weather, which lead to the development of design standards used by [Elenia Säavarma Underground Cables](#).

- **Institutional Capacity** - This resource concerns the human and technical capacity of institutions to carry out their functions relating to climate change adaptation. Climate change adaptation capacities vary between Member States but all have the basic institutional frameworks that allow for further development. Research institutes are undertaking projects related to climate adaptation in all EU Member States, thus creating a base for further development. National authorities are aware of the topic on the central and local level, and are undertaking actions according to their mandate and capabilities. The legislative framework is being enforced, as project developers are conforming to the guidelines and requirements set through the aforementioned EU financing mechanisms. The present study also observed that sporadically, a number of project developers who were not financed through EU funds had undertaken climate adaptation measures. Public institutions, the private sector and research institutes are keen to improve long-term planning for climate adaptation. Resources are available to increase adaptation capacity throughout the EU as this topic is increasing recognised as an important complement to more established efforts on climate mitigation. Examples of adequate institutional capacity include [Netzwerk Vulnerabilität](#) and the [Rotterdam Climate Initiative](#), as these initiatives increase the collaboration of diverse stakeholders with the aim to facilitate climate adaptation. Projects such [Baltadapt](#) were realised in the context of the EU requirement for MSs to produce their national or transnational climate change adaptation strategies, supporting the institutional capacity of the MSs. Increased institutional capacity can also be supported by improving democratic participation: the KiezKlima urban development project in Berlin shows that participation of citizens can be of much added value in a climate adaptation project as regards social acceptance.
- **Data availability** - At the EU-level, climate change adaptation data is available and openly accessible to all interested parties; providing an overview of impacts of climate change and adaptation actions by country and by sector. Data inputs used for modelling, risk calculations and vulnerability analysis were found in almost all countries. Individual Member States have publically-available databases intended to provide concerned actors with a variety of information to support the successful implementation of adaptation measures in their respective areas of responsibility. Examples of good practice data availability include, but are not limited to, [Klimawandelanpassung.at](#), [climat.be](#), [WIKLIMAT](#), [Klimada](#), [Climate Data Centre](#), [Climate Ireland](#), [NAKFO](#), [ruimtelijkeadaptatie.nl](#), [Klimatilpasning.dk](#), and the [UK Climate Projections](#).
- **Methodologies** - Methodologies to fulfil each step of the European Structural Investment Fund (ESIF) requirements (vulnerability and risk assessment, adaptation measures, appraisal, planning) for major projects exist to support project developers and interested parties with the integration of climate change adaptation into major infrastructure projects. We have identified a number of EU

⁷ 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 Text with EEA relevance

⁸ For an update of the transposition of the EIA directive, please visit <http://eur-lex.europa.eu/legal-content/EN/NIM/?uri=CELEX:32014L0052>

and Member State methodologies that enable infrastructure project developers to determine vulnerabilities and assess the risks of climate change, including: Cost Benefit Analysis, Cost Effectiveness, Risk Assessment, Community Vulnerability Assessment Tool, Community Vulnerability and Adaptation Assessment and Action, Multi-criteria Decision Analysis, Environmental Impact Assessments, Strategic Environmental Assessments and Sustainability Impact Assessments. Relevant management methods used include [DPSIR](#) (Drivers-Pressures-State-Impact-Response), [SPIM](#) (South Pacific island), and [DESSIN](#) (Demonstrate Ecosystem Services Enabling Innovation in the Water Sector). A few examples where methodologies are used effectively include [Klimalotse](#), [Climate Adaptation Toolbox](#) and the [Highways England Adaptation Framework Model](#). The methodology [Cost Relevance of Adaptation in Cities](#) demonstrates the quantitative and qualitative information that can be collected on damage caused by climate change, which can be considered in assessments of adaptation measures (e.g. flood protection measures). The methodology as part of the [North West Bicester Eco Development](#) provides a strong example for housing developments by incorporating extensive use of UKCP09 projections as well as proposed adaptation measures.

- **Tools** – The availability of tools for planning, evaluation, and impact estimation is key in assisting communities and project planners to anticipate, plan for, and adapt to the changing climate. The majority of tools identified for assessing climate vulnerabilities tend to be focussed on flooding. It has to be noted that the EU Floods Directive⁹ requirements acted as a catalyser for the development of these tools across the EU. Across the EU, more tools have been developed in the context of EU-funded research projects, or from national authorities, that combine climate projections with geo-spatial data, and which are presented in online interactive interfaces. These tools are highly valuable to project developers who are able to estimate physical parameters such as precipitation patterns, wind stresses, and river outflows. More tools are available that assist policy makers and local communities to develop adaptation strategies in particular countries, such as [CYPADAPT](#) and [BaltADAPT](#). The EU Cities Adapt¹⁰ project review tools and guidance documents which can make the task of adaptation planning more manageable for adaptation practitioners. [Climate-ADAPT](#) also provides access to several tools, such as the Urban Adaptation Support Tool. A selection of Tools being used effectively include [DRIAS](#), [Stadtklimalotse](#), the [MEDIATION](#) toolbox, the [Rotterdam Climate Game](#), [Climatools](#), [Tools for strategic planning and management of urban water](#), and the [Sustainable Drainage Systems Tool](#).
- **Guidance** - The provision of guidance documentation on how to use methodologies, or develop the required infrastructure project documentation relating to climate adaptation is crucial to overcome uncertainties in project planning. Primary guidance is provided within the major projects application form, and most importantly under Section F.8 on 'Climate change adaptation and mitigation, and disaster resilience'¹¹. Further [guidance is published by EUFIWACC](#) – European Union Financial Institutions Working Group on Adaptation to Climate Change; the European Commission and [JASPERS](#)¹², who have provided several practice-oriented guidance in 2017, including the '[Basics of Climate Change Adaptation, Vulnerability and Risk Assessment](#)' and '[A compilation of the climate change requirements for major projects in 2014-2020](#)'. The DG CLIMA of the European Commission has published the '[Non-paper Guidelines for Project Managers: Making vulnerable investments climate resilient](#)', which is widely used across the EU in the design of major projects. Additional useful guidance exists from the European Union for

⁹ Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks (Text with EEA relevance)

¹⁰<http://climate-adapt.eea.europa.eu/metadata/publications/eu-cities-adapt-adaptation-strategies-for-european-cities-final-report>

¹¹ Within the major projects application form, the project promoter is provided with the set of guiding questions for climate adaptation, for the feasibility study, the option analysis, environmental profile, CBA, etc.

¹² guidance by JASPERS is the result of common discussions between DG CLIMA, DG REGIO and JASPERS and it is provided on behalf of the European Commission

Integrating Climate Change and Biodiversity into Environmental Impact Assessments, and the widely used Guide to Cost Benefit Analysis of Investment projects by DG REGIO. Guidance at Member State level often builds upon EU-level guidance, such as the [brochure on "climate change and major projects"](#), as well as the guidance document for climate change adaptation standards, which was developed by The European Committee for Standardisation (CEN) and Electrotechnical Standardisation (CENELEC). Guidance is available throughout Member States, such as [KomPass](#), the translated 'Handleiding Klimaat in MER' for adaptation in EIAs and the "Guidelines for klimatilpasning i kystområder".

- **Design standards** – Published design standards for infrastructure projects include sections or appropriate provisions to ensure the resilience to climate change impacts. Design standards for climate adaptation projects are in the process of being developed. CEN and CENELEC established the [Adaptation to Climate Change Coordination Group \(ACC-CG\)](#), to support the implementation of the EU Strategy on Adaptation to Climate Change. Member States are participating in the preparation of the standards and are expecting their finalisation in order to adopt them. There are few good examples of where specific climate change adaptations are integrated within standards, both within sectors, for example through [drainage systems](#), and more generally on a national basis for climate change adaptation. The RESIN project (WP5) has a liaison with two ISO committees¹³ and will continue working with both ISO and CEN on standardising adaptation options. In September 2017, ISO has asked for international experts to get involved in the drafting of a standard on 'Climate Change Adaptation – A Guidance to Vulnerability Assessment'¹⁴.

Sectoral resources

This study reviewed the preparedness in terms of availability of sector-specific resources for six different sectors of the economy. The level of sectoral resources available varies significantly between Member States, with some Member States relying more on sector resources provided at an EU-level. In general, most of the sourced material and a comparative higher level of climate change adaptation preparedness is found in the transport, urban development and water sectors, owing to a large extent to the fact that these are predicted to be the most impacted sectors. In the energy sector there is a greater focus on decarbonisation and climate change mitigation rather than adaptation at present. In the majority of Member States, there is relatively little preparedness in the broadband and waste sectors.

- **Transport** - Significant experience has been developed in the transport sector, as many projects are adapting to the forecasted impacts of climate change. The methodology used for the [High Speed 2 \(HS2\)](#) rail project in the UK allowed for the incorporation of adaptation measures in the planning stage, in what is one of the largest infrastructure projects in Europe. Depending on the location, adaptation measures may vary: the development of the [Attica Tollway](#) has included flood management systems to take account of increased flood risks for instance, whereas in the project [Railway line No. 1 on the section Częstochowa-Zawiercie](#) for instance, the broader impact of climatic factors on railway infrastructure were assessed, to ensure a higher resilience of the newly developed infrastructure. Case-studies in the Transport show high replicability throughout the EU, such as the results of the [ROADAPT](#) and the [CliPDaR](#) projects and the PIARC publications relevant to climate adaptation on [transport strategies](#), [road bridges](#) and the [international adaptation framework](#).
- **Broadband** - The present study found a limited availability of resources for the broadband sector in respect to the actions being taken to adapt to climate change.

¹³ Relevant working groups within ISO are ISO/TC 268 'Sustainable cities and communities'¹³, WG 2 'City indicators' ISO/TC 207 'Environmental management'¹³, - 'ISO/TMB/TF 7' on Climate Change Adaptation.

¹⁴ <https://www.adelphi.de/en/news/call-experts-developing-iso-standard-vulnerability-assessments>

A significant resource is the 2011 Guidance by JASPERS on how to complete the [Funding Application for Broadband Projects](#). The majority of Member State representatives (managing authorities, industry associations, research centres, etc.) contacted in the framework of the study offered few if any resources or information on developments in the broadband sector relating to climate adaptation. Major projects in the broadband sector need to comply with the requirements set out in the Common Provisions Regulation and its implementing acts. An [Overview of EU Funding for Broadband](#) is available, where it is stated that 6 126 Million Euros have been made available for broadband projects in the 2014 – 2020 investment period by EU MSs. It is found that broadband services can be used to improve the ability of a city to adapt to climate change: the 'I-Sand project' developed broadband services to be able to better realise the coordination of relief measures relating to climate change adaptation through a prototypical monitoring system.

- **Urban development** - Climate change adaptation projects relating to urban development are often delivered through spatial planning. In most Member States, municipalities are encouraged to develop adaptation plans. Openly available material to assist project planners in this sector includes regional planning policy, for example [witboek ruimte Vlaanderen, Kettingplein](#), the [Cascais Municipality](#) project or the development of a [National Spatial Strategy](#). Support to the development of local adaptation strategies may also be nationwide: the [Urban Adaptation Plans \(2016-2019\)](#) project, for instance, co-financed under Cohesion Fund (OP Infrastructure and Environment 2007-2013), aims at increasing adaptive capacity in cities with more than 100,000 people. The development of so-called "climate-proof neighbourhood" in several cities promotes the integration of future climate parameters into the urban infrastructure. This can be done with the use of tools such as the [Cloud-based Flood Prevention and Monitoring System](#) to support the integration of flood risk into the risk assessments, or [guidance](#) on developing solutions against the urban heat island effect. The tool [Adaptation Compass](#) supports the development of climate-proof area by checking vulnerability and adaptation potentials through data acquisition and coordination.
- **Energy** - Most countries have an analysis of the vulnerability of the energy sector to climate change. For several countries, taking the vulnerability of their transmission network into account, the development of [specific design standards for underground cables](#) can be a solution to improve the resilience of the electricity distribution network. Other countries have dedicated specific attention to adaptation in connection with new or existing hydropower, as dams mitigate the increased variation of river discharge. To support the integration of climate change and relevant adaptation measures into the business strategies of energy infrastructure, methodologies have been developed as part of specific projects, such the [ENDESA Pilot Case](#), and could be replicated.
- **Water** - The water sector is found to be well prepared and relatively active in climate change adaptation. Following the EU Floods Directive (2007/60/EC), all Member States are obliged to take climate change into account in their flood risk maps and flood risk management plans. Additionally, Member States need to comply with the ESIF requirements set in the Common Provisions Regulation. Member States also adjust their sewer system to account for heavy rainfall. A vast amount of tools are available for the water sector, including one for [integral adaptation strategies](#) to mitigate flooding effects. There is, typically, good practice universally in the areas of flood management, and sustainable drainage¹⁵, supported by the [adoption of adapted design standards](#). Projects funded through the Cohesion Fund aiming to increase the resilience of water systems often involved the improvement of linkage between separate distribution systems and improved

¹⁵ Sustainable Drainage Systems (SUDS) is a generic term used in the UK to refer to various measures aimed at controlling surface water runoff (and associated flooding and pollution problems) from urban catchments. Examples of SUDS include green roofs, soakaways, swales, infiltration trenches ponds and wetlands.

drainage. Project examples include the 'Iterative Climate Risk Management' report and KerkeBEEK's [flood risk management and implementation plan](#). Focus is also given on the effects of climate change on river basins, models and tools (e.g. [CLIMHYDEX](#)) are to develop long term forecast of the impacts of not only climate change but also land management in order to adapt Water Basin Management Plans and take relevant measures.

- **Waste** - There were few examples of a climate change adaptation response in the waste sector that were found during the course of this study. Generally the sector uses general advice applicable to infrastructure. An example was the Landfill park development at Nauerna (Netherlands), which aims to redevelop the current landfill Nauerna in Assendelft into a future public nature and recreation area. Additionally, when Member States apply for EU funding for major projects in this sector, they need to comply with the ESIF requirements set in the Common Provisions Regulation.

Conclusions

Major infrastructure projects incorporating climate change adaptation require information prior to their development, such as access to data, guidance documents and climate-specific design standards in order to retrieve the relevant information.

As identified in this report, there is currently a wide range of resources relevant for climate change adaptation available to infrastructure developers across different Member States and sectors. All the identified resources featured in the present report have been split to EU-level resources (i.e. Guidance by the European Commission), and Member-state resources (i.e. national adaptation plans, or publications from local research institutes). EU-level resources are found in this present final report at the chapter *Available resources at the EU level*, and in *Annex I: EU level additional resources*, while they are also featured in the accompanying country reports. Complementary to those, Member State resources are found primarily in the country reports, while the most prominent resources are featured in the final report's chapter titled *Summary of resources on the Member State level*. All identified publications, research projects, web platforms etc. are compiled in *Annex II: References*, which numbers more than 1800 entries. Moreover, the country reports contain case studies of climate adaptation projects -be they infrastructure projects or research projects- and a selection of those is also featured in the present report in the chapter *Case studies of sectoral good practices*. The full list of all case studies is compiled in *Annex V: List of case studies*.

Opportunities remain for all Member States to develop their capacities (in research, administration, financing), industries (development of new products and solutions) and infrastructure (resilient design, ecosystem-based approaches, necessary retrofits) to meet the challenges that Europe is beginning to face from the increasing impacts of climate change. The EU has realised the urgency to act on this front, and is supporting national processes through ESI Funds investment and the mainstreaming of climate change into legislation, funding and financing priorities, as seen in the priorities of the EIB and of the Horizon 2020. The opportunity to adapt existing systems and infrastructure priorities is laid out for Member States to take ownership of and secure a resilient future, therefore avoiding the potential billions of euros lost from the increasing frequency and impact of natural disasters.

Readers' guide

The **Executive Summary** provides a short description of the overall project findings and conclusions. While it offers a general direction and a snapshot of the progress of climate adaptation resources, more numerous information is to be found in the rest of the report, and especially in the country reports.

The **Project overview** chapter, presents the background, objectives and methodology of the study. It is not a necessary reading for climate adaptation but it offers the reader an understanding of the scope of work and its limitations.

The next chapter, **Context**, provides a more in depth overview of the context for the study, including a description of the policy, legal and financial framework at EU level for integrating climate change adaptation in infrastructure projects.

In the chapter on **Available EU level resources**, the introduction provides information on three types of sources that hold an abundance of material, being the European Climate Adaptation Platform Climate-ADAPT, European research projects (FP7 or HORIZON 2020) and city networks. The availability of material is then discussed covering: climate change data and information, methodologies, tools, guidance, design standards, system and legal framework and institutional capacity. There is some overlap between system and legal framework and institutional capacity and the context provided in the chapter 'Project Review'. Therefore reference is made to the related sections.

In the chapter on the **Summary of resources on the Member State level**, the country reports of the 28 Member States are summarised. Context, institutional framework, most relevant resources and sector level information are briefly described. The purpose of this section is to provide an overview of the material found in the country reports and as thus it is not a replacement for them. For better information, please consult the individual country factsheet reports in annex. In the table below, an overview of number of identified resources for each country is presented.

The chapter **Case studies of sectoral good practices**, contains a diverse selection of case studies. The selected case studies present good practices across the EU, which are replicable, innovative, have added value and for which data should be available. The individual country factsheet reports in annex contain additional case studies.

In the final chapter **Conclusions**, the main findings and conclusions are presented, including areas for further opportunities in the development of climate adaptation practice in infrastructure projects.

The **Annexes**, include additional resources at EU Level, a reference list of all resources found in this study and country reports, a list of consulted stakeholders, a list of all identified case studies, and a list of abbreviations. The majority of resources are to be found in the 28 individual Member State factsheet reports, which are included in the annexes.

For readers mainly interested in **country-specific information**, we refer to the country factsheet reports.

For readers mainly interested in **sector-specific information**, we refer to chapter *EU level resources* of this final report, the Annex I as well as to '*Chapter 4. Sector overview*' of the country factsheet reports. In *annex I on EU level additional resources*, the mentioned sources are listed in a table. One of the columns states which sectors are addressed in a specific source. The case studies also hold inspiring good practices in different sectors.

Each section of the **country reports** found in the annex can be read as a stand-alone text. When specific material is relevant both for a specific sector, and for a resource category

(i.e. Tools) then it is included in both sections. The following table presents the number of resources found for each section and sector, per Member State.

| Identified resources | Data Availability | Methodologies | Tools | Guidance | Design standards | System | Institutional capacity | Transport | Broadband | Urban Development | Energy | Water | Waste | Case studies |
|----------------------|-------------------|---------------|-------|----------|------------------|--------|------------------------|-----------|-----------|-------------------|--------|-------|-------|--------------|
| EU | 60 | 27 | 28 | 18 | 39 | 22 | 23 | | | | | | | |
| Austria | 16 | 12 | 7 | 9 | 3 | 7 | 7 | 5 | 4 | 10 | 11 | 14 | 7 | 2 |
| Belgium | 50 | 24 | 22 | 22 | 12 | 31 | 11 | 17 | 5 | 27 | 10 | 32 | 8 | 3 |
| Bulgaria | 12 | 4 | 5 | 4 | 3 | 12 | 8 | 6 | 3 | 6 | 3 | 13 | 7 | 1 |
| Croatia | 17 | 2 | 8 | 2 | 4 | 23 | 13 | 1 | 2 | 1 | 0 | 12 | 4 | 1 |
| Cyprus | 15 | 5 | 11 | 3 | 3 | 8 | 12 | 5 | 4 | 5 | 3 | 9 | 4 | 3 |
| Czech Republic | 23 | 3 | 9 | 3 | 4 | 5 | 9 | 13 | 4 | 7 | 5 | 15 | 3 | 0 |
| Denmark | 16 | 5 | 10 | 8 | 3 | 17 | 16 | 16 | 1 | 7 | 4 | 15 | 4 | 2 |
| Estonia | 33 | 8 | 10 | 15 | 5 | 16 | 9 | 3 | 3 | 7 | 3 | 12 | 5 | 5 |
| Finland | 20 | 3 | 12 | 8 | 4 | 19 | 11 | 5 | 6 | 7 | 6 | 10 | 5 | 2 |
| France | 28 | 4 | 18 | 10 | 4 | 13 | 12 | 11 | 10 | 7 | 6 | 13 | 4 | 2 |
| Germany | 25 | 8 | 14 | 3 | 10 | 18 | 8 | 4 | 3 | 10 | 2 | 18 | 4 | 3 |
| Greece | 14 | 14 | 6 | 2 | 4 | 6 | 5 | 6 | 3 | 5 | 2 | 9 | 4 | 3 |
| Hungary | 23 | 8 | 7 | 5 | 3 | 9 | 8 | 3 | 8 | 8 | 4 | 13 | 9 | 2 |
| Ireland | 26 | 1 | 11 | 4 | 4 | 13 | 11 | 4 | 3 | 4 | 2 | 7 | 2 | 3 |
| Italy | 10 | 7 | 6 | 10 | 5 | 7 | 3 | 0 | 2 | 5 | 0 | 11 | 3 | 2 |
| Latvia | 25 | 2 | 6 | 4 | 3 | 12 | 12 | 2 | 3 | 4 | 4 | 12 | 5 | 1 |
| Lithuania | 31 | 4 | 5 | 6 | 4 | 19 | 14 | 8 | 3 | 3 | 2 | 9 | 5 | 1 |
| Luxembourg | 10 | 2 | 9 | 5 | 3 | 9 | 4 | 4 | 2 | 11 | 2 | 16 | 5 | 2 |
| Malta | 7 | 4 | 5 | 3 | 3 | 14 | 9 | 0 | 1 | 0 | 0 | 10 | 4 | 1 |
| Netherlands | 30 | 7 | 10 | 18 | 4 | 13 | 10 | 16 | 7 | 27 | 7 | 18 | 12 | 3 |
| Poland | 13 | 7 | 8 | 8 | 5 | 9 | 2 | 12 | 4 | 9 | 4 | 13 | 6 | 2 |
| Portugal | 15 | 6 | 10 | 8 | 3 | 12 | 5 | 3 | 2 | 6 | 2 | 9 | 6 | 3 |
| Romania | 24 | 7 | 8 | 6 | 3 | 12 | 8 | 3 | 3 | 2 | 3 | 22 | 3 | 4 |
| Slovakia | 8 | 3 | 4 | 3 | 2 | 21 | 2 | 9 | 5 | 5 | 4 | 12 | 5 | 3 |
| Slovenia | 11 | 7 | 7 | 9 | 3 | 10 | 4 | 1 | 1 | 3 | 1 | 12 | 3 | 2 |
| Spain | 20 | 3 | 10 | 7 | 3 | 17 | 4 | 20 | 2 | 12 | 4 | 17 | 4 | 3 |
| Sweden | 25 | 3 | 17 | 11 | 3 | 30 | 6 | 7 | 2 | 9 | 3 | 12 | 4 | 3 |
| United Kingdom | 17 | 6 | 21 | 23 | 8 | 16 | 13 | 16 | 9 | 13 | 15 | 13 | 7 | 3 |

Disclaimer: The identified resources (see Annex II: References) are non-exhaustive and present a snapshot of the readily available and accessible material identified during 2017. This information was collected through finite web-based desk research, and through questionnaires and interviews aimed at the relevant national competent authorities (managing authorities, research institutes, ministry officials, etc.). Further resources might be available but not accessible due to privacy restrictions, or a lack of mandate to share related material. Since the publication of the present report, more resources will continue

to reach the public domain, including through Climate-ADAPT and the identified national websites.

Project overview

Background

The European Commission, Directorate-General for Regional and Urban Policy has commissioned Ernst & Young and Arcadis to produce the present report on climate change adaptation through a stock-taking of the existing situation both on the EU and the Member States level, with special attention to major infrastructure projects³. The assignment covers all twenty-eight Member States and all of the infrastructure sectors¹⁶ represented by the Major Projects portfolio for the European Regional Development and Cohesion Funds. This report:

- Presents the findings of the stock-taking exercise; incorporating results on both a European-wide and individual Member State level;
- Identifies strengths and gaps on a selection of resources¹⁷ necessary to assist those involved in the development of an infrastructure project (see "Project Overview" for further information); and
- Outlines good practice case study examples, by sector, of the integration of climate change adaptation and resilience into infrastructure projects.

Across the European Union, significant experience is being developed on making essential infrastructure resilient to climate change impacts, such as frequent extreme weather phenomena. The present report provides a resource for Member States and project developers to adapt infrastructure projects to climate change. It helps to identify good practices and available resources across the EU for undertaking high quality climate change adaptation, vulnerability and risk assessments in project preparation, and integrating climate change adaptation into the development of infrastructure projects.

In order to carry out this assignment, Ernst & Young and Arcadis initially conducted a desk-based literature review of relevant climate change adaptation data and documentation, before undertaking in country-specific interviews for all 28 EU Member States. This ensured there was appropriate stakeholder engagement and consultation.

Objective

Experience indicates that there are differences between various EU Member States and between infrastructure sectors in terms of addressing the requirements and assessing the climate resilience of projects. The purpose of this assignment is to provide information on the resources made available by different Members states to enable identification of areas of good practice as well as areas where additional focus may be beneficial.

The Common Provision Regulation for ESI Funds requires Member States to "take into consideration the climate change mitigation and adaptation potential of investments made with the support of the ESI Funds, in accordance with Article 8, and ensure that they are resilient to the impact of climate change and natural disasters such as increased risks of flooding, droughts, heat waves, forest fires and extreme weather events. Moreover, Managing authorities shall undertake actions throughout the programme lifecycle, to avoid or reduce environmentally harmful effects of interventions and ensure results in net social, environment and climate benefits."¹⁸

¹⁶ Transport, Broadband, Urban Development, Energy, Water and Waste

¹⁷ Data Availability, Methodologies, Tools, Guidance, Design Standards, System, and Institutional Capacity

¹⁸ Common Provisions Regulation (EU) No 1303/2013, point 5.2 of Annex I

Therefore, this study is an opportunity to provide an overall stock-taking of resources available for all Member States with regards to applying the climate change requirements of the 2014-2020 programming period, as well as obtain early good practices which will be shared between Member States in order to recognise the lessons learnt.

Structure

This project followed three phases, including interviews with key stakeholders, a desk-based review of available resources, and the preparation of the present report.

The structure of the project consists of two main elements; a stock-taking exercise and good practice case studies. The stock-taking exercise is an assessment on both a European and Member State level, covering an analysis of the current situation with regard to the available resources for undertaking good quality climate change adaptation vulnerability and risk assessment in project preparation in the following areas:

| Resources | Explanation |
|-------------------------------|--|
| Data Availability | The availability, accessibility and applicability of data on climate projections and impacts, on geophysical parameters, on long-term scenarios, on economic, environmental and social impacts, etc. |
| Methodologies | The existence of quantitative or qualitative methodologies (a system of processes, a set of principles and rules) for integrating climate change adaptation in the development of infrastructure projects. |
| Tools | The availability of tools for planning, evaluation, impact estimation (i.e. software, maps, computer simulations, long term climate forecast visualisations etc.) to assist with the adaptation of infrastructure to climate impacts |
| Guidance | The provision of guidance on how to use methodologies (i.e. for conducting climate change vulnerability and risk assessments) or develop the required infrastructure project documentation relating to climate adaptation. |
| Design Standards | The availability of published engineering design standards (i.e. by BSI, DIN, ISO) for infrastructure projects that include sections or appropriate provisions to ensure resilience to climate change impacts |
| System | The institutional and legal framework that the formal authorities work with to deliver their primary responsibilities for climate adaptation, infrastructure, and management of European Structural and Investment Funds ¹⁹ |
| Institutional Capacity | The human and technical capacity of institutions to carry out their functions. It depends on being adequately resourced, on having the appropriate expertise, and on collaborating effectively and enforcing laws and regulations |

The stock-taking exercise undertaken found Member States to show a variable level of availability of the defined resources. When local resources are not particularly well-

¹⁹ The term 'Formal authorities' in this study refers to those government ministries or agencies who are responsible for climate adaptation, including for the provision of resources to stakeholders who wish to achieve ESI Funds.

developed in a Member State, the default position is to seek EU-level guidance for each resource.

The project has also gathered good practice case study examples of the integration of climate change adaptation and resilience into infrastructure projects. The case studies reflect a variety of Member States, geographical locations and sectors, presented in a standardised manner to allow an easy dissemination of key messages.

Phase I

Phase I entailed interacting with key stakeholders (DG REGIO, DG CLIMA, DG ENV, JASPERS and others) through face-to-face, phone or video conferences; with an identification of potential types of case studies and an initial expected outcome for the assignment.

Phase II

Phase II focused on the desk study literature review of all relevant documentation, including online sources. The assignment aimed to gather detailed and up-to-date information in order to establish baseline information and set a context for detailed mapping. Some of the documentation included:

- Climate adaptation and infrastructure projects, including the EU Adaptation Strategy providing guidance for project managers on how to make vulnerable investments climate resilient;
- EC material relating to existing adaptation initiatives;
- Material from other international agencies (e.g. UNFCCC and JASPERS); and
- Country-specific documents published by Governments, Institutions, Environmental Agencies and Development Agencies, among others.

Phase III

Phase III consisted of country-specific interviews based on the key priorities in the desk study. Country-specific interviews by phone or video conference identified interlocutors in all 28 EU Member States and aimed to identify the following:

- Additional resources not gathered in the desk study;
- Case study examples and/or a review of draft examples;
- Institutional framework addressing climate change adaptation strategies specific to projects;
- Ongoing initiatives; and
- Perspectives of strengths, weaknesses, desired knowledge and capacity gaps.

This report draws on all the information gathered at each stage of the assignment to present the outcome of the stock-taking exercise; incorporating the results of the mapping, and ultimately drawing conclusions on the key findings in each Member State.

Context of the study

Atmospheric build-up of greenhouse gas emissions (GHGs) has altered the energy balance of the Earth's climate system and has resulted in significant climate changes that are increasingly felt in Europe and worldwide, according to the Working Group I (WGI) contribution to the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5). The global average of land and ocean surface temperatures has increased, along with ocean acidity levels. All of these changes have magnified the existing risks affecting the biosphere, also with implications for societies and economies. Moreover, the impact of man-made climate change will continue to increase in the coming decade, even if emissions are completely mitigated, due to the delayed impacts of past and current GHGs. Therefore, it is essential that natural and human systems develop adequate adaptive responses to avoid the risks posed by climate change, and even take advantage of any opportunities that may arise.

Climate change adaptation considerations are integrated in the preparation and approval of major projects.²⁰ Adaptation seeks to ensure adequate resilience of major projects to the adverse impacts of climate change, for example flooding, based on a vulnerability and risk assessment. Mitigation, on the other hand, seeks to reduce the emissions of greenhouse gases, for example by implementing low-carbon energy options.

Major projects that are funded by the European Regional Development Fund (ERDF) and the Cohesion Fund are listed in the concerned operational programmes. A [major project](#) has a total eligible cost exceeding € 50 million (and € 75 million for e.g. transport projects)²¹, with a qualified list of around 500 major projects foreseen during the period 2014-2020, and where climate change adaptation and mitigation considerations are to be integrated in the preparation and approval of major projects.

The regulatory requirements for major projects are found at the website of DG REGIO outlining the [European Structural and Investment Funds Regulations for 2014-2020](#), and are hereby listed in Figure 1.

A Strategic Framework on Adaptation

The Adaptation White Paper "Adapting to climate change: Towards a European Framework for action" (EC, 2009) set out a framework to reduce the EU's vulnerability to the impact of climate change. The paper was a continuation from the Green Paper (2007) with further research efforts that identified action to be taken in the short-term. In 2013, the [EU Adaptation Strategy](#) to climate change was adopted by the EC, and set out a framework and mechanisms to ultimately ensure the EU is more prepared for current and future impacts of climate change. It aims to allow Member States to have a systematic exchange of best practice on how to adapt to climate change, covering the whole of the EU, and to develop a coherent approach and improved coordination of adaptation action. The strategy includes eight actions, which among others include provisions to ensure more resilient infrastructure and to facilitate the climate proofing of the Cohesion Policy. As part of the Adaptation Strategy package the European Commission has provided [guidelines to help Member States formulate adaptation strategies](#), and developed [guidelines for project managers on how to make vulnerable investments climate resilient](#). Additional relevant regulatory documentation can be found at the website of the EU Adaptation Strategy.

Table 1: the eight actions of the EU Adaptation Strategy

EU Adaptation Strategy

²⁰ There are also legal requirements around the consideration of climate change adaptation with major projects, as shown in Figure 1.

²¹ See Footnote 3 referring to Article 100 of the Common Provisions Regulation for the definition of major projects

| | |
|----------|---|
| Action 1 | Encourage all Member States to adopt comprehensive adaptation strategies |
| Action 2 | Provide LIFE funding to support capacity building and step up adaptation action in Europe (2013-2020) |
| Action 3 | Introduce adaptation into the Covenant of Mayors' framework (2013/2014) |
| Action 4 | Bridge the knowledge gap |
| Action 5 | Further develop CLIMATE-ADAPT as the 'one-stop shop' for adaptation information in Europe |
| Action 6 | Facilitate the climate-proofing of the Common Agricultural Policy (CAP) the Cohesion Policy and the Common Fisheries Policy (CFP) |
| Action 7 | Ensure more resilient infrastructure |
| Action 8 | Promote insurance and other financial products for resilient investment and business decisions |

The implementation of the Adaptation strategy relies on the implementation of related legislation, policies and funding sources such as the [Floods Directive](#) (2007/60/EC), the EU Strategy on [Green Infrastructure Strategy](#) (COM (2013)249 final) and the [LIFE funding 2014-2020](#) (EC No 1293/2013). For the Floods Directive, Member States have to develop a flood risk management plan, with the specific requirement to take into account the climate change projected changes for the prediction of future floods and expected impacts, including a socio-economic analysis.

The EU Strategy on Green Infrastructure aims to ensure that the protection, restoration, creation and enhancement of green infrastructure becomes an integral part of spatial planning and territorial development whenever it offers a better alternative, or is complementary, to standard grey choices. Climate change adaptation actions are closely linked to Green Infrastructure as often Green Infrastructure can serve as an adaptation measure, e.g. floodplain restoration, urban green to counteract the urban heat island effect, etc. The [LIFE Funding](#) for climate action ensures demonstration and innovative projects with the objective of climate adaptation can be funded and ensure an increased resilience to climate change.


Furthermore, the climate resilience of infrastructure investments is pursued through e.g. mainstreaming climate adaptation in all relevant EU policies, climate proofing these policies (Action 6) and ensuring climate-resilient infrastructure (Action 7).

The 2014-2020 programming period is the first where climate considerations went from being a voluntary action to being included in the legal framework for preparation and implementation of programmes and projects. This is addressed through various provisions: In the 2014-2020 programming period, the European Structural and Investment Funds support investment priorities to promote climate change adaptation, risk prevention and management ([Mainstreaming of Adaptation into the ESIF 2014-2020](#)). EU Cohesion Policy, managed by the European Commission's Directorate-General for Regional and Urban Policy (DG REGIO), specifically promoted a consideration of climate impact and opportunities, i.e. mainstreaming adaptation²² in project proposals that request co-funding. This has been included in the legal basis for the funds as a horizontal requirement, and explained in a draft thematic guidance fiche for desk officers "[Climate Change Adaptation, Risk Prevention](#)

²² Action 6 of the Climate Adaptation Strategy

and Management, Version 2 – 20/02/2014”, following on from the DG CLIMA “Methodologies for Climate Proofing Investments and Measures under Cohesion and Regional Policy and the Common Agricultural Policy” and the ‘Non-paper guidelines for project managers’.

The 2015 UNFCCC Paris Agreement ensured that worldwide, climate change concerns were taken seriously. The international commitments made in Paris included national strategies on lowering emissions, and also aimed to ensure action is taken in the area of climate adaptation. Furthermore, the 2030 Agenda for Sustainable Development also included a worldwide goal to take urgent action to combat climate change and its impacts, and aimed to ensure cities and human settlements were resilient and sustainable.



Legal Basis

| | |
|--|---|
| <p>Common Provisions Regulation (EU) No 1303/2013</p> | <p>The Common Provisions Regulation (CPR) lays down a single set of rules covering the EU’s five Structural and Investment Funds (the ESI Funds). Amongst other climate change requirements, Article 101 sets the requirements for the information necessary for the approval of a major project, stating the need for ...“<i>taking into account climate change adaptation and mitigation needs and disaster resilience</i>”.</p> |
| <p>Commission Delegated Regulation (EU) No 480/2014</p> | <p>Annex II of Commission Delegated Regulation (EU) No 480/2014 sets the quality review criteria against which the information provided on a major project is assessed. Criterion 6.1 states: “<i>Demonstrated contribution to the objectives of environmental and climate change policies, in particular targets linked to the Europe 2020 strategy and evidence of account being taken of the risks related to climate change, adaptation and mitigation needs, disaster resilience and of appropriate measures implemented or foreseen to ensure resilience of the project to climate change variability</i>”</p> |
| <p>Commission Implementing Regulation (EU) No 1011/2014</p> | <p>Annex I, Part B of Commission Implementing Regulation (EU) No 1011/2014 sets the format for the Independent Quality Review (IQR) Report. Criterion 7.2 States: “<i>Summarise relevant information on the climate change adaptation and mitigation, and disaster resilience. Give a clear statement whether or not the project meets the relevant criteria for quality review</i>”</p> |
| <p>Commission Implementing Regulation (EU) No 2015/207</p> | <p>CIR 2015/207 lays down detailed rules implementing Regulation (EU) No 1303/2013. This includes the format for submission of the information on a Major Project in Annex II (specifically sections D.2, D.3, E.2, E.3 F.1 and F.8 refer to climate change) and the methodology for carrying out the cost-benefit analysis in Annex III (specifically sections 2.1.4, 2.3.3 and 2.4 refer to climate change).</p> |

4

Figure 1: The different legislative provisions for major project appraisal and their links to climate change adaptation requirements (Source: JASPERS and DG REGIO webpage on ESI Funds Regulations 2014-2020)

Major projects are subject of a specific approval procedure where the European Commission decides whether to approve the co-financing of the project. Climate change considerations form part of that approval process.

JASPERS (‘Joint Assistance to Support Projects in European Regions’) is a technical assistance partnership between the European Commission and the European Investment Bank. Its purpose is to promote the efficient use of EU Structural Funds, thereby stimulating future investment. JASPERS advises Member States and assesses projects by the Member States as part of the different approval processes contained in the legislative framework. JASPERS provides advice at all stages of the project development cycle, this includes, amongst other topics, advice on climate change, to support the development of sustainable, low carbon and climate resilient projects. The advice JASPERS provides on climate change is prepared on behalf of and in close cooperation with DG CLIMA and DG REGIO.

From the perspective of the project managers, developing project dossiers and requiring funding, guidelines were developed through "[Guidelines for Project Managers: Making vulnerable investments climate resilient](#)". These Guidelines indicate the climate impacts on economic sectors including transport, construction and buildings, energy supply as well as the water infrastructure sector. It also gives a baseline assessment of climate change impacts for the various EU Member States. The guidelines have been further developed and summarised (with references to the legal basis) in the [brochure](#) "Climate change and major projects" published on DG CLIMA's website. In order to assist managing authorities and beneficiaries in addressing climate change concerns in the development of their projects, JASPERS, through their networking platform, organised a series of seminars (i.e. a [seminar](#) entitled on climate change requirements was held on 6 December 2017) providing further clarifications on the climate change related requirements for major projects.

Ex-ante conditionalities are one of the key elements of the cohesion policy reform for 2014-2020. They were introduced for the European Structural and Investment Funds (ESI Funds) to ensure that the necessary conditions for the effective and efficient use of ESI Funds are in place. Ex-ante conditionality 5 on Risk Prevention and Risk Management, which is funding pre-condition for the investments under thematic objective 5, requires the existence of national or regional risk assessments for disaster management taking into account climate change adaptation. One of the criteria for fulfilment is the taking into account, where appropriate, national climate change adaptation strategies. This is translated into two requirements:

- National climate change adaptation strategies address the impact of climate change on health, agriculture and forest, biodiversity and ecosystems, water, coastal and marine areas, and infrastructures and constructions.
- The Climate change adaptation strategies have been taken into account to prioritise the investments to address specific risks, ensuring disaster resilience and developing disaster management systems

Action 1 of the EU Adaptation Strategy encourages all Member States to adopt comprehensive adaptation strategies. These climate adaptation plans or strategies provide the relevant state-of-the-art on planned actions of a Member State in the consideration of climate adaptation into national and regional policies, and often provide an overview of relevant sources, tools and methodologies developed at the national level. Up to date, adaptation strategies for 25 Member States have been finalised, with remaining strategies under development. Where relevant, these plans are discussed in the specific country reports.

In May 2014, a newly amended [Environmental Impact Assessment \(EIA\) Directive](#)²³ entered into force, introducing [requirements](#) under Article 3 (1) to identify, describe and assess in an appropriate manner, in the light of each individual case, the direct and indirect significant effects of a project on a number of factors, including "*land, soil, water, air and climate*", where it is further clarified in ANNEX IV that impacts relevant to climate adaptation are to be included.

²³ 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 Text with EEA relevance

Available resources at the EU level

The Adaptation Strategy's key objective is to provide knowledge to all stakeholders. [Climate-ADAPT](#)²⁴ is the climate change adaptation web portal for the EC²⁵, where most information at EU level can be found. Climate-ADAPT, the European Climate Adaptation Platform, is a partnership between DG CLIMA of the European Commission and the European Environment Agency (EEA). The most important tools, methodologies, guidance, etc. provided on the platform, or developed for the platform, that are relevant for infrastructure projects are found in Annex I and the chapters on the seven criteria²⁶.

'[The Map Book Urban Vulnerability](#)' provides, for instance, access to exposure, sensitivity and response capacity indicators and data for a selected set of cities. Another example is the '[Urban Adaptation Support Tool](#)', which provides guidance for cities and (regional) administrations to set up their own climate change adaptation plan and policy. The Tool links to additional support material, such as data sources or specific methodologies.

Climate-ADAPT has some high-level information related to CCA within sectors. With regard to these six defined sectors (Broadband, Energy, Transport, Urban, Water, and Waste), they are often not explicitly mentioned in EU-level adaptation information sources. While Energy, Transport and Water are mentioned the most, they are often included in publications on 'urban' adaptation. Larger building sites and areas of development are also covered in urban development. Several information sources, such as the [Open European Day Report](#) by ICLEI (2016), imply that extensive climate change adaptation information is being developed at city level. Telecommunications is mentioned in only a few research projects. For both the Waste and Broadband sectors, there is little qualitative climate change sensitivity information, nor specific potential climate change adaptation measures or approaches. This is an emerging topic that is in progress.

The EEA has a duty to provide information sharing and knowledge building in relation to climate adaptation (Action 4 of the Adaptation Strategy), and has published various climate change adaptation reports. The EEA report '[Urban Adaptation to Climate Change in Europe](#)' (2016) states: "There are not enough studies of some cross-sectoral aspects of climate impacts, for instance cascading impacts of climate change on urban services such as transport, electricity supplies, water, food and health services. ..." The increasingly emphasised link between climate change adaptation and disaster risk prevention and management seems to provide a partial answer to this issue. The EEA has recently published "[Climate change adaptation and disaster risk reduction in Europe](#)" in order to contribute to a better informed EU, national and subnational strategies, plans and processes for enhancing coherence between climate change adaptation and disaster risk management action. The '[National climate change vulnerability and risk assessments in Europe, 2018](#)' report provides a review of national climate change impacts, vulnerability and risk assessments across Europe, while at the same time providing lessons learned and knowledge from good examples.

In addition, the following projects funded by the EC through FP7 or Horizon2020 are relevant in terms of their key contribution towards data and information, tools and methodologies or standard development. Some case studies include relevant applications of climate considerations in specific sectors and regions. Key projects are included below. These comprise the most recent projects with key outputs that are of relevance for consideration of climate adaptation integration into (major) projects. Most information, guidance and tools developed through these projects are mainly of relevance towards urban development and planning. However, some of the outputs integrate various

²⁴ this report is based on the content of Climate-ADAPT in October 2017

²⁵ A more detailed analysis of the available climate data and information, methodologies, tools, guidance, design standards, and info on legal & system framework and institutional capacity is listed in the relevant chapters. Only material that is relevant for infrastructure projects is mentioned. As such, this chapter does not contain a full overview of available information on Climate-ADAPT. It is also important to note that Climate-ADAPT is regularly updated and as such, it is worthwhile to check the website for new information on climate change adaptation approaches in the different sectors.

²⁶data, methodologies, tools, guidance, design standards, legal and system framework and institutional capacity

stakeholders and sector needs, delivering practical outputs for these sectors through the case studies. These key projects are outlined in the Table below.

| Name | Information |
|-----------|---|
| RAMSES | <p>In progress- http://www.ramses-cities.eu/home/ RAMSES stands for Reconciling Adaptation, Mitigation and Sustainable Development for citiES. The Transition Handbook embeds the most important findings from the project in a process management cycle, using the Urban Adaptation Support Tool developed by the European Environment Agency. The project results are synthesised in a step-by-step resource presentation that cities can use to strengthen their knowledge of climate adaptation planning. The Training Package complements the Transition Handbook by taking stock of existing toolkits to support adaptation management in cities, and proposes worksheets and exercises that cities can use to progress on their adaptation endeavours. The worksheets complement the information contained in the Transition Handbook and offer cities a clear path towards becoming more climate adaptive.</p> <p>Of particular interest are the result pages, which have in-depth methodologies, climate information and guidance. A few examples are: adaptation cost curves, cost calculation methodologies, an assessment of climate impacts for the transport, energy and urban sectors.</p> |
| RESIN | <p>In progress- http://www.resin-cities.eu/home/</p> <p>RESIN is an interdisciplinary, practice-based research project investigating climate resilience in European cities. Through co-creation and knowledge brokerage between cities and researchers, the project is working on developing practical and applicable tools to support cities in designing and implementing climate adaptation strategies with a local context. The project aims to compare and evaluate the methods that can be used to plan for climate adaptation in order to move towards formal standardisation of adaptation strategies. Final results will include a vulnerability and impact assessment method and a measures library.</p> |
| EU CIRCLE | <p>http://www.eu-circle.eu/ EU-CIRCLE’s scope is to derive an innovative framework for supporting interconnected European Infrastructure resilience to climate pressures, supported by an end-to-end modelling environment where new analyses can be added anywhere along the analysis workflow. It also allows multiple scientific disciplines to work together to understand interdependencies, validate results, and present findings in a unified manner. This provides an efficient “Best of Breeds” solution, integrating into a holistic resilience model with existing modelling tools and data in a standardised fashion. The project’s research organisations are working in close partnership with the project’s 4 core cities; Paris, Manchester, Bratislava, and Bilbao.</p> |
| RESCUE | <p>http://www.resccue.eu/ RESilience to cope with Climate Change in Urban arEas, is a multi-sectoral approach focusing on water. Cities included are Bristol (coastal, river and pluvial flooding, droughts and sea-level rise) Barcelona (urban flooding, combined sewer overflow during heavy storm events, droughts, heat waves and sea level rise), Lisboa (urban flooding, sea-level rise and derived coastal erosion and heat waves). Methods applied will be replicable for other cities with similar characteristics and</p> |

| | |
|-------------------------------|--|
| | climate issues. Outputs will include hazard, risk and vulnerability assessment for urban services operation, resulting in a resilience and adaptation strategy ready for market uptake for each of the cities. |
| Mediation | http://www.mediation-project.eu/ Methodology for Effective Decision-making on Impacts and AdaptATION. Objective: integrate, consolidate and enhance access to the existing knowledge in the proper context of local, regional and sectoral application, methods and data. Adaptation Platform provides three interlinked Core Elements - the Adaptation Pathfinder, the Toolbox, and the Case Study Navigator |
| Urban Adaptation Support tool | http://climate-adapt.eea.europa.eu/knowledge/tools/urban-ast The Urban Adaptation Support Tool (Urban AST) was developed as a practical step-by-step guidance tool to assist signatories of the Mayors Adapt, and the now integrated Covenant of Mayors for Climate and Energy initiative, in planning for and taking adaptation action. The tool is available through the Climate-ADAPT platform. |
| EU cities adapt | The EU cities adapt project provided capacity building and assistance for cities in developing and implementing an adaptation strategy, and additional technical support to DG CLIMA on the state of play of urban adaptation. Its objective is to raise awareness, help knowledge exchange and good practice and development of tools and guidance on how cities can adapt to climate change. 6 adaptation tools / methodologies were analysed in depth, a long list of 50 tools is also included (see annex 6 of the Adaptation Strategies for European Cities final report). Many of the tools have a focus on policy, but the Baltic Climate tool also targets businesses. The report is mainly useful for (local) authorities, looking to increase their (adaptation related) institutional capacity. |
| Placard | http://www.placard-network.eu/ PLACARD's (PLatform for Climate Adaptation and Risk reDuction) mission is to be the recognised platform for dialogue, knowledge exchange and collaboration between the Climate Change Adaptation (CCA) and Disaster Risk Reduction (DRR) communities. |
| WeAdapt | http://www.weadapt.org weADAPT is a collaborative platform on climate adaptation issues. It allows practitioners, researchers and policy-makers to access credible, high-quality information and connect with one another. It began as a UK initiative but currently includes worldwide research and adaptation cases. It is especially meant to be a knowledge-sharing platform. |

Various other projects are included in Annex I.

In addition, climate change is one of the 12 focus areas for the [Urban Agenda](#). A partnership of cities and regions will focus on vulnerability assessments, climate resilience and risk management, including the social dimension of climate change adaptation strategies.

Next to the national adaptation plans, cities have taken the lead in guiding, demonstrating, funding and implementing climate adaptation considerations. These cities demonstrate relevant information, tools and methodologies through various networks, as can be seen from the Table below. Networks of cities work towards a common goal, share good practices and promote tools to assist cities in reaching these goals.

The following networks have EU cities as members:

| Name | Information |
|----------------------|--|
| Mayors Adapt | <p data-bbox="373 264 1066 297">http://www.covenantofmayors.eu/Adaptation.html</p> <p data-bbox="373 331 1372 622">Mayors Adapt – the Covenant of Mayors Initiative on Climate Change Adaptation – was set up by the European Commission to engage cities into taking action to adapt to climate change. It was launched in 2014 as a parallel adaptation initiative to the Covenant of Mayors, which focused on mitigation. In 2015, the European Commission merged the two initiatives in an effort to promote an integrated approach to climate and energy action. From 2017 onwards, adaptation and therefore the Mayors Adapt initiative, will be entirely integrated into the Covenant of Mayors for Climate and Energy.</p> <ul data-bbox="424 656 1372 1261" style="list-style-type: none"> - The Covenant of Mayors Monitoring and Reporting framework now includes a section on adaptation to climate change. - The Covenant of Mayors (CoM) collects case studies to inspire cities and facilitate peer-to-peer learning. - The Funding instruments page gives an overview of information on funding on the CoM website. - An e-learning module on adaptation for cities is available for signatories to the Covenant of Mayors exclusively. The module features practical information, case studies and links to useful resources. - The Urban adaptation tool (http://climate-adapt.eea.europa.eu/knowledge/tools/urban-ast/step-0-0) is a practical step-by-step guidance tool to assist signatories of the Mayors Adapt, and the now integrated Covenant of Mayors for Climate and Energy, initiative in planning for and taking adaptation action. |
| C40 network | <p data-bbox="373 1294 1372 1552">Network C40 (Climate Leadership Group) is the network of delta cities and has developed a good practice guide, with practical examples, on how deltaic cities adapt to climate change impacts (i.e. sea level rise, flooding and storms). The good practice guide includes both soft and technical measures - such as pumping, sea walls, green-blue infrastructure, organisational approaches and flood-proofing. Good practice is available from all over the world, including European cities such as Rotterdam, Copenhagen, London</p> <p data-bbox="373 1585 1246 1619">http://deltacities.com/documents/5_C40_GPG_CDC.original.pdf</p> <p data-bbox="373 1653 1372 1877">Furthermore, it has included a knowledge portal with a focus on water management, urban development. http://deltacities.com/knowledge-portal. The 100 Resilient Cities – Network Exchange Programme offers Chief Resilience Officers and members of their cities’ resilience teams the opportunity to share knowledge, source innovation and discover new solutions to the pressing resilience challenges that they face. One example is a network exchange on multi-benefit solutions to water management.</p> |
| 100 resilient cities | <p data-bbox="373 1910 1372 2011">http://www.100resilientcities.org/ 100 Resilient Cities — pioneered and financially supported by The Rockefeller Foundation, and managed as a sponsored project by Rockefeller Philanthropy Advisors (RPA), is an</p> |

| | |
|-------------------|--|
| | independent 501(c) (3) non-profit organisation that provides governance and operational infrastructure to its sponsored projects. |
| Resilient Regions | http://www.resilientregions.org/ /RESILIENT REGIONS ASSOCIATION IS A NEUTRAL ARENA where the business sector, academia, municipalities and government agencies meet to solve regional challenges. |

Data Availability

The majority of reviewed documents on EU-level provide an insight in the most important climate change impacts in Europe and often refer to information from the EEA webpages on climate change adaptation. Most of the identified data sources are useful at least at a strategic level for a project²⁷. Datasets that can be used for modelling, in-depth risk calculations and vulnerability analysis are rarer²⁸.

The accompanying document of the Adaptation Strategy 2013, titled “[Adapting infrastructure to climate change](#)”, contains an Annex (1) with climate risk and impacts on transport infrastructure (2) Climate risks and impacts on energy infrastructure (3) climate impacts on buildings/construction sector. The second accompanying document highlights the various EU Directives that deal with climate change from a water, coastal and marine perspective. For example in 2009, the European Commission (2009) published “[Guidance Document no. 24. River Basin Management in a Changing Climate](#)” which provides information on data sources (climate data projections at EU and Member State level), climate impacts and approaches on how to take climate change into account in implementation of the Water Framework Directive²⁹, Floods Directive and the [Strategy on Water Scarcity and Droughts](#)³⁰. Also in relation to Natura2000, the Commission issued [guidelines](#) on climate change and Natura2000, targeted at site managers and policy makers. While these documents offer guidance in the first place, they also provide climate change information. It is envisaged that these documents will be consulted during EIA procedures, covering the thematic areas of impact on biodiversity and the water environment. Furthermore, various documents promote the establishment of green infrastructure and other ecosystem-based approaches to adaptation.

While information on Climate-ADAPT is mainly policy-oriented (including the sector policy pages), the website contains very useful data regarding project preparation. Climate-ADAPT provides:

- A database on climate change adaptation information, e.g. case studies, tools, guidance, maps, graphs and datasets, etc. The database provides over 2,200 quality checked sources of information and offers inspiration to include climate change adaptation in infrastructure projects in all sectors;
- Links to additional case-study databases: <http://climate-adapt.eea.europa.eu/sat>;

²⁷ For example: Urban adaptation to climate change in Europe (EEA, 2016); Resilience of large investments and critical infrastructures in Europe to climate change (JRC, 2015); Implications of sea-level rise and extreme events around Europe: a review of coastal energy infrastructure; Ariscc (ariscc.org); Climate change adaptation, coastal and marine issues (EC, Climate Strategy 2013); Financing urban adaptation on Climate Change (EEA, 2016); SWD (2013) 133 - Climate change adaptation, coastal and marine issues; TOPDAD; Base, Adaptation Inspiration Book (2016); ECCONET; etc.

²⁸ For Example: Map Book Urban Vulnerability, Map Viewer Climate-ADAPT, Climate Change Impacts and Vulnerability (EEA, 2016), SWD (2013) 133 - Climate change adaptation, coastal and marine issues, EEA Technical report No 5/2015 Overview of climate change adaptation platforms in Europe, CLIPC, etc.

²⁹ 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

³⁰ Communication from the Commission to the European Parliament and the Council - Addressing the challenge of water scarcity and droughts in the European Union (COM/2007/0414 final)

- A section on knowledge, including:
 - The option to search information by type of adaptation information (vulnerability and risk, adaptation options, observations and scenarios, etc.). This functionality is very practical for end users. These pages often lead to different studies and web links. The quality and user friendliness is then dependent on the original information sources. The information on adaptation options is however processed in a recognisable format and can be searched by sector, including transport, energy, buildings, urban, water and others. Waste and Broadband are not mentioned as such. The relevant results from the database of case studies and examples are accessible. In this way, it is easy to access all Vulnerability and Risk tools identified on Climate-ADAPT
 - It also includes a list of research projects
 - A set of [tools](#) such as the Adaptation Support Tool, map viewers and a set of links to external tools such as ClimWatAdapt. These tools are important sources of information, especially in countries where downscaling of climate models has not (yet) been carried out.

With regard to raw climate data, datasets, maps and graphs, the '[Urban Map Book](#)' and '[Map Viewer](#)' appear to be the most hands-on tools to find climate data and data on climate change indicators (hazards, impacts, etc.) on Climate- ADAPT. Both tools combine information from several research projects (e.g. [ENSEMBLES](#)) and from different institutions and programmes (JRC, EEA, Copernicus, etc.). It is not clear whether these tools are systematically updated when new information is available through research projects, although these projects often link to climate-ADAPT and mention a link to Climate-ADAPT in their work packages.

There is some data available for option appraisal of adaptation measures, and the latest research projects offer more information on appraisal (e.g. [Ramses Resin](#), EU Cities Adapt, Climate- ADAPT, etc.).

[Copernicus](#) is the European Union's Earth Observation Programme. It was previously known as GMES (Global Monitoring for Environment and Security) and consists of a complex set of systems which collect data from multiple sources: earth observation satellites and in situ sensors. Land monitoring and emergency management are operational, while atmosphere monitoring and marine monitoring are in a pre-operational mode, with climate change monitoring in a development phase. The services are provided free of charge to users. The information is included in Table 1. It also delivers newsletters on climate change (C3S – Copernicus Climate Change Service) that provides governments, scientists and industry with the tools and information to make better, evidence-based decisions. Next to C3S, there is also a Copernicus Emergency Management Service – Floods (CEMS). Next to the data services, in the near future, C3S will also provide metrics and tools from the global climate models projections that will address the needs of the coastal, water, insurance and energy sectors. C3S has also seven proof of concepts working with sectors to develop the services, so that it meets the needs of the users. Services include the water sector, the energy sector, agriculture, health and infrastructure and insurance sector.

The [Disaster Risk Management Knowledge Centre](#) (DRMKC) is a focal point of reference in the European Commission that supports the development of DRM-related actions. The [DRMKC Risk Data Hub](#) (2016) includes knowledge and models developed by different sectors and for different hazards over recent decades and economic (and other types of) loss data to feed the models and to improve forecasting of expected losses.

Some of the core activities of the DRMKC are to develop an EU wide web-based platform focusing on dissemination and visualisation of data, tools and methodologies (started in 2017). The DRMKC is supported and coordinated by a number of relevant Commission

Services³¹ in partnership with a key network of Member States³². The objective is to build partnerships and networks to improve science-based services, to allow better use and uptake of research and operational knowledge, as well as to develop innovation tools and practices for risk and crisis management. The web-platform for DRM developed within the DRMKC, aims to support science-based advice as well as to inform Member States, Commission services, operational actors and the wider international community on DRM research projects, existing networks, foreseen activities and available tools on an ongoing basis.

The Joint Research Centre (JRC) makes various data portals and data sets available [online](#). The most important ones in relation to climate adaptation are found under the themes "climate change", "desertification and drought", "floods", "hazards and risk to climate change impacts", "natural and man-made hazards". The webpage also includes scientific tools and databases.

The European Centre for Medium-Range Weather Forecasts ([ECMWF](#)) is an independent intergovernmental organisation supported by 34 states. ECMWF is both a research institute and a 24/7 operational service, producing and disseminating numerical weather predictions to its Member States. This data is fully available to the national meteorological services in the Member States. The Centre also offers a catalogue of forecast data that can be purchased by businesses worldwide and other commercial customers.

An overview of the principle climate data sources is given in Table 2

Table 2 : Overview of Principle Climate Data Sources at EU-level

| | |
|----------------|--|
| Drought | IES- European Drought observatory |
| Floods | European Flood Awareness system (EFAS) Flood prediction (including flash floods)- |
| Forrest Fire | IES/ Copernicus- The European Forest Fire information system (EFFIS) Historic data not directly accessible through the website, only limited time (e.g. 90 days) available online |
| Climate models | Regional climate model- CORDEX. Cordex is the successor for the ENSEMBLE Regional climate data portal and a source for scenario forecasts. |
| Soil | IES- European Soil Data Centre (ESDC) e.g. future rainfall erosivity |
| Temperature | COPERNICUS Average surface air temperature monthly maps |
| Ice cover | COPERNICUS Monthly sea-ice maps |
| Hydrology | COPERNICUS Hydrological climate variables |

³¹ Joint Research Centre (JRC), Directorate General for Humanitarian Aid and Civil Protection (ECHO), DG for Research and Innovation (RTD), DG for Home Affairs (HOME), DG for Environment (ENV), DG for Climate Action (CLIMA), DG for Health and Food Safety (SANTE), DG for Regional and Urban Policy (REGIO) and DG for International Cooperation and Development (DEVCO).

³² Building on a network of Member States – the United Kingdom, Sweden, Finland and Hungary – involved in a pilot project surveying best practices for evidence-based policy making on risk reduction and decision making during emergencies.

| | |
|-------------------|---|
| Seasonal forecast | COPERNICUS Air and sea-surface temperature, atmospheric circulation and precipitation – forecasts are updated every month and cover a time range of six months. |
| | ECMWF: various datasets available- availability dependent on membership |
| | JRC: various datasets available (e.g. water indicators, precipitation, drought...) |

Indicator based reports or tools provide both quantitative and qualitative data. The EEA and JRC are two main sources of these types of reports and data. Examples are for instance:

- [Climate Change Impacts and Vulnerability 2016](#), EEA
- [Climate change adaptation and disaster risk reduction in Europe, 2017](#), EEA.

These reports provide in depth data and the studies on which they build are the source of information for the Climate-ADAPT data tools. Figures included in these reports are based on EU-wide records and have been translated in a meaningful way for practitioners. Another example is [CLipC](#), an FP7 project building on the results from Copernicus, with the objective to provide access to Europe’s climate data and information in a more comprehensible way. Part of the toolkit is made available through integration with Climate-ADAPT. There are other in-house JRC, FP7 and Horizon2020 research projects which make use of the gathered data from either Copernicus or JRC. The benefit of these tools and reports is how they give access to different (sets of) indicators and combine information³³. Another positive aspect is their scientific ‘authority’. Qualitative information, often relevant at a more strategic level (e.g. sensitivity analysis for a certain sector) is only provided in the reports (qualitative information) and not in map viewers. The reports have the benefit of providing more background information, making it less likely to misinterpret data and information, and are easier to use the information in the correct way. The range of work carried out at the JRC also includes the compilation of a large number of databases, in addition to the development of software and modelling tools. These [resources](#) are either available to all members of the public or to specific research groups, such as providing assistance to scientists in carrying out their work.

Methodologies

There are methodologies to fulfil each step of the ESIF requirements (vulnerability and risk assessment, adaptation measures, appraisal, planning).

Research projects, such as FP 7 / Horizon 2020 projects, often combine a research topic (e.g. cascading impacts or financial impact of adaptation measures) with a set of case studies in an urban setting (city or project site). Depending on the objectives of the (research) projects or studies, the information made available can vary in how easy it is to interpret by infrastructure development practitioners, such as project managers. [Ramses](#) offers full working papers and methodologies on the project website as does [EU Cities Adapt](#). It is not yet possible to evaluate the [Resin](#) project.

These projects often come up with a tool, a guidance or methodology and are mainly covered in these sections. Not all of the project deliverables are always usable by third parties (e.g. a project developer or managing authority) or it is not always clear from the

³³ See Annex I

project website if all tools are readily and freely available (e.g. [TURAS](#)). This is mentioned in the description of the initial findings for the relevant research projects (e.g. Resin).

The Platform for cooperation between national road authorities, 'CEDR', has developed a risk analysis and management method for the road transport sector, called Risk Management for Roads in a Changing Climate (RIMAROCC). It is a method for risk management and is based on risk identification, risk probability, and [risk consequences](#). The 2016 CEDR report "[Acting on Climate Change](#)" gives a review of risk identification methods as they are applied in the road sector. The results from the 2012 research projects [Roadapt](#) and [CliPDaR](#) are part of the report. Specific examples include areas such as information to road users, incident management, implementation through planning phases, tools for risk analyses, legislative work, research, information-sharing and much more.

Within the framework of its Strategic Plan 2012–2015, the World Road Association (PIARC) has set up a range of technical committees to deal with issues associated with roads and road transport policy and practices, within an integrated sustainable transport context. One of these technical committees is 'TC 1.3 Climate Change and Sustainability'.

The efforts on climate change adaptation by PIARC have led to several publications, such as the 'International climate change adaptation framework for road infrastructure' report (2015). In addition to this publication, a spreadsheet is provided for making a strategy and an action plan.

The framework guides road authorities through the process of increasing the resilience of their networks and assets through four stages:

Stage 1: Identifying scope, variables, risk, and data

Stage 2: Assessing and prioritising risks

Stage 3: Developing and selecting adaptation responses and strategies

Stage 4: Integrating findings into the decision-making process

The publication was followed in 2016 with the report '[Transport strategies for climate change mitigation and adaptation](#)' (see also section on guidance) which does not go into full detail on methodologies, but provides a good overview of state of the art information on climate change adaptation in the transport sector.

For an overview of relevant methodologies, please check Annex I.

Tools

Most of the tools identified also provide data (see data-availability). Examples are Map viewers such as [the Urban Vulnerability Map Book](#) or the [CLIPC-tool](#).

A few Excel-based tools, for calculating impacts and/or analysing vulnerability and risks were identified, such as the format from CoM for Climate and [Energy](#), [Topdad](#) and the [SRA tool](#). The SRA-tool was developed by the sector organisation for the gas industry ([GIE](#)).

Within the [RAMSES project](#), as part of [the Transition Handbook](#), schematic figures summarising the causal structure of vulnerability and risk within each impact chain are included. Impact chains studied in RAMSES include "Heat to human health", "Heat to urban comfort", "Heat to work productivity", "Flood to traffic disruption" and "Flood to build environment". In a following phase, methods and tools for hazard analysis at city scale are presented. It presents a list of models/methods for impact analysis indicating the main characteristics and model needs for climate change impact analysis, focussing on both

flood and heat models/methods. It then provides an operational framework, including risk components (exposure, hazard), vulnerability dimensions (sensitivity, adaptive capacity) and receptor characteristics and impact domains. It demonstrates an overview of possible grey, green and technological adaptation options to flood and heat waves, and ends with guidance on how to perform cost assessment.

Case studies included relate to London, Antwerp, Bilbao, Bratislava, Malmö, Skopje and several cities outside of Europe. In order to provide local municipal staff with a complete collection of resources to make the wide-reaching results of the RAMSES Project accessible and usable, a slide-deck summarising the most policy relevant project findings has been developed. This is meant to support cities (including municipal staff, policy makers and other stakeholders) to explain the importance of climate adaptation to different stakeholders. The slide-deck is available in slide format so that it can be downloaded and tailored to practitioners' needs. For example, the slide-deck could be used during a workshop to introduce a topic on which a city would like to work practically using the training package, or just to raise awareness on crucial aspects linked to urban climate adaptation. The slide-deck can be consulted and downloaded from the [RAMSES website](#). The Ramses project also developed a [taxonomy](#) of adaptation measures and corresponding indicators for resilient architecture and infrastructure.

It contains both flood adaptation measures and heat reduction measures, and each measure is characterised by various indicators such as its expected outcome, the performance indicator, the affected urban surface perimeters, its resilience dimensions and includes various references to reviewed literature. Also on governance, the project has demonstrated through the case studies what structure cities are using in order to have successful implementation of adaptation considerations, also highlighting specific support needs the city had with regard to adaptation (e.g. knowledge, involving stakeholders, etc.)

The [EU Cities Adapt](#) project reviews tools and guidance documents which can make the task of adaptation planning more manageable for adaptation practitioners. The review has identified 50 resources which offer different perspectives and are focussed on a range of sectors and stages in the adaptation process.

The [Resin-EU project](#) will develop a series of tools to support and guide the process of impact and vulnerability analysis for critical infrastructures and built areas. It will accompany these tools with software using cases to demonstrate how users would apply the tool to the various phases of such an impact and vulnerability analysis. The project also develops a searchable archive of all tools developed within the project (city typology, impact and vulnerability analysis), as well as documentation on adaptation measures previously implemented in different cities.

For an overview of relevant tools, please check Annex I.

Guidance

The EU Adaptation Strategy (2013) contains several guidance documents that provide guidelines regarding the integration of climate change adaptation in infrastructure projects (also mentioned in the chapter 'Context of the study'). In this chapter, only the guidance most relevant to project management and implementation in project preparation are mentioned. The first part will provide information on existing guidance in the context of the ESI funding.³⁴ The second part of this chapter will go into other sources, such as guidance documents from policy studies and research projects.

Guidance on ESIF and how to fulfil the different requirements for major projects and other funded projects, can be found on the [DG REGIO webpages](#). In addition, a specific

³⁴ For an overview of how adaptation is integrated in ESIF, see sections "System and Legal Framework" and "Institutional capacity" of this report.

application, 'Regiowiki', has been developed to navigate the legislation and guidance notes on the European Structural and Investment Funds 2014-2020 in a dynamic way.

The Commission Implementing Regulation 2015/207 provides a practical template for applying for funding as a major project, including details on the information required on climate change adaptation (vulnerability & risk assessment, CBA and option appraisal)³⁵.

With regards to cost-benefit analysis, the EC '[Guide to Cost-Benefit Analysis of Investment Projects for Cohesion Policy 2014-2020](#)' (2014) provides guidance on project appraisals, as embodied in the regulations of the European Regional Development Fund (ERDF), the Cohesion Fund (CF), and Instrument for Pre-Accession Assistance (IPA).

Other guidance than can be of use to beneficiaries of the ESIF fund is:

- [Guide to Multi-Benefit cohesion Policy Investments in Nature and Green Infrastructure](#) (2013). The guide shows that investing in nature, biodiversity and green infrastructure are relevant for a cohesive policy. The guidance assists authorities and stakeholders with practical recommendations to improve the delivery of the co-funded programmes and projects.
- [Guidance for beneficiaries of European Structural and Investment Funds and related EU instruments](#) (2014). The guidance provides weblinks to find the most relevant websites and documents
- A [checklist](#) to help identify which EU-fund is the most appropriate funding source for a particular project
- [Guide to high-speed broadband investment](#) (2014): this guide is primarily aimed at public authorities and gives practical tips to support the preparation of broadband investment projects, including those co-financed by ESIF. As such the guide can help beneficiaries with efficient and effective project preparation.
- [Funding opportunities for disaster risk management within EU cohesion policy](#) (2016): This brochure highlights the funding opportunities for risk prevention from cohesion policy in the 2014-2020 period. It also showcases a number of good examples and explains how you can get support.
- [DG Growth provides a series of handbooks concerning support for SMEs in the context of Cohesion Policy](#). These are available in different EU languages and they feature (among other topics) a general guide about using ESIF for promoting entrepreneurship policy (2016).

As the Member States share responsibility in the management of ESIF fund, relevant guidance is offered at the [DG REGIO](#) webpages, for instance on:

- (draft) guidelines and information on programmes, territorial development and investments, etc.
- [Guidance for the MS on Integrated Sustainable Urban Development](#) (art. 7 ERDF regulation)
- [Guidance on the calculation of total eligible costs to apply for major projects in 2014-2020- Q&A](#)
- [Guidance Note on Nomenclature of Categories of Intervention and the Methodology for Tracking of Climate Change Related Expenditure under Cohesion Policy](#)
- [Guidance on Ex Ante Conditionalities for the European Structural and Investment Funds \(and Q&A\)](#)
- [Guidance on financial instruments](#)

³⁵ For more detailed information on the actual requirements, see section "System and Legal Framework" of this report.

- Information concerning thematic objectives, including an overview of the different regulations where thematic objective 5- Adaptation and Risk Management is addressed: Climate Change Adaptation, Risk Prevention and Management

The '[Non-paper Guidelines for Project Managers](#)' (2011) provides guidance to integrate adaptation in project development for different infrastructure sectors, both in EU-funded projects and those found more widely.

Practical guidance to integrate CCA in infrastructure projects, other than adaptation strategies and action planning, have become more numerous since 2014. Examples include the '[Climate change in major projects' publication](#)' (2016), the guidance document for CCA in standards (2016), developed by CEN: CENELEC and the [EUFIWACC paper](#) (2016). The EUFIWACC paper brings experience working on CCA in major projects and good practice together.

JASPERS, in cooperation with DG CLIMA and DG REGIO, has provided several practice-oriented [guidance](#) in 2017:

- The '[Basics of Climate Change Adaptation, Vulnerability and Risk Assessment](#)' report;
- An overview of the [most important sources for integrating climate change in \(major\) projects](#), including climate change adaptation and resilience. The document provides the links to the main sources;
- A [compilation of the climate change requirements for major projects in 2014-2020](#)
- [Guidelines to fill up the Application for Funding in Broadband Projects](#)
- [A Guide to Cost-Benefit Analysis of Investment Projects](#)
- [Guidance for integrating climate change and biodiversity into Environmental Impact Assessments](#)

Climate adaptation considerations are integrated in the environmental and social principles and [standards](#) and [handbook](#) of the European Investment Bank. The standards are part of the framework for project approval and include climate related standards. In addition to these documents, there is a reference document that provides the template contractual clauses on environmental matters contained in the finance contracts signed by the EIB. The EIB is also developing specific guidance, e.g. on hydropower '[Environmental Climate and Social Guideline on Hydropower Development](#)' (draft, 2018), which can be useful in scoping of impacts and defining the steps to take in order to fully integrate climate considerations, but also social and other environmental impacts in project preparation.

The previously mentioned 'state of the art reports' often offer conclusions in the form of a guidance (reviewed reports date up to 2017). The [ARISCC report](#) (2010) is one example. The guidance offered in this project serves as a framework for decision making by the rail infrastructure manager in Belgium. The implementation of the project outcomes is one of the measures mentioned in 'The Federal Contribution to the [National Adaptation Plan](#)' for Belgium. Other examples are the report '[Transport strategies for climate change mitigation and adaptation](#)' (PIARC, 2016) or the report of the Forum of European Highway Research Laboratories (FEHRL, 2017). They published a progress report on their 'Forever Open Road' initiative, in which Climate resilience is one of the three topics under consideration. The report provides guiding principles and related actions (e.g. identifying vulnerabilities) for new road transport infrastructure at a high level, but also points out which research and innovation topics should be addressed in the coming year. By doing so they offer information on potential (future) climate change adaptation measures. Last but not least, the report also provides an overview of demonstrating the projects.

In some cases research projects offer guidance which is not focused on project preparation as such, provide useful but fragmented information or 'part of the way to follow' (e.g. [Urban adaptation to Climate Change](#), 2016; [Ramses](#); [Turas](#)). One would need to combine the information from these different projects in order to develop a comprehensive approach for integration of climate change in project preparation. While local authorities and pilot cases gain a lot of very specific information and insights in the local situation from participating in these projects, direct application of the outcomes by (other) project managers/ developers is not always easy. Reasons are:

- Scientific language in reports³⁶;
- Specific data sets are used which are not available in every country, region or community;
- A missing step towards practical application and offering only part of the solution³⁷
- Use of models which are not available outside of a specific research institute (e.g. [Turas](#));
- Uncertainty about quality of project results;
- Not every detailed report is available in all official EU languages

For an overview of all relevant guidance, please check Annex I.

Design Standards

The information on design standards has been fairly limited. Both sources ([ARISCC](#); [CEN/ CENELEC](#)) offer standards and guidelines on standards. The European standardisation organisations have had a coordination group on climate change adaptation since 2014 and recently released a guidance document to help the writers/ developers of standards to include CCA in new standards.

CEN and CENELEC have developed and published a '[Guide for addressing climate change adaptation in standards](#)' (2016). This Guide is intended to help standard writers address the consequences and implications of climate change. It includes a simple checklist to help establish whether climate change adaptation is relevant to a particular standardisation activity and a decision tree to help identify which actions should be taken. It includes business case examples on flood protection, drainage systems and rail infrastructure. Also, it provides guidance for integrating climate change adaptation provisions in the product standard. It covers each life cycle stage and provides examples of climate change impacts and climate change adaptation provisions. A decision-tree helps to identify major impacts and provisions and assign possible actions. The CEN-CENELEC GUIDE 32 'Guide for addressing climate change adaptation in standards' addresses and updates how climate change adaptation is taken into account in the following European standards:

- EVS-EN ISO 14001:2015 Environmental management systems. Requirements with instructions for use ;
- EVS-EN ISO 14004:2016 Environmental management systems. General guidelines for implementation ;
- EVS-EN ISO 14015:2010 Environmental management - Environmental assessment of sites and organisations (EASO);
- EVS-EN ISO 14031:2013 Environmental management. Environmental performance assessment. Guidelines;

³⁶ This reason was also mentioned by several practitioners during a DRMKC workshop in 2017: <http://drmkc.jrc.ec.europa.eu/innovation/Support-System/Training-FP7-H2020-CIP>

³⁷ Ibid.

- EVS-EN ISO 14040:2006 Environmental management. Life Cycle Assessment. Principles and framework;
- EVS-EN ISO 14044:2006 Environmental management. Life Cycle Assessment. Requirements and instructions for use;
- EVS-EN ISO 14046:2016 Environmental management - Water footprint - Principles, requirements and guidelines (ISO 14046:2014);
- EVS-EN ISO 14064 series Greenhouse gases;
- CEN ISO/TS 14071:2016 Environmental management - Life cycle assessment - Critical review processes and reviewer competencies: Additional requirements and guidelines to ISO 14044:2006 (ISO/TS 14071:2014); and
- EVS-EN ISO 50001:2011 Energy management systems. Requirements with implementation guidelines.

Also in 2016, CEN-CENELEC organised three [workshops](#) for the transport, energy and building sectors to have an exchange with the experts from the specific sectors on the related climate challenges are the standardisation needs necessary to adapt to the unavoidable impacts. The presentations of the workshops are available on the website. As from 2017 the focus is on the revision and development of the identified standards aiming to improve the resilience of European infrastructure in the priority sectors to the adverse effects of climate change. These revised and new priority standards will represent best practice examples on how to address climate change adaptation aspects in standards. The work will also cover the development of a tailored guidance for the Technical Committees. The guidance will provide information on the availability and use of climate data, including recommendations for dealing with uncertainty, as well as approaches for vulnerability assessment and adaptation based on the best practices and experience gained during the project.

The RESIN project (WP5) has a liaison with two ISO committees³⁸ and will continue working with both ISO and CEN on standardising adaptation options. In September 2017 ISO has asked for international experts to get involved in the drafting of a standard on 'Climate Change Adaptation – A [Guidance to Vulnerability Assessment](#)'.

In the [Resin](#) project, the aim is to link the requirements for critical infrastructure to the development of standards. The Standardisation Institute of the Netherlands (NEN) is working with the project partners in streamlining the project's outputs into European standardised approaches. The project is currently exploring the feasibility of standardisation and certification, framed by the three RESIN topics (impact and vulnerability, selecting and prioritisation adaptation option and decision tool) and the three priority sectors identified for the project (energy infrastructure, transport infrastructure, and buildings).

The British Standards Institute has released a guide on [Adapting to Climate Change using the Business Continuity Management System](#). Business continuity management (BCM) includes methods for, and experience of, dealing with potential and actual disruptive events, as well as a remit to access and relate to all areas of the business. Other standards that may be equally appropriate for managing climate risks, are Risk Management (ISO 31000), Environmental Management (ISO 14001), and Quality Management (ISO 9001). Specifically, ISO 14001 will be influential in driving climate change adaptation when its revisions are complete.

Performance standards, such as [BREEAM](#), [CEEQUAL](#) and [SuRe](#) are not design standards, though they do require consideration of climate change adaptation into the design of new infrastructure.

³⁸ Relevant working groups within ISO are ISO/TC 268 'Sustainable cities and communities'³⁸, WG 2 'City indicators' ISO/TC 207 'Environmental management'³⁸, - 'ISO/TMB/TF 7' on Climate Change Adaptation.

System and Legal Framework

Introduction

Section "Context of the study" of this report provides an overview of the main legal documents and programmes, such as the Adaptation Strategy, the different provisions of ESIF, etc. A shorter presentation is given in this section on policy and legal framework in this chapter. This chapter will first explain the structure of Structural Funding, the different funds included in ESIF and the legal requirements on climate change adaptation since 2014³⁹. This is the case for Major Projects, but also other projects funded through ESIF have to demonstrate how they contribute to climate change policy targets. Next, the different authorities at EU-level are described. Finally, other supportive systems are mentioned. Where relevant, the link to Member States is addressed.

Guidance and training opportunities to develop a major project and to fulfil the ESIF requirements (see below) are addressed in the chapters on guidance and institutional capacity.

The Structural Funds and major projects

To keep climate change below dangerous levels, the international community agrees that rise of the average global temperature must be limited to no more than 2°C with an aim to 1.5°C above the pre-industrial temperatures. The EU is therefore working to reduce its emissions, to encourage other major polluters to take strong action, and to address the unavoidable impacts of a changing climate. The EU Strategy on Adaptation to Climate Change⁴⁰ sets out actions for promoting adaptation within the EU, and, among other actions, it encourages all EU countries to adopt comprehensive adaptation strategies; provides funding to support capacity building and step up adaptation action in Europe; addresses knowledge gaps on adaptation; mainstreams adaptation by integrating it into EU policies and legislation; and ensures more resilient infrastructure.

The European Structural and Investment Funds comprise a family of five funds: the European Regional Development Fund (ERDF) and European Territorial Cooperation goal (ETC, which falls under ERDF); the Cohesion Fund (CF); the European Social Fund (ESF); the European Agricultural Fund for Rural Development (EAFRD); and the European Maritime and Fisheries Fund (EMFF).

The European Structural and Investment Funds promote eleven Thematic Objectives, of which Thematic Objective 5 is 'Promoting climate change adaptation, risk prevention and management'. National and/or regional risk assessments for disaster risk management are a precondition (ex-ante conditionality) for funding under Thematic Objective 5. National climate change adaptation strategies and related climate vulnerability assessments are required, where appropriate, to inform national risk assessments. A [draft thematic fiche](#) shows the relevant provisions in:

- the Common Provisions Regulation (No 1303/2013)- in particular
 - o Art 8- Sustainable development
 - o Art 9 (5)- climate change adaptation, risk prevention and management
 - o Art 96- information in the operational programmes (ERDF, ESF and CF)
 - o Art 101- Information necessary for the approval of major projects

³⁹ While there are requirements for climate change mitigation as well, these do not fall within the scope of this study and as such are not addressed here.

⁴⁰ The EU Adaptation Strategy is undergoing evaluation at the time of writing of this study https://ec.europa.eu/clima/policies/adaptation/what_en

- Annex XI- part I: Thematic ex ante conditionalities
- the ERDF Regulation (N° 1301/2013)
- the Cohesion Fund Regulation (N° 1300/2013)
- the European Territorial Cooperation Regulation (N° 1299/2013)

The fiche mentions in detail how each work of legislation integrates climate change adaptation, risk prevention and management.

Major projects receive support through the [ERDF](#) (European Regional Development Fund) and/or [Cohesion Fund](#). Climate change adaptation considerations have been included in the preparation and approval process of (ESIF) major projects (i.e. projects having a total eligible cost exceeding €50 million, or €75 million in the case of transport projects) and this has contributed to climate-proofing such projects.

The [Common Provisions Regulation](#) (Regulation (EU) No 1303/2013) sets the overall funds framework, and states that for a major project to be approved, the managing authority needs to ensure the availability of an analysis of the environmental impact, taking into account climate change adaptation and mitigation needs, and disaster resilience⁴¹. The provision also defines ex-ante conditionality 5.1. Risk prevention and risk management, asking for the existence of national or regional risk assessments for disaster management, taking into account climate change adaptation, for projects under Thematic Objective 5. It has to be noted that the EU's major projects legislation for the 2014-2020 programming period is the first to define specific climate change related requirements.

The Commission Implementing Regulation (EU) 2015/207 lays down detailed rules for implementing the Common Provisions Regulation. In the case of EU-funded major projects, the beneficiary has to provide the information requested in the format for submission of the information on a major project (ANNEX II of this implementing act).

The main sections of the Major Project Application Form asking for information on climate change adaptation are:

- Section D (Feasibility studies carried out, including option analysis, and the results) includes a section D.2., requesting an option analysis, including
 - (ii) options for scale (against, among others, environmental criteria) and options for location of the proposed infrastructure;
 - (iv) risks involved for each alternative, including risks related to climate change impacts and weather extremes.

To comply with these requirements, the outcomes of a vulnerability and risk appraisal and EIA/SEA procedures should be reflected in this section. The criteria for selecting the best solution need to be specified. Section D.3 then asks for a short summary of the feasibility of the selected option, including climate change impacts and risks on the project. Reference to for instance the vulnerability study and risk assessment should be made. This should be covered in a paragraph D.3.3, and a table with references to studies, the pages where the information can be found in the application file etc.

- Section E (a cost-benefit analysis, including a financial and economic analysis and a risk assessment) includes a requirement to produce an economic analysis (E.2.). The requirement includes a description of externalities, including ones related to climate change resilience and disaster resilience. References to section F should be made. Section E.3.3 asks for a summary of a Risk-Assessment, and states that

⁴¹ According to Article 101 (f) of the EU Regulation 1303/2013

special attention should be given to environmental risks, climate change related risks and other natural disasters related risks.

- Section F (Environmental Impact) includes a section
 - o F.1.1. requires the project to show how the project contributes and takes into account environmental policy objectives including climate change (among which resilience to climate change impacts). Policy documents to refer to are, for instance, national adaptation strategies or action plans⁴².
 - o F.3. mentions the Application of the EIA Directive and F.3.3 asks for a non-technical summary of the EIA report. Climate change should be included in the EIA (since May 2017).
 - o F.5. requires an assessment of effects on water bodies. Due to the characteristics of climate-change impacts, there can be overlap with, for instance, the climate change vulnerability and risk assessments.
 - o F. 8 on “Climate change adaptation and mitigation, and disaster resilience”, where it is requested to explain how the project contributes to climate change targets; how climate change related risks, adaptation and mitigation considerations, and disaster resilience have been taken into account; and what measures have been adopted to ensure resilience to current climate variability and future climate change within the project
- Section G (financing plan) includes section G.3 which demands a summary of the main risks to the successful physical and financial implementation of the project and proposed risk mitigation measures. Climate change related risks should be included.

In the same implementing regulation, the Cost Benefit Analysis Methodology is also included (Annex III of the Implementing Regulation) and it is further explained that climate change impacts and natural disasters also have to be considered in the CBA, including in the feasibility and option analysis, the economic analysis and should be given particular attention in the risk analysis.

Other forms are available in the annexes of the different implementing acts, such as the format for notification of a selected major project, a model for transmission of financial data, etc.

All European Structural and Investment Funds Regulations 2014-2020 are published at the DG REGIO webpages.

Cohesion policy is enacted through the cohesion policy programmes, which specify the funding opportunities in the Member States and regions up to 2020. As explained on the DG REGIO webpages: “*Member States run the programmes, via Managing Authorities. These give information on the programmes, select projects and assist implementation. On this website you can read the programmes and discover the contacts of your Managing Authorities.*” An overview of the management system for ESIF and the responsible authorities in each Member State can be found in the country reports that accompany this report. If made online available by the Member State, links to formats for project applications are also covered in the different country reports.

Aside from the managing authority, the Member States also appoints a certification body (to certify statements of expenditure and payment application before they are transferred to the commission) and a auditing body “to oversee the efficient running of the

⁴² Country-specific information on relevant policy documents can be found in the country reports of this study

management and monitoring system). More information on the financial management of the Structural Funds can be found on the [webpages](#) of DG REGIO.

Responsible authorities

At the European level, climate change adaptation is integrated in the policies of different Directorate Generals (DG) of the European Commission (EC) and other European institutions, such as the European Investment Bank or EU agencies, such as the EEA. [Climate-ADAPT](#) provides an overview of relevant organisations at global, EU, transnational and national, regional and local governance level. The web platform also provides links to the relevant EU policy documents and websites.

The main contributing authorities at EU-level for the uptake of climate change adaptation (in projects) are:

EC DG CLIMA: The Directorate-General for Climate Action (DG CLIMA) of the European Commission works with the Member States through the Working Group on Adaptation of the Climate Change Committee on implementation of the 2013 Adaptation strategy and further initiatives in this area. DG CLIMA gives an overview of recently completed projects in relation to climate adaptation on their [website](#), including a list of documents on mainstreaming climate action in the European Structural and Investment Funds 2014-2020.

EC DG REGIO: The Directorate-General for Regional and Urban Policy manages the European Structural Investment Funds (ESIF). Through ESIF, climate change considerations are integrated in the project development process of all projects that apply for funding. Moreover, adaptation of climate change and risk prevention is one of the policy themes in DG REGIO. DG REGIO works together with DG CLIMA and Jaspers to provide guidance on how to realise climate change adaptation in projects.

EC DG ENV: The Directorate-General for Environment defines European environmental policy and as such has many links with climate policy. One example is the integration of Climate change into the revised EIA Directive. Another example is the focus on [green infrastructure](#) and nature based solutions, which offers many chances for climate change adaptation measures (e.g. reduction of heat island impacts in an urban setting by developing green-blue networks).

EC DG JRC: The Directorate-General Joint Research Centre (JRC) and in particular the Institute for Environment and Sustainability (IES) provides data and information on climate change adaptation.

EC DG RTD: The Directorate-General Research and Innovation manages the funding for research and Innovation projects. Under [Horizon 2020](#), several societal challenges are defined. An example is the Climate Action, Environment, Resource Efficiency and Raw Materials programme. It supports research and innovation related to climate change, such as development of climate modelling and science for climate services, development of tools, methods and standards, understanding the economics of climate change and creating climate change networks.

EEA (European Environment Agency) is an agency of the European Union, whose task is to provide sound, independent information on the environment. The EEA provides climate data, climate change adaptation studies and sectoral reports or state of the art reports on this topic, both regarding climate change data, policies and the uptake in different sectors (e.g. [on adaptation of the transport sector](#) (2014), [Climate Change Impacts and Vulnerability](#) (2016)).

ETC/ CCA (European Topic Centre on Climate Change Impacts, Vulnerability and Adaptation).

EC DG DEVCO has published criteria in order to mainstream climate adaptation into projects outside of the EU. The purpose of a climate screening exercise is to identify potential climate change risks that may affect the achievement of the project objectives. The findings of the screening will help identify if a more detailed [Climate Risk Assessment \(CRA\)](#) is necessary.

EC DG ECHO works towards the Sendai Framework for Disaster Risk Reduction, committing itself to reduce disaster damage to critical infrastructure and disruption of basis services. There is no specific information on how climate considerations are integrated, except for their previous collaboration with EEA and EC DG CLIMA on "Climate change adaptation and disaster risk reduction in [Europe – Enhancing coherence of the knowledge base, policies and practices](#)". DG ECHO is responsible for European civil protection and humanitarian aid operations.

The EIB has committed also to climate mainstreaming. EIB has a climate strategy and climate is a key consideration of financing. The document on "[the costs of climate-change adaptation in Europe: a review \(2012\)](#)" compares estimates on adaptation costs based on their adaptation perspective. Climate adaptation considerations are integrated in the [environmental and social principles and standards](#) and [handbook](#). The standards are part of the framework for project approval and include climate related standards. In addition to these documents, there is a reference document that provides the template contractual clauses on environmental matters contained in the finance contracts signed by the [EIB](#). Although climate is included in the definition of 'environment' in the reference document, there is no specification on climate change (mitigation⁴³ or) adaptation. Furthermore, the EIB supports the LIFE funding programme and Strategy on Green Infrastructure by its [Natural Capital Financing Facility \(NCFF\)](#) providing funding to nature-based solutions, with the aim of boosting investment for biodiversity and nature-based adaptation to climate. Furthermore, it can assist through providing technical assistance, including for climate vulnerability assessments and recommendations for ecosystem-based adaptation solutions.

JASPERS stands for [Joint Assistance to Support Projects in European Regions](#) and is a technical assistance partnership between three partners (European Commission, EIB and EBRD). They provide independent advice to beneficiary countries to help prepare high quality major projects to be co-financed by the ERDF and Cohesion Funds. By doing so, they provide assistance to make a project comply with the requirements on climate change adaptation.

Although sector organisations are not strictly speaking a 'responsible authority', they can play an important role in the uptake of climate change by their members, being in close contact with them and having a forum to raise awareness and transfer knowledge on this topic. Some sector organisations recognise the benefits for their members to include climate change considerations in projects. Some have established working groups, studies or tools to help their members to do so. Examples are⁴⁴:

- CEDR: Platform for Cooperation between National Authorities ([research calls](#), [guidance](#), [workshops](#))
- PIARC: [World Road Association](#) ([risk assessment](#) and [environmental](#) topics covered in working groups and guidance)
- PIANC: World Association for Waterborne Transport Infrastructure ([working group and guidance](#))
- GIE: Gas Infrastructure Europe ([risk assessment tool](#))

⁴⁴ This list is not exhaustive

Additional sources of information at EU-level on the legal and system framework

Aside from information on [Climate-ADAPT](#) on the network of relevant organisations and the webpages of the different stakeholders mentioned above, more info on the legal and institutional frameworks on either EU, national or local level can be found in 'State of the art' reports such as [Urban Adaptation to Climate Change in Europe 2016](#) or [Open European Day](#)). The EEA report '[Climate Change Impacts and Vulnerability](#)' offers an overview of the policy background for climate change adaptation at EU level, country level and macro region level (Chapter 2), and the development of the associated knowledge base (Chapter 7). Often these reports also showcase how institutional capacity can be increased or used to its best potential.

For an overview of relevant sources, please check Annex I.

Institutional Capacity

Section "Context of the study" of this report provides an overview of the main legal documents and programmes, such as the different provisions of ESIF, relevant EU policy, etc. An overview of responsible authorities at EU-level is provided in the previous chapter (System and Legal Framework). As institutional capacity is very much linked with the system and legal framework, the studies, guidance, tools and other sources mentioned in the previous chapter are in general also relevant for this chapter on institutional capacity and vice versa. This chapter first provides some information on ESIF as a financial instrument. Practical (more technical) guidance to integrate climate change adaptation in project preparation is not covered in this section, but in the chapter on guidance. The chapter then provides some links to webpages set up to support institutional capacity of managing bodies at MS level, with references to tools, guidance, review reports. Next non-ESIF funding sources with relevance to the topic of climate change adaptation and co-funding opportunities are mentioned. Then, the chapter describes technical and resource capacity from other EU sources (non-ESIF), including a review of the climate-adapt platform and status of national and regional climate change vulnerability studies. The final paragraphs address cooperation and learning opportunities to increase institutional capacity.

The funding requirements of the EU Structural Funds (ESIF) are an important instrument for integrating climate change considerations in (infrastructure) investments in Europe. Thematic documents, such as the '[European funding for Broadband](#)' publication provide an insight into the importance of these sources to the different Member States. The DG REGIO portal on ESIF provides general information on managing authorities, beneficiaries, the operational programmes and more.

With regards to EU regional funding opportunities, DG REGIO informs on (non-exhaustive list)⁴⁵:

- Data and information on the [available budget for 2014-2020](#). Funding for regional and cohesion policy in 2014-2020 amounts to €351.8 billion. Data for allocated budgets per Member State can be accessed;
- Information and guidance regarding [funding opportunities for disaster risk management within EU cohesion policy](#). With €8 billion for climate change adaptation and risk prevention and management, cohesion policy is one of the most important sources for funding in this area. Twenty Member States have selected risk prevention as a priority for the 2014-2020 funding period;
- Information on [EU investments](#) in the different Member States (2017 factsheets);

⁴⁵ See previous chapters on guidance and system framework

- Practical guidance on [accessing the funds](#), linking to other parts of the webpages on regional and cohesion policy funding.

Of particular relevance to increasing institutional capacity of responsible authorities at Member State level are for instance:

- [EU Competency framework for management and implementation of the ERDF and Cohesion Fund](#). The framework includes several elements:
 - A [brochure](#) explaining the framework in short
 - Excel files identify the competencies that employees of administrations should possess.
 - A Self-Assessment Tool for national coordinating bodies, managing authorities, certifying and audit authorities, joint secretariats and intermediate bodies. The tool helps to identify and address potential competency gaps
 - [User guidelines](#) for the tool are also made available.
- Information on the [financial management](#) of the programmes;
- Evaluations (country reports and EU-level) of the funding period 2007-2013, including on environment.

The different ESIF regulations and implementing acts provide information on, for instance, the characteristics of web-tools to collect applications for funding from beneficiaries.

Other relevant EU funding sources can be found here:

- Life-calls: Life is the only EU instrument focused on the environment and climate change. The LIFE sub-programme for Climate Action supports projects in the field of climate change mitigation and adaptation, and climate governance and information;
- Research projects: Several relevant projects are being funded by the EC through FP7 or Horizon2020 in terms of their key contribution towards data & information or tools & methodologies or standard development.⁴⁶ Some are specifically designed to support adaptation efforts through a community building approach. There are three specifically relevant 'Societal Challenges' under Horizon 2020:
 - o Food security, sustainable agriculture and forestry, marine, maritime and inland water research and the bioeconomy;
 - o Climate action, environment, resource efficiency and raw materials;
 - o Secure societies - protecting the freedom and security of Europe and its citizens.

It is estimated that overall climate-related expenditure should exceed 35% of the total Horizon 2020 budget.

- The Civil Protection Financial Instrument aims at supporting and complementing the efforts of Member States to protecting people, the environment and property, including cultural heritage, in the event of natural and man-made disasters, acts of terrorism and technological, radiological or environmental accidents. Its budget

⁴⁶ A few examples are: Ramses, Resin, EUCircle, Rescue, Mediation, EU Cities Adapt, Placard, WeAdapt

amounts to €368 million covering, among other aspects, disaster prevention and preparedness studies and projects;

- The general pages on [EU-funding](#).

Effective collaboration: training, networking and collaboration

There is freely available training on cohesion policy 2014-2020 for EU Member State experts, e.g. on implementing issues. The training material is made available. One example is the presentation on "[Generating successful projects, developing and managing the project pipeline](#)".

The programme '[TAIEX REGIO PEER 2 PEER](#)' is designed to share expertise between bodies that manage funding under the European Regional Development Fund (ERDF) and the Cohesion Fund. It helps public officials involved in the management of these funds to exchange knowledge, good practice and practical solutions to concrete problems, thus improving their administrative capacity and ensuring better results for the EU investments.

The Commission has created a [Task Force for Better Implementation](#) to provide tailored support to eight Member States that are facing particular challenges linked to the implementation of Cohesion Policy Funds (Bulgaria, Croatia, Czech Republic, Hungary, Italy, Slovakia, Slovenia and Romania).

Additional initiatives to improve how the ESIF are invested and managed can be found on a [specific webpage](#) from DG REGIO.

The JASPERS networking platform, in close cooperation with DG CLIMA and DG REGIO, has organised a series of seminars covering topics such as the climate change requirements for major projects and climate adaptation and resilience of major infrastructure projects. The aim of such events is to provide capacity building on relevant topics and allow representatives from managing authorities, line ministries and beneficiaries to share their experiences from projects.

Several private companies also provide (paying) courses to support knowledge on ESIF, project preparation and how to apply for funding.

In terms of capacity building, conferences and sector-based workshops provide opportunities to network, exchange best practice and challenge researchers with the practical needs of the sectors and infrastructure projects. This was, for instance, the case during the [DRMKC workshop](#) in March 2017 where a mix of researchers, policy makers and sector representatives were present. During the conference, the need for the translation from research output to practical solutions for infrastructure project managers and, for instance, engineering teams was highlighted. Another example of such a conference are the '[Resilient Cities Conference](#)' and '[Open European Day](#)' by ICLEI. The [ICLEI Resilience Resource Point](#) provides a gateway into the growing collection of websites, networks and literature dedicated to adaptation and resilience, with a particular focus on urban regions and cities.

As described in the introduction to this chapter on available material at EU level, there are different international city networks that offer support in a similar way (e.g. 100ResilientCities, C40, etc.). In addition, climate change is one of the 12 focus areas for the [urban agenda](#).

Technical and resource capacity

The European Climate Adaptation Platform (Climate-ADAPT) is a one stop shop providing easy access to e.g. several tools, such as the Urban Adaptation Support Tool in order to

increase adaptation capacity. There are specific sector pages, which contain links to relevant sectoral policy documents and research studies.

In June 2018, the EEA published an evaluation report '[Sharing adaptation information across Europe](#)' on how the growing knowledge on adaptation in Europe has been captured, how it is presented on climate-ADAPT and shared across Europe. The report states that *"the visibility of information and weblinks to information sources for city, sub-national and sectoral information providers should be improved. ...The platform is less effective in its support of sectoral users, users new to adaptation and users from eastern and central European countries (web statistics, user/provider survey, ad hoc collected feedback)... the links to sector knowledge platforms need to be further improved."* Concerning the future development of climate-ADAPT, the report states that for instance, links to DRMKC and the [Risk Data Hub](#) will be explored and *"various key data, knowledge and policy developments that are relevant to national adaptation strategies and to mainstreaming adaptation in sector policies should be taken into account for the future of Climate-ADAPT."*

The 'National climate change vulnerability and risk assessments in Europe, 2018' study provides a systematic review of national climate change impact and risk assessments in Europe. The report shares experiences and knowledge on approaches and practical solutions that countries have used to produce and present their assessments.

Sector organisations and federations can drive the technical and resource capacities, by increasing both awareness and the knowledge-base for climate change adaptation, as shown in the transport sector. Key reports and tools have been developed by for instance, both CEDR (Conference of European Road Directors- Platform for cooperation between National Road Authorities), PIARC (World Road Association)⁴⁷ and PIANC (World Association for Waterborne Transport).

The Use of EU Resources in actions at Member State level

Although the resources at EU level and at Member State level are discussed separately in this report, it is clear that they influence each other and that they are complementary. ESIF, for instance, provides a bridge between EU policy and Member State action and the regulations that are instrumental to drive, among other objectives, the uptake of climate change considerations in (EU-funded) projects. Examples, other than infrastructure projects, are the various city initiatives and how they are supported by EU support frameworks (Covenant of Mayors, workshops, The Urban Agenda, etc.).

There is pronounced use of EU resource material by the Member States, and this study has shown that in some countries, EU material is used to provide guidance and to find data. An example of this is the 'Non-Paper Guidelines for Project-Managers by DG CLIMA'.

There is a very high cooperation of Member States, represented by national partners in FP7 or Horizon 2020 research projects. Often, EU-funded research projects include local level projects as case studies, and finance their development. While the case studies are often approached from a scientific point of view, and not so much from a project-development perspective, they build the knowledge base for the integration of adaptation in a project development in the sector and the (local) area.

A large number of pan-European projects and legislative requirements offer a solid basis for projects developers to conduct vulnerability and risk assessments. Key examples of these efforts are the downscaling of global climate models facilitated by the existence of the [CORDEX](#) database, and the requirement of the EU Floods Directive 2007/60/EC for Member States to perform flood risk assessment and to elaborate [flood hazard and risk maps](#) and [flood risk management plans](#).

⁴⁷ See previous chapters on data, methodologies, tools, guidance and design standards

Similarly, the EU Adaptation Strategy encourages all Member States to adopt comprehensive adaptation strategies and climate adaptation plans. These climate adaptation plans provide the implementing actions of a Member State for the consideration of climate adaptation into national and regional policies. The National and/or regional-developed adaptation strategies provide an important source of information on both data, tools, methodologies and standards applied in the EU Member States. Up to date adaptation strategies for 25 Member States have been finalised, and the remaining strategies are under development. Where relevant, these plans are discussed in the specific country reports.

Summary of resources on the Member State level

The present chapter presents a short overview of some of the available resources per Member State: Context, institutional framework, most relevant resources and sector level information are briefly described. The purpose of this section is to provide a glimpse of the material found in the country reports and as such it is not a replacement for the full country reports. For all identified resources, their context, and relevant supporting material, please consult the individual country reports annexed to the present report. The following table presents an overview of the number of identified resources for each country.

| Identified resources | Data Availability | Methodologies | Tools | Guidance | Design standards | System | Institutional capacity | Transport | Broadband | Urban Development | Energy | Water | Waste | Case studies |
|----------------------|-------------------|---------------|-------|----------|------------------|--------|------------------------|-----------|-----------|-------------------|--------|-------|-------|--------------|
| Austria | 16 | 12 | 7 | 9 | 3 | 7 | 7 | 5 | 4 | 10 | 11 | 14 | 7 | 2 |
| Belgium | 50 | 24 | 22 | 22 | 12 | 31 | 11 | 17 | 5 | 27 | 10 | 32 | 8 | 3 |
| Bulgaria | 12 | 4 | 5 | 4 | 3 | 12 | 8 | 6 | 3 | 6 | 3 | 13 | 7 | 1 |
| Croatia | 17 | 2 | 8 | 2 | 4 | 23 | 13 | 1 | 2 | 1 | 0 | 12 | 4 | 1 |
| Cyprus | 15 | 5 | 11 | 3 | 3 | 8 | 12 | 5 | 4 | 5 | 3 | 9 | 4 | 3 |
| Czech Republic | 23 | 3 | 9 | 3 | 4 | 5 | 9 | 13 | 4 | 7 | 5 | 15 | 3 | 0 |
| Denmark | 16 | 5 | 10 | 8 | 3 | 17 | 16 | 16 | 1 | 7 | 4 | 15 | 4 | 2 |
| Estonia | 33 | 8 | 10 | 15 | 5 | 16 | 9 | 3 | 3 | 7 | 3 | 12 | 5 | 5 |
| Finland | 20 | 3 | 12 | 8 | 4 | 19 | 11 | 5 | 6 | 7 | 6 | 10 | 5 | 2 |
| France | 28 | 4 | 18 | 10 | 4 | 13 | 12 | 11 | 10 | 7 | 6 | 13 | 4 | 2 |
| Germany | 25 | 8 | 14 | 3 | 10 | 18 | 8 | 4 | 3 | 10 | 2 | 18 | 4 | 3 |
| Greece | 14 | 14 | 6 | 2 | 4 | 6 | 5 | 6 | 3 | 5 | 2 | 9 | 4 | 3 |
| Hungary | 23 | 8 | 7 | 5 | 3 | 9 | 8 | 3 | 8 | 8 | 4 | 13 | 9 | 2 |
| Ireland | 26 | 1 | 11 | 4 | 4 | 13 | 11 | 4 | 3 | 4 | 2 | 7 | 2 | 3 |
| Italy | 10 | 7 | 6 | 10 | 5 | 7 | 3 | 0 | 2 | 5 | 0 | 11 | 3 | 2 |
| Latvia | 25 | 2 | 6 | 4 | 3 | 12 | 12 | 2 | 3 | 4 | 4 | 12 | 5 | 1 |
| Lithuania | 31 | 4 | 5 | 6 | 4 | 19 | 14 | 8 | 3 | 3 | 2 | 9 | 5 | 1 |
| Luxembourg | 10 | 2 | 9 | 5 | 3 | 9 | 4 | 4 | 2 | 11 | 2 | 16 | 5 | 2 |
| Malta | 7 | 4 | 5 | 3 | 3 | 14 | 9 | 0 | 1 | 0 | 0 | 10 | 4 | 1 |
| Netherlands | 30 | 7 | 10 | 18 | 4 | 13 | 10 | 16 | 7 | 27 | 7 | 18 | 12 | 3 |
| Poland | 13 | 7 | 8 | 8 | 5 | 9 | 2 | 12 | 4 | 9 | 4 | 13 | 6 | 2 |
| Portugal | 15 | 6 | 10 | 8 | 3 | 12 | 5 | 3 | 2 | 6 | 2 | 9 | 6 | 3 |
| Romania | 24 | 7 | 8 | 6 | 3 | 12 | 8 | 3 | 3 | 2 | 3 | 22 | 3 | 4 |
| Slovakia | 8 | 3 | 4 | 3 | 2 | 21 | 2 | 9 | 5 | 5 | 4 | 12 | 5 | 3 |
| Slovenia | 11 | 7 | 7 | 9 | 3 | 10 | 4 | 1 | 1 | 3 | 1 | 12 | 3 | 2 |
| Spain | 20 | 3 | 10 | 7 | 3 | 17 | 4 | 20 | 2 | 12 | 4 | 17 | 4 | 3 |
| Sweden | 25 | 3 | 17 | 11 | 3 | 30 | 6 | 7 | 2 | 9 | 3 | 12 | 4 | 3 |
| United Kingdom | 17 | 6 | 21 | 23 | 8 | 16 | 13 | 16 | 9 | 13 | 15 | 13 | 7 | 3 |

Austria

System and Institutional framework

Austria adopted its [National Adaptation Strategy](#) and its [National Action Plan](#) in October 2012 and the Bundesländer have either developed regional adaptation strategies, integrated adaptation and mitigation strategies, or they have integrated adaptation into existing climate mitigation strategies. The responsible institutions, organisations and groups for climate adaptation are the [Federal Ministry of Agriculture, Forestry, Environment and Water Management](#), the National Climate Protection Committee, the Interministerial Committee to Coordinate Measures to Protect Global, and the [Climate Change Centre Austria](#).

Resources

The main website for climate adaptation is [Klimawandelanpassung.at](#), while general information is available on the [webpage](#) of the Federal Ministry of Agriculture, Forestry, Environment and Water Management. Data for Climate Change Adaptation are available from Climate Change Centre Austria, from the [Central Institute for Meteorology and Geodynamics](#), and the [Centre for Natural Hazards](#). Impact Assessments are available, namely the [Austrian Assessment Report Climate Change 2014: Information and materials](#), and the [Environmental Impact Assessment Satisfying Adaptation Goals Evolving from Climate Change](#). Methodologies that support climate adaptation are available from Klimawandelanpassung that contains a [Handbook on Methods and Tools for Adaptation to Climate Change - a handbook for provinces, regions and cities](#), from the COIN project, and from the project PACINAS. Tools that support climate adaptation include an [evaluation tool \(SALDO\)](#), the demonstration of the [feasibility of climate-adapted infrastructure](#), and [Flood Maps](#). Guidance for the climate adaptation of projects is accessible from the Institute for Meteorology ([ENVISAGE-CC](#)), from the [Strategic support for integrating climate change into project planning](#) for large projects and from the project SPECIFIC. EU-level resources in use are primarily the [Guide to Cost-Benefit Analysis of Investment Projects](#), the publication on [Climate Change and Major Projects](#) and the non-paper [Guidelines for Project Managers](#). Financial resources are found to be available from the [ESI Funds](#) and from the [Climate and Energy Fund \(KLAR!\)](#).

Sectors

The [transport sector](#) is highly exposed to climate change. The [Natural hazards radar](#) is an early warning detection system and the [Austrian Federal Railways \(ÖBB\)](#) has also implemented a nationwide [Meteorological Monitoring System](#). Broadband is addressed in the [Austrian Programme for the Protection of Critical Infrastructure \(APCIP\)](#). For the urban development sector the [Hazard Zone Plan](#) is a comprehensive assessment of hazards and [Planning tools](#) are used for construction and refurbishment. The energy sector is focusing mostly on climate mitigation ([Austrian Energy Strategy](#), [APG Master Plan \(2009\)](#)), and less on climate adaptation. The water sector is presenting a number of initiatives such as the [Wasserinformationssystem WIS](#), includes information on future provision safeguarding against climate change adaptation, an [early warning system](#), and the study [Klimawandel - Anpassungsstrategien für Österreichs Wasserwirtschaft](#). Austria has an updated [National Water Management Plan](#). The waste sector is a cross-section topic within the [NAP](#) - adopting approaches from both the [Waste Management Act 2002](#) and [Federal Waste Management Plan 2017](#).

Case studies

Case studies of climate adaptation have been conducted in the recent study and are available in the respective country report for Austria. The [CCCA - PACINAS_Factsheet 3](#) provides information on the cost relevance of adaptation in cities, and the [CCCA - PACINAS_Factsheet_2](#) offers information on Iterative Climate Risk Management.

Belgium

System and Institutional framework

The [National Adaptation Strategy](#) and the [National Adaptation Plan \(2017-2020\)](#) were approved by the [National Climate Commission \(NCC\)](#) in December 2010 and in April 2017 respectively. Since Belgium is a federal state, the regional and the federal governments have adopted, each in their own area of competence, adaptation plans (the [Brussels Capital Region Adaptation Plan](#), the [Flanders Adaptation Plan](#), the [Walloon Adaptation Action Plan](#), and the [Federal Contribution to the National Adaptation Plan](#)). The responsible institutions for climate adaptation are the [National Climate Commission](#), the Permanent Secretariat and working group on adaptation (CABAO); the [Coordination Committee for International Environmental Policy](#), the [Climate Change Adaptation Team](#), the [Flemish Task Force Adaptation \(VTFA\)](#), the [Wallonia Air and Climate Agency](#), [Climate Change Unit \(AWAC\)](#); and the [Brussels Environmental Agency \(BIM/ IBGE\)](#).

Resources

The main website for climate adaptation National Climate Platform www.climate.be / www.klimaat.be. All regions ([Brussels](#), [Flanders](#), and [Wallonia](#)) have web pages where climate information is gathered and there are links to research projects. Data for Climate Change Adaptation are available from the [Invent](#) and [Fedra](#) databases, and [StatBel](#), the Belgian national statistics agency. Additionally, information is found through the [The MIRA portal and report \(2015\)](#), the [Royal Meteorological Institute](#), the research project [CORDEX.BE](#), the [Flanders Hydraulics Research](#), [KU Leuven \(KUL\)](#) and [VITO](#). Impact Assessments are available, namely for the [Brussels Capital Region](#), for the [Flemish region](#), for the [Wallonia region](#), and for the [Federal level](#).

Methodologies that support climate adaptation are available. Examples include the [Standard method for socio-economic cost-benefit analysis of transport infrastructure projects](#), including specifications for [freight transport and sea port infrastructure](#)), and the [multi-layer water safety framework](#). Tools that support climate adaptation include the [water assessment \(watertoets in Dutch\)](#), the GIS-based tool [LATIS](#), the [climate perturbation tool](#) for statistical downscaling, the [UrbClim](#) model for heat island effects, the [SIRIO tool \(2017\)](#) for sewer and rainwater systems modeling, the [Cities and municipalities adapt tool](#), the [green tool Antwerp](#), and the tool 'Adapte ta Commune' (2017). Tools developed following EU requirements include [Flood Maps](#) which are mapping areas of potential significant flood risk and include a set of interactive maps available with the [Walloon waterways](#), [Walloon Floods portal](#) and several portals in Flanders such as the [VMM mapviewer \(geoloketten in Dutch\)](#), www.waterinfo.be, [DOV](#). Guidance for the climate adaptation of projects is accessible, in the [Scheldt River Basin Management Plan](#) and the [Program of Measures](#), the [Flanders coastal Protection Master Plan \(2011\)](#), the [Sigma Plan \(2005 update\)](#) and the [The Guidelines for integrating climate change adaptation in EIA \(2016\)](#) in Flanders. All regions ([Flanders](#), [Wallonia](#) and [Brussels Capital Region](#)) have extensive information, including guidance documents and templates available for project applications (ERDF / INTERREG). EU-level resources in use are primarily the [Guide to Cost-Benefit Analysis of Investment Projects](#), the publication on [Climate Change and Major Projects](#) and the non-paper [Guidelines for Project Managers](#). The [Bureau for Standardisation \(NBN\)](#) is collaborating with the European standardization bodies at the [Adaptation to Climate Change Coordination Group \(ACC-CG\)](#) and there are design standards for all sectors accessible at [BEN-website](#). Financial resources are found to be available from the [ESI Funds](#), while more specifically, some [guidance](#) is available on financing adaptation projects and integrating adaptation in [spatial planning](#).

Sectors

The transport sector is highly exposed to climate change. The 'Evaluation of vulnerabilities for the Walloon Region regarding climate change' (2011) is a vulnerability analysis for the territory in Wallonia, and there is a brief discussion note on [climate change in the transport sector](#) (2016). The [Federal Contribution to the NAP](#) (2016) includes adaptation targets and actions for the transport sector. The broadband sector is not involved in the federal or regional climate change adaptation plans or initiatives organized by the administrations and other governmental bodies. The urban development sector is taking steps towards climate adaptation. The regional planning policy plans (Flanders draft spatial policy plan- [Witboek ruimte Vlaanderen](#) (2016), Wallonia Spatial development Plan [SDER](#) (2013) and Brussels regional development plan [GPDO](#) (2013) take adaptation into account on a strategic level. The province of Antwerp has its [own regional adaptation plan](#) (2016) with seven key actions, one of which is specifically to [support the uptake of adaptation by municipalities](#). The energy sector is represented by the FEBEG (the federation of Belgian electricity and gas companies), and a [general report](#) and [conclusions of an energy workshop](#) provide insight into potential impacts and the sector's overall sensitivity to climate change. The energy sector is represented in both the [Flanders Adaptation Plan](#) (VAP) and Brussels [Integrated Air-Climate-Energy Plan](#). The water sector is presenting a number of initiatives to adapt to climate change. There are efforts to define [water quantity targets](#) (2016), a guidance exists on how to [increase rain water infiltration](#), and a report on the [Climate change adaptation for maritime and inland port and navigation structure](#). Notable are the [Water management Waterways, preview 2020](#) masterplan, the methodologies for [Flood Risk Management Plans](#) and for developing [rainwater plans](#), the [Water assessment](#) (watertoets), and the [GIS-webplatform](#) that shows flood-risk. The waste sector is currently adapting via EU level initiatives, such as the [Directive 1999/31/EC on the landfill of waste](#)⁴⁸, the [Directive 2010/75/EU on industrial emissions](#)⁴⁹ (IED) and the BAT reference document (BREF) on Waste Treatments Industries.

Case studies

Case studies of climate adaptation have been conducted in the present study and are available in the respective country report for Belgium, offering brief insights into the Redevelopment Groenplaats in Antwerp, the KerkeBEEK Flood risk management and implementation plan and the Kettingplein project. Two examples within the framework of [Flanders' masterplan coastal safety](#) (2011) are the [storm surge barrier in Nieuwpoort](#) or the adapted [sea dike in Wenduine](#) (2015).

Bulgaria

System and Institutional framework

The 2014 [Climate Change Mitigation Act](#) sets out the responsibility for Climate change policy, including adaptation. The Ministry of Environment and Water (MOEW) is responsible for climate change policy covering the period up to 2030 and has initiated the process to develop a National Adaptation Strategy (NAS) and a National Adaptation Plan (NAP), both expected to be finalised in 2018. The [National Expert Council on Climate Change](#) was established following the introduction of the Climate Change Mitigation Act (2014) as an advisory body to the MOEW for the purpose of supporting the minister in implementing climate change policy.

Resources

The [National Institute for Hydrology and Meteorology](#) provides weather-related statistical data, whilst the National Statistical Institute (NSI) collects data regarding the costs (in

⁴⁸ Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste

⁴⁹ Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)

terms of damage to infrastructure and property) resulting from weather-related catastrophic events. The report [Analysis and Assessment of the Risk and Vulnerability of the Bulgarian Economy from Climate Change](#) provides details on climate models and scenarios for Bulgaria, to assess the risk of natural disasters. The framework document "[National climate change risk and vulnerability assessment for the sectors of the Bulgarian economy](#)" allows integration of climate change risk assessments for different economic sectors and regions within a single framework. The [European Climate Adaptation Platform](#) is considered to be very useful by Bulgarian experts who value its easy access to EU-level policy documents and case studies. A tool available for climate adaptation in Bulgaria is the [Flood Risk Management Plan \(FRMP\)](#), which defines the long-term planning for flood risk reduction. The Operational Programme on [Transport and Transport Infrastructure](#) adheres to the guidelines of the "[Non-paper Guidelines for Project Managers: Making vulnerable investments climate resilient](#)" that helps developers of physical assets and infrastructure incorporate resilience to current climate variability and future climate change within their projects. More EU resources are in use, such as the [Guide to Cost-Benefit Analysis of Investment Projects](#), and the publication on [Climate Change and Major Projects](#). The [Bulgarian Institute for Standardization](#), the national standards authority, is collaborating with the European Committee for Standardisation (CEN) and the Electrotechnical Standardisation (CENELEC) that established the [Adaptation to Climate Change Coordination Group \(ACC-CG\)](#) and coordinate standardisation work in the field of adaptation to climate change. Financial resources are found to be available from the [ESI Funds](#), including 77 Million EUR under the Thematic Objective 5 on promoting climate change adaptation, risk prevention and management, from the state budget, and from the EEA and Norway Grants, out of which, 13 Million EUR are allocated for [environment protection and climate change](#).

Sectors

The Ministry of Transport, Information Technology and Communications uses the guiding document of JASPERS [The Basics of Climate Change Adaptation, Vulnerability and Risk Assessment](#) to consider the principles and practices of reducing risk and asset damage in the development of infrastructure projects. The framework document [Risk and Vulnerability Analysis and Assessment of the Bulgarian Economic Sectors to Climate Change](#) was finalised in early June 2014. The framework document [National Climate Change Risk and Vulnerability Assessment for the Sectors of the Bulgarian economy](#) serves as a risk and vulnerability evaluation methodology that could be used within the broadband sector. The Ministry of Environment and Water (MOEW) has developed a [National climate change risk and vulnerability assessment for the sectors of the Bulgarian economy](#). The MOEW provides both a [General Section](#) on urban planning, which describes the basic principles, and a [Specific Section](#) on urban planning which considers ecosystems and biodiversity, energy, tourism, surface waters all of which are relevant to urban development. The energy sector is not involved in the federal or regional authority climate change adaptation plans or initiatives organised by governmental bodies. In accordance with the [National Strategy for the Management and Development of the Water Sector](#), investments in the irrigation sector and in the protection of the water sector generally can be considered as measures to adapt to climate change. Topics relating to water, floods and landslides are covered under the [Operational Programme Environment 2014 – 2020 funded by Cohesion Funds and the Regional Development Fund](#) where investments are to be directed towards the achievement of "Promoting climate change adaptation, risk prevention and management". The Operational Programme aims to promote investment to address climate specific risks, enhancing disaster resilience and also ensuring the development of disaster management systems. Waste is covered under the [Operational Programme Environment 2014–2020 funded by Cohesion Funds and the Regional Development Fund](#), where investments need to contribute to the achievement of the thematic objective 5 "Promoting climate change adaptation, risk prevention and management".

Case Studies

A case study entitled [OrientGate](#) attempts to explore climate risks faced by coastal, rural and urban communities. This project examines cross-boundary cooperation in South East Europe.

Croatia

System and Institutional framework

The National Adaptation Strategy and Plan are being developed in 2017 / 2018. A working version and a draft version of the National Adaptation Strategy ([Green book](#) and [White book](#)), and of the draft of the [National Adaptation Plan](#) for 2019 – 2023 are available. The responsibility for the climate change policy in Croatia falls within the competence of the Ministry of Environment and Energy. The [Committee for inter-sectoral coordination for policies and measures for mitigation and adaptation to climate change](#) was established in September 2014 by the Croatian Government, with the task to coordinate this, monitor and evaluate climate mitigation and adaptation policies. Local authorities are involved in climate adaptation, and the [City of Zadar](#), participated in the [EU Cities Adapt](#) project, while Daruvar, Pitomača and Kloštar Podravski joined the European Commission's [Mayors Adapt](#) initiative, and the municipalities of Buzet, Labin, Pazin, Poreč, Pula and Rovinj are participating in the [LIFE SEC ADAPT](#) project.

Resources

The climate adaptation [documents page](#) at the ministry of Energy and Environment includes a [Capacity Building Assessment Study](#), [Information brochure on adaptation to climate change](#), an overview of current research, an [Assessment of vulnerability to climate change](#), and a [page on Climate modelling](#). Data for climate change adaptation are available from the [Database of Climate Change Indicators](#), the [Croatian Meteorological and Hydrological Service](#), the [Platform for Disaster Risk Reduction](#), and the [Croatian Bureau of Statistics](#). Impact Assessments are available, namely the [vulnerability assessment until 2040 and 2070](#), the [SEE forum climate change vulnerability assessment \(2012\)](#), and the aforementioned [Assessment of vulnerability to climate change at the ministry of Energy and Environment](#). Methodologies that support climate adaptation are currently being developed in the [National Adaptation Strategy](#), while the Croatian State Water Company is developing a methodology applicable to the water sector. Tools that support climate adaptation include a [Regional Climate Model \(RegCM\)](#), the [DIVA model](#), and the [eRineus](#) heatwave warning system. Following EU requirements [Flood Maps](#) are available. Guidance for the climate adaptation are limited to the [Guidelines for the Development of Disaster Risk Assessment \(2014\)](#), and EU-level resources are in use for project development, consisting primarily of the [Guide to Cost-Benefit Analysis of Investment Projects](#), the publication on [Climate Change and Major Projects](#) and the non-paper [Guidelines for Project Managers](#). The [Croatian Standards Institute \(HZN\)](#), the national standards authority, is collaborating with the European standardisation organisations and following the work of the [Adaptation to Climate Change Coordination Group \(ACC-CG\)](#). Financial resources are found to be available from the [ESI Funds](#), from the state budget, and by the private sector (including public-private partnerships - PPP).

Sectors

The transport sector has been sporadically included in the draft of the [National Adaptation Strategy](#), and climate adaptation is covered primarily through EU financing and, more recently, EIA requirements. The Croatian Railways Infrastructure Ltd (HŽI), for example has applied climate change vulnerability and risk assessments and have taken into consideration climate change mitigation and adaptation measures for projects financed by the ESI Funds. Broadband infrastructure resources have not been identified, but the sector is required to take climate adaptation into account for major projects. In the urban development sector steps are taken towards climate adaptation as, for example, the [City](#)

of Zagreb, has carried out an analysis of the anticipated climate change impacts. The energy sector is focusing mostly on climate mitigation and less on climate adaptation, and during the present study, no sector resources that include climate adaptation were identified. The water sector is presenting a number of initiatives to adapt to climate change. Due to EU Directives there are [River Basin Management Plans \(RBMP\)](#), [flood hazard and risk maps](#) and [flood risk management plans](#). The World Bank supported climate adaptation with studies on a [Water and Climate Adaptation Plan for Sava River Basin](#), and with the development of the hydrologic model for the Sava river basin. Moreover, Croatia participated in the project [Integration of Climate Variability and Change into National Strategies for Integrated Coastal Zone Management](#) funded by GEF and UNEP. The waste sector is currently adapting via EU level initiatives, such as the [Directive 1999/31/EC on the landfill of waste](#), the [Directive 2010/75/EU on industrial emissions \(IED\)](#) and the [BAT reference document \(BREF\) on Waste Treatments Industries](#).

Case studies

Case studies of climate adaptation have been conducted in the resent study and are available in the respective country report for Croatia. Dubrovnik Airport, a large reconstruction investment currently being executed, includes in the planning and design phase the consideration of climate change impacts.

Cyprus

System and Institutional Framework

Cyprus' National Adaptation Strategy and the National Adaptation Action Plan were approved in 2017. The [Ministry of Agriculture, Rural Development and Environment](#) is the central body coordinating the adaptation policy-making process. The [Department of Environment](#) supervises the implementation of policy and the adoption of European policy and legislation on the environment. The [National Council for Research and Innovation \(NCRI\)](#) and the [Cyprus Scientific Council \(CSC\)](#), are the main bodies responsible for strategy and planning. The [Strategic Plan of the Ministry of Environment](#) examines the need to enhance the institutional capacity and improve the effectiveness of the Department for Climate Change Adaptation. It comments on the lack of an integrated automation system, restricting the efficiency of the [Department](#).

Resources

National data relating to climate change can be found at the [Department of Meteorology](#), the [Department of Air Quality](#) and from the [Meteorological Service](#). Additional climate change adaptation data can be found on the [Cyprus National Open Data Portal](#). CYPADAPT contains a database which has been developed with the aim to provide information on adaptation measures applied worldwide. The CYPADAPT methodology is developed in line with the [Intergovernmental Panel on Climate Change](#) framework, for assessing policies against climate change adaptation needs as part of a project. A [risk assessment methodology](#) (produced by the Horizon2020 "BINGO project Deliverable 4.1: Water Sector Risk Assessment"), aims to create adaptation strategies for water management. CYPADAPT also developed a [multi-criteria analysis \(MCA\) tool](#) for the selection of the most appropriate set of [adaptation options](#). DARECLIMED is a [CYI](#) project which aims to create a climate data repository and knowledge sharing platform, and to improve data availability for the Eastern Mediterranean region. [CYI](#) uses meteorological, hydrological and climate models as tools for estimating the impacts, the vulnerability and risks from climate change and for developing climate adaptation options. [CIRIA](#) has produced a number of guidance documents covering a range of opportunities and challenges related to water management. Guidance on natural water retention measures are available at the [NWRM EU Platform](#), where the focus is on green infrastructure. EU resources are in use, such as the [Guide to](#)

Cost-Benefit Analysis of Investment Projects, the publication on Climate Change and Major Projects and the non-paper Guidelines for Project Managers.

Sectors

The 2016 [Climate Change Risk Assessment](#) provides an overview per sector of potential risks and opportunities of climate change for Cyprus until 2100. It has focused on 11 priority sectors, including infrastructure. The critical infrastructure of Cyprus has been developed near the coastal area, except for Lefkosia (Nicosia) which is located near the centre of the island. Rising sea levels will lead to further erosion and heightened safety threats for infrastructure such as Larnaca airport. The [Flood Risk Management Plan](#) identifies a significant risk of flooding due to urbanisation, and foresees measures to enhance the resilience of road infrastructure in these affected areas. The [Flood Risk Management Plan](#) includes a total of 38 actions covering all aspects of flood risk management (e.g. actions to increase knowledge, the development of information and best practices in the management of flood risk etc.). The [Cyprus Climate Change Risk Assessment Report](#) mentions how Nicosia is vulnerable to urban heat island (UHI), whereby an area experiences elevated air temperatures. A [Vulnerability assessment](#) on energy demand due to climate change in Cyprus includes a variety of measures that Cyprus is taking to increase the supply and resilience of domestic energy in response to the increased risk of damage and the increased demand for heating and cooling. The broadband and waste sectors are not involved in the national or regional authority climate change adaptation plans or initiatives organised by governmental bodies.

Case Studies

A number of case studies on climate adaptation have been provided in the country report for Cyprus, describing a [transnational network of innovation for agriculture](#) in the Mediterranean, and knowledge and innovation transfer project (AQUA KNIGHT), and the project [AGWATER](#) for sustainable agricultural production under climate change.

Czech Republic

System and Institutional framework

The Czech Republic adopted the [Strategy on Adaptation to Climate Change in the Czech Republic](#) in 2015. The implementing [National Action Plan on Adaptation to Climate Change](#) was adopted in 2017, and will be reviewed every 4-5 years. The [State Environmental Policy](#) sets the overall framework for an effective protection of the environment and provides information on adaptation measures, mainly for water management. The Ministry of the Environment is the central state's administrative authority and supreme inspection authority in environmental affairs. It has responsibility over the development of the climate change adaptation policy of the country, and is supported by the involvement of other ministries and research institutes (Environment Centre of the Charles University, Academy of Sciences, Czech Hydrometeorological Institute).

Resources

Information on climate change adaptation is available on the [webpage dedicated to Adaptation to climate change](#) on the website of the Ministry of the Environment. Meteorological data is maintained by Czech Hydrometeorological Institute, whilst [CzechAdapt](#) provides information about the expected impacts, risks and vulnerability of potential adaptation measures. The 2017 [National Action Plan](#) is the main guidance document available and provides guidelines to achieve climate adaptation goals for individual sectors. The Ministry of Transport, as the Managing Authority for the Operational Programme for Transport, has made available online several [methodological guidance](#) documents for transport projects, where climate adaptation is included. EU resources are

in use, such as the [Guide to Cost-Benefit Analysis of Investment Projects](#), the publication on [Climate Change and Major Projects](#) and the non-paper [Guidelines for Project Managers](#). There are three tools available in Czech Republic with regard to climate change adaptation; Clidata – a tool to archive climate data, Agriclim, a software to evaluate aspects and indicators of current and future climatic conditions, and a [Flood Map](#) presenting rainfall projections and erosion projections. The [Czech Office for Standards, Metrology and Testing](#), the national standards authority, is collaborating with the European standardisation bodies in the [Adaptation to Climate Change Coordination Group \(ACC-CG\)](#).

Sectors

Czech Republic's institutional support to climate change adaptation is most evident in the water, urban development, transport and energy sectors, which are addressed in the [National Adaptation Strategy \(2015\)](#), the [Comprehensive Impact Assessment, the Impact Assessment and the Risks Related to Climate Change in the Czech Republic \(2015\)](#) and the [National Action Plan for the Adaptation to Climate Change \(2017\)](#). The document reports expected impacts on the sectors and provides the relevant adaptation measures and their estimated costs. In the framework of the Transport Operational Programme, the Ministry of Transport has issued a report on [expert background to take into account the impacts of climate change on the preparation of transport infrastructure projects](#). UrbanAdapt, a project that aimed at developing adaptation plans in the cities Prague, Brno and Pilsen, developed a [methodology](#) to support the adaptation of cities using environment-friendly measures. A [Flood Map](#) is available on the website of the Department of Geographic Information Systems and Cartography of the Masaryk Water Research Institute. Similar [flood forecasts](#) are available on the website of the Czech Hydro-meteorological Institute. The broadband, energy and waste sectors are not involved in the national or regional authority climate change adaptation plans or initiatives organised by governmental bodies. A number of major [infrastructure projects](#) benefiting from European Structural Investment Funds, relating to climate change adaptation, are planned for the Czech Republic for the 2014 – 2020 programming period.

Case Studies

In the context of the present study, no case studies were identified for Czech Republic on climate change adaptation.

Denmark

System and Institutional framework

The inaugural [Danish Strategy for Adaptation to a Changing Climate](#) was published in 2008, followed by an [Action Plan for a Climate-Proof Denmark](#) in December 2012. The Ministry for Energy, Utilities and Climate carries out legislative work in cooperation with other government agencies – in particular the [Danish Energy Agency](#). They are primarily responsible for coordination and development of domestic climate and energy policy, inter-ministerial coordination, and negotiation and implementation of international agreements and EU regulations. The Ministry consults with other ministerial institutions when in need of expert advice. All [Danish municipalities have finalized their climate adaptation action plans](#). Local Government Denmark (LGDK) has a specific department focusing on technology and the environment, which assists the municipalities with consultancy services within areas such as water, nature, planning, urban and road traffic.

Resources

The Danish portal "Klimatilpasning" provides open access to the latest knowledge of climate change adaptation, and is continually being developed so it can be used by authorities, businesses, sector specialists and the general public. The portal will thus help support

autonomous adaptation. Meteorological data are available throughout Denmark, via the Danish Meteorological Institute (DMI) offering open-source climate change adaptation-related data, planning tools and information used to capture climate change adaptation information. There are also sector-specific websites, such as [kyst.dk](#) with further work currently being carried out to coordinate between each key stakeholder at municipality level, before disseminating this information nationally to businesses, local government and all citizens. Climate change adaptation methodologies adopted across Denmark vary between municipality and on a case-to-case basis. The decision to delegate responsibility for climate change adaptation methodology to individual municipalities, rather than national government is intended to support municipalities having greater flexibility in assessing climate change adaptation requirements. A mutual agreement between the national government and LGDK in 2012 led to each municipality being required to prepare a local climate change adaptation plan “[Kommuneplan](#)”. The Danish web portal [Klimatilpasning](#) has published a [guide](#), introducing a general methodological framework and model to estimate climate change risks and climate change adaptation possibilities. [Klimatilpasning.dk](#) provides a set of interactive tools to help users, including an interactive climate change map and a report featuring models to do with erosion and perceived risk. EIONET provide both [Flood Maps](#) and [Flood Risk Management Plans](#). This is publically available and maps areas of potential significant flood risk. Institutes at [Aarhus University](#) and the [University of Copenhagen](#) work closely with relevant institutes and agencies such as the DMI and DEA, who collect and share knowledge regarding climate change adaptation throughout Denmark. [Local Government Denmark \(LGDK\)](#) is the network and interest group for all 98 Danish municipalities. The mission of LGDK is to assist and ensure that local authorities are provided with up-to-date and relevant information. Klimatilpasning is anchored in The Ministry of Environment and Food of Denmark, but in collaboration with a number of ministries, government agencies and stakeholders, including Danish regions and LGDK. Further resources are required in order to work with the economic analysis. There is currently a lack of coordination between authorities, and it can be unclear at which level of government responsibility lies for producing such analysis i.e. with municipalities or with national authorities. EU resources are in use, such as the [Guide to Cost-Benefit Analysis of Investment Projects](#), the publication on [Climate Change and Major Projects](#) and the non-paper [Guidelines for Project Managers](#).

Sectors

The Danish Road Directorate (“[Vejdirektoratet](#)”) is committed to protecting the Danish state-owned road network through climate change adaptation by producing a strategy. With a new [climate change adaptation plan](#) and a [contingency plan for torrential rain](#), Copenhagen Airport is now in the process of adapting to future climate conditions. Local authorities have carried out a number of smaller projects to ensure stable connection across the country. An example is the Solrød municipality, which has internally-connected their local institutions with fibre connections. [Flydende og fast](#) is a Danish handbook with methods and tools to develop climate change adaptation solutions, particularly within urban cities; whereas [Kysterne](#) contains interactive maps that depend on inputs and show different scenarios regarding especially floods and erosion. [Klimatilpasning.dk](#) provides up-to-date news and information regarding various strategies and projects, including in the [Energy distribution page](#). The [National Environmental Research Institute](#) is also involved in energy and climate adaptation projects, such as NORD-STAR. There is a national focus on water-related measures in urban areas, particularly since the [Copenhagen floods in 2011](#). In Copenhagen, there have been calculations regarding the risk of damage from rising seawater levels. This is further described in the Copenhagen Climate Change Strategy (“[Københavns Klimatilspasningsplan](#)”). Various organisations in Denmark are establishing strategies to ensure the waste management sector is adapting to climate change. One organisation, “[Multikant](#)”, develops strategies and solutions for state-of-the-art waste handling and for both the public and the private sector.

Case studies

The case studies found in the accompanying country report for Denmark, feature Copenhagen's 2012 [Cloudburst Management Plan](#), a socio-economic study analysing the combined sewer solution in the city; and a [local adaptation planning project across 15 Danish municipalities](#).

Estonia

System and Institutional framework

The Estonian [National Climate Change Adaptation Development Plan](#) was approved in 2017. The [Ministry of Environment](#) is responsible for the implementation of the adaptation strategy and shall annually present to the Government of the Republic an overview about the execution of the NAS and the achievement of its objectives. Partial responsibility has been given to the Ministry of Rural Affairs, Ministry of Economic Affairs and Communications, Ministry of the Interior, Ministry of Finance, Ministry of Education and Research and other ministries. A Steering Committee was formed to support the development of the NAS. The Steering Committee was led by the Estonian Environmental Research Centre, and included representatives of concerned government authorities, associations and organizations. The climate change adaptation [Development Plan's](#) main objective is to increase readiness and capacity of the state, and of regional and local levels to adapt to climate change.

Estonia is a member of the [EU Strategy for the Baltic Sea Region](#) and the [Strategy for the Baltic Sea Region Action Plan](#) sets the framework for implementation. The Strategy and Plan are both complete, with the Plan's [web portal](#) providing a comprehensive list of projects undertaken in Estonia. A report by the [Baltic Environmental Forum](#) describes strategies adopted by Estonia for climate change adaptation since 2008, and gives the list of national institutions involved in the process and their assigned responsibilities. Other active institutes include the Estonian Environmental Research Centre and the University of Tartu.

Resources

Various resources are available to support climate adaptation. The official web portal, "[Keskkonnaministeerium](#)", contains all Climate Change Adaptation data. Regarding the value at risk (VAR) from climate change, a study commissioned by the Ministry of the Environment of Estonia "[Adapting to climate change in the fields of economy and society](#)" analyses the social and economic impacts of climate change adaptation on Estonia. The [Estonian Environmental Research Centre](#) provides relevant and up-to-date information on climate change adaptation and strategies for each sector for citizens, municipalities and businesses. The [State Weather Service](#) also surveys meteorological and hydrological parameters throughout the country. Information about the [sea level status, trends, projections and water temperatures in different coastal regions](#) of Estonia is held by the Marine Systems Institute at Tallinn University of Technology. There also exists an advanced [tool for scenarios of the Baltic Sea ECOsystem to SUPPORT decision making \(ECO SUPPORT\)](#). The Baltadapt project has created the a [Vulnerability Assessment Concept](#), a tool for the prioritisation of the most relevant issues for macro-regional cooperation, and a methodology for the [conceptualisation of vulnerability and review of assessments around the Baltic Sea region](#). National guidance exists in the form of the Climate Change Adaptation Strategy until 2030 ([NAS](#)) and National Action Plan ([NAP](#)). Baltadapt created [Guidelines on System Vulnerability](#), an analysis of the Baltic Sea region vulnerability to the impact of climate change. EU resources are in use, such as the [Guide to Cost-Benefit Analysis of Investment Projects](#), the publication on [Climate Change and Major Projects](#) and the non-paper [Guidelines for Project Managers](#). Design standards have been amended for climate change adaptation, for instance a rule by the Haapsalu City Government following flooding in 2005. In the areas of planning, health and rescue capabilities, the University of Tartu conducted research on the project "[WHAT: Assessing the Impact of Climate Change](#)

and Developing Adaptation Measures in Planning, Land Use, Human Health and Rescue Capacity.

Sectors

Estonia has prepared resources for some of its sectors to adapt to climate change. The [Estonian transportation sector](#)⁵⁰ is well adapted to the seasonal changes and climate extremes in general - transport infrastructure is built in line with the climatic conditions of latitude. In the areas of energy and infrastructure, the Stockholm Centre for the Environment conducted the project "[ENFRA: Estonian Infrastructure and Energy Sector Climate Change Adaptation Strategy](#)". The broadband sector is not addressed in the Estonia climate change adaptation [Development Plan](#). For urban development, the [Development Plan](#) prioritises Land Use and Planning, and Infrastructure and Buildings to alleviate the risk of flooding and erosion through effective urban planning. In the energy sector, the objective of the [Estonian climate adaptation strategy for infrastructure and energy](#) has been to analyse the climate change impacts and suggest adaptation measures for the adaptation strategy. For the water sector, there is information available on sea level trends and projections for different coastal region. [Flood risk management plans](#) and [flood risk maps](#) are available following the requirements of the EU Floods Directive. The [WEAP](#) software tool that takes an integrated approach to water resources planning to evaluate climate adaptation options under different climate, economic, agricultural and energy scenarios. For the waste sector, reducing the environmental risk from waste is a part of the [National Waste Management Plan 2014–2020](#). Taking into consideration that the forecasts predict an increase in the occurrence of extreme weather conditions, the [arrangement of landfills and mining waste storages](#) is also a measure which helps to adapt to climate change.

Case Studies

The present study examines five case studies for climate adaptation projects and infrastructure projects in Estonia, with more information provided in the respective country report. The selected case studies the [climate adaptation strategy for infrastructure and energy](#), [integrated marine and inland water management](#), the development of a [system modelling and decision support tool](#), a [Cloud-based Flood Prevention and Monitoring System](#), and the promotion of [cross-border sustainable urban drainage systems](#).

Finland

System and Institutional framework

Finland published a [National Strategy for Adaptation to Climate Change](#) in 2005, and set the framework for its implementation in 2014, with the [National Climate Change Adaptation Plan 2022](#). The Helsinki Metropolitan Area has, since 2012, a [Climate change adaptation strategy](#). The [Finish Climate Change Panel](#) has realised a project on [Monitoring the national energy and climate strategy - systematics and accessibility of climate policy reporting in Finland](#) (2015), where it maps out the key actors and their specific roles in climate policy reporting of Finland. A [Monitoring Group on Climate Change](#) was appointed in 2015 to coordinate the implementation of the National Climate Change Adaptation Plan. This cross-sectorial working committee, appointed by the government and led by the Ministry of Forestry and Agriculture, is monitoring and developing the implementation of the national adaptation plan. Regional and local steering is developing with over 40 municipalities

⁵⁰ Lahtvee, V. Allik, A., Annuk, A., Heinap, J., Jüssi, M., Kallaste, T., Kirsimaa, K., Klein, K., Kuldna, P., Nõmmann, T., Oisalu, S., Rimmelgas, L., Uiga, J., Piirsalu, E., Poltimäe, H., Tuhkanen, H., (2015), Eesti taristu ja energiasektori kliimamuutustega kohanemise strateegia – lõpparuanne. SEI Tallinn, Eesti Maaülikool, Balti Keskkonnafoorum, Fridjof Nanseni Instituut. Tallinn-Tartu, 724 lk.
https://www.envir.ee/sites/default/files/enfra_lopparuanne.pdf

participating in the climate campaign of the Association of Finnish Local and Regional Authorities.

Resources

The main web portal for information on climate change adaptation is the [Climateguide Finland](#). The website of the [Ministry of Agriculture and Forestry](#) also presents information adaptation, it references the main framework documents and links to relevant publications. It has also developed a [database](#) of projects on climate change adaptation across different sectors. The Finnish Environment Institute (SYKE) offers comprehensive data on [flood modelling and mapping](#) that helps in efficient flood risk management. Methodologies supporting climate adaptation are available for the construction and water sectors. A [review of Finland's climate change adaptation studies](#)⁵¹ contains a wealth of information on existing studies and their methodologies for estimating climate impacts. Tools regarding climate-proof planning by urban planners, construction, and landscape industries are available. [FINESSI](#) is a web tool developed at the Finnish Environment Institute which enables its user to explore the possible impacts of climate change. The Finnish Innovation Fund SITRA commissioned the development of [climate screening tool](#) with a view to enabling Finnish organisation in understanding and managing potential risks associated with climate change. The [Climate-Proof City](#) project 'ILKKA' offers tools to climate-proof planning for urban planners and construction and landscape industries based on best-practices developed in Helsinki. The [National land use guidelines of 2008](#) state that the flood hazard areas specified in official reports must be taken into consideration in land use planning and every effort must be made to prevent flood-related risks. The Finnish Association of Local and Regional Authorities issued in 2012 a [guidance](#) for the sound management of storm water in urban planning. The Finnish Meteorological Institute published a guidance for the [evaluation of energy demand](#) and [indoor physics](#) of buildings taking into account future climate change impacts. The Finnish Environment Institute has issued design standards for the lowest building levels on inland waterways and the seashore area. The [storm water guidance](#) has technical design standards on how the storm water drainage system should be sized properly. The [guide for preparing for floods in buildings](#) includes design standards required by law which state what is the lowest recommended height from sea level for constructing buildings. EU resources are in use, such as the [Guide to Cost-Benefit Analysis of Investment Projects](#), the publication on [Climate Change and Major Projects](#) and the non-paper [Guidelines for Project Managers](#).

Sectors

The Finnish Transport Agency provides guidance on adaptation measures for both roads and railways. The [Climate Policy Programme](#) for the Ministry of Transport and Communications' administrative sector for 2009-2020 also acknowledges that the need for resources might increase in the future and but only vaguely refers to broadband. The [ELASTINEN](#) project recognises that urban areas are more sensitive to climate risks, the biggest risk factors being storm water floods, prolonged heat and dryness. In land use planning, new construction should not be placed in flood risk areas. The [Climateguide.fi](#) repository notes the energy sector should prepare especially in production of waterpower and power distribution networks. The Energy Authority has issued a report on the reliability and development of the Finnish electricity networks. The biggest risks are increased flood or drought period. Their effects are already visible, and require adaptation measures. The Finnish Environment Institute published a report on [Water resources and Climate change – effects and adaptation](#) in 2012. The waste sector is not involved in the federal or regional authority climate change adaptation plans or initiatives organised by governmental bodies.

Case Studies

⁵¹ "Arvioita Suomen muuttuvasta ilmastosta sopeutumistutkimuksia varten"

Two case studies for Finland were identified, focusing on energy infrastructure and the Elenia Säälvarma Underground Cables; and on [reducing the overflow of sewage to river Vantaa](#).

France

System and Institutional framework

The [National Adaptation Strategy](#) was adopted in 2006 and complemented in 2011 by the adoption of the [National Adaption Plan](#). The process for the revision of the National Adaptation Plan (NAP) has started in June 2016 and is expected to conclude in 2018. Adaptation is under the responsibility of the Ministry of the Environment since 2001, when climate change was identified in the Environmental Code as a national priority. To address climate adaptation at the national level, the National Observatory on the Effects of Climate Change (ONERC) was set up in 2001 by the Ministry of the Environment, as part of the General Directorate on Energy and Climate and tasked with the collection and dissemination of information on the risks posed by climate change. It primarily works with the Intergovernmental Expert Group on the Evolution of Climate (GIEC), a research group under the aegis of the International Panel on Climate Change (IPCC). At the regional level, each region has to submit a [Regional Scheme for Climate, Air and Energy](#) since 2007. These must include a vulnerability assessment of the territory and a section dedicated to adaptation to climate change.

Resources

Important websites for climate adaptation information and data are provided by the [Ministry of the Environment](#), [WIKLIMAT](#), and by the [National Meteorological Service, Météo France](#), which is accessible online. Regional data can be found in the Regional Schemes for Climate, Air and Energy (SRCAE). France has set up as a resource centre providing [methodological and operational support for the implementation of a Climate-Territorial Energy Plan](#). From the outcome of the review and recommendation process that will serve as a basis for the 2018 National Adaptation Plan, [the new NAP will provide a clear methodology](#) to support the identification of infrastructure projects critically at risk from climate change. The National Meteorological Service [Météo-France](#) has developed several tools to assess the potential impacts of climate change, including [DRIAS](#), [ARPEGE CLIMAT](#) and [ClimatHD](#). To assess the overall risk for a territory in France, the Ministry of the Environment developed an [interactive map](#) of all the geological risks, the [GEORISQUE](#) tool. The ADEME has compiled a [list of potential vulnerability indicators](#) in a report in an effort to provide public authorities in charge of undertaking vulnerability assessment with a toolbox. As an action of the 2011 National Adaptation Plan, a specific tool is [being developed](#) by the Centre for Study and Expertise on Risks, the Environment, Mobility and Planning (CEREMA) to support decision-making in the transport sector. As part of the 2010 report on the [Economy of the adaptation to Climate Change](#) the Ministry of the Environment published guidance on the assessment of costs and benefits of adaptation in 2010 which can be applied to territories or infrastructure. A [guidance for territories to perform climate change vulnerability analysis](#) was also published in 2011 by the MOE to assist local authorities in assessing their vulnerability to climate change. As part of the 2010 report on the [Economy of the adaptation to Climate Change](#), the MOE published guidance on the assessment of costs and benefits of adaptation in 2010, which can be applied to territories or infrastructure. As an action of the 2011 National Adaptation Plan, a specific guide is being developed to provide assistance in estimating costs and benefits of adaptation measures in the transport sector: the Centre for Study and Expertise on Risks, the Environment, Mobility and Planning has published a first [methodological framework](#). The French Standardisation Association (AFNOR) has yet to address the issue of climate change adaptation. EU resources are in use, such as the [Guide to Cost-Benefit Analysis of Investment Projects](#), the publication on [Climate Change and Major Projects](#) and the non-paper [Guidelines for Project Managers](#).

Sectors

The transport sector was specifically targeted by the 2011 National Adaptation Plan with four different actions carried out by the General Directorate for Infrastructure, Transport and Sea (DGITM) and the Centre for Studies and Expertise on Risks, the Environment, Mobility and Planning (CEREMA). The broadband sector has so far taken little steps towards adaptation, but from the outcome of the review and [recommendation process](#) that will serve as a basis for the 2018 National Adaptation Plan, [adaptation of broadband will be addressed](#). Urban development was specifically addressed in the 2011 National Adaptation Plan with four measures to improve how adaptation is taken into account in urban planning. ROSAU is a tool specifically developed to increase urban resilience. In the energy sector, the French TSO (RTE) publishes a yearly report on projected consumption and production patterns which is used for the evolution of planning procedures to ensure that maintenance processes are planned according to the new patterns influenced by temperature evolutions. Overall, the existing infrastructure is considered to be able to sustain projected temperatures, though localised adjustment may be necessary. For the water sector, in 2016 the CEREMA published a new [national vulnerability assessment](#) on the risk of flooding. It is noted that following an engagement during the COP21, the six regional water regulators Agences de l'Eau [committed](#) to integrate adaptation measures in their planning schemes for the period 2016-2021. The waste sector is not dealt with in the national or regional authority climate change adaptation plans or initiatives organised by governmental bodies.

Case Studies

Case studies identified in France cover a Water management initiative in a new district in Rouen (more information from: [Luciline - Rives de Seine](#)) and the [Bellegarde Railway Station](#).

Germany

System and Institutional framework

The key documents regarding climate change adaptation in Germany are the [German Strategy for Adaptation to Climate Change](#), combined with the [National Action Plan](#) and the [Progress Report on the German Strategy for Adaptation to Climate Change](#). Every four years the Interministerial Working Group on Adaptation Strategy publishes a [Monitoring Report on the Impacts of Climate Change \(2015\)](#). The German Federal Environment Agency (UBA) and the associated [Competence Center on Climate Impacts and Adaptation \(KomPass\)](#) provide institutional support for climate adaptation. Climate change adaptation is a competence shared between the federal level and the regions. Each Bundesland has developed climate change adaptation strategy for their territory. The National Action Plan lays down a set of criteria for measures to be taken at the level of the regional level.

Resources

There is a wealth of resources available in Germany to support climate adaptation available through authorities, several universities and research institutions. The German Federal Environment Agency (UBA) uses data of the [Deutscher Wetterdienst \(DWD\)](#) to create climate models. Associated to the DWD is the [Deutscher Klimadienst \(DKD\)](#), which is a network of authorities and offices that provide operational, reliable and long-term climate information and climate services. The Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) is in the process of creating an online data platform, which will be freely accessible and is expected to be launched in 2018 under the name "Klimavorsorgeportal" (KliVoPort). A number of tools are available from different authorities, ministries and research institutions, such as [Tatenbank](#), [Klimalotse](#), [Stadtklimalotse](#) and [Klimanavigator](#). [Tatenbank](#), for instance, offers more than a hundred

examples of measures and projects on climate adaptation in Germany. The main portal "KomPass" offers direction on 'how to start' addressing climate change adaptation for different target groups and which instruments and project examples are available. The [Deutsches Institut für Normung](#) (DIN, the German Institute for Standardisation) has established two working groups dealing with the adaptation of DIN standards due to climate change. Since 2012, the German Institute for Standardisation has set up the [Working Group on Adaptation to Climate Change \(DIN KU-AK 4\)](#) through the coordination centre for environmental protection. The aim is to more effectively take into account the consequences of climate change in standards. The German [Federal Environment Agency \(UBA\)](#) and the associated [Competence Centre on Climate Impacts and Adaptation \(KomPass\)](#) provide institutional support. Both the [Adaptation Strategy, 2008](#) and the [Action Plan, 2011](#) require regular evaluation and updating. This process is supported by the Competence Centre for Climate Impacts and Adaptation at the Umweltbundesamt (KomPass). At the municipality level, several municipalities have put in place so called "Klimaschutzmanager" – climate protection managers. Currently, approximately 309 municipalities around Germany employ climate protection managers. EU resources are in use, such as the [Guide to Cost-Benefit Analysis of Investment Projects](#), the publication on [Climate Change and Major Projects](#) and the non-paper [Guidelines for Project Managers](#).

Sectors

On the sectoral level, there are a number of initiatives. Transport is one of the sectors analysed within the [National Adaptation Strategy](#). Most of it focuses on transport infrastructure issues, but some aspects of transport services. Broadband services in the field of climate change adaptation are used in the [I-Sand project](#) in the city of Dresden. For the urban sector, the Federal Institute for Building, Urban and Regional Research (BBSR) commissioned the Federal Ministry of Education, Building and Urban Affairs (BMBF) to focus on a "[cross-evaluation](#)" of [central federal cooperation projects](#) on adaptation to climate change on urban and regional development. Examples of cities that developed climate change adaptation strategies are the city of Nürnberg, Stuttgart, Munich, Cologne and Berlin. In the energy sector examples of climate change adaptation most often refer to the (changing) energy demand of companies, cities or regions in association with extreme weather phenomena due to climate change. The water sector in Germany shows reasonable resources with respect to climate change adaptation. Most cases refer to flood protection measures, adapting to heavy rainfall events in urban areas and adapting the water supply and management system within a city or region. At the national level, adaptation measures aimed at reinforced arrangement of natural flood surfaces and recovery of retention surfaces (e.g. polders formed close to nature) / dyke relocations according to the [National Flood Protection Program](#). The waste sector is not involved in the federal or regional authority climate change adaptation plans or initiatives organised by governmental bodies.

Case studies

Case studies for climate adaptation identified within the context of the present study comprise of the [Future Cities' Green-Blue corridor](#), which disconnects storm water from the nearby paved areas, and ecologically improves the Kamen stream; a case study for [Sun-Protection for Bus Stops](#) in Nordhessen; and the [KiezKlima](#) project in Berlin.

Greece

System and Institutional framework

The [National Adaptation Strategy \(NAS\)](#) was adopted in 2016 with a 10-year implementation horizon. Significant responsibilities have been assigned to the 13 Regions which need to develop climate adaptation action plans. The Regional Adaptation Action Plans are the key tool for ensuring the sustainability of infrastructure against climate

change and their content has been specified in [Ministerial Decision 11258/2017](#), which set out the [content requirements for Regional Adaptation Plans](#). The Ministry of Energy & Environment (MEEN) is the national competent authority for national adaptation policy. A National Climate Change Adaptation Committee has been established, it is chaired by the Minister of Environment and Energy, and includes representatives of all competent ministries, the regional and local government, the National Meteorological Service, the academic and research community, NGOs and the national enterprises federation. It is the central advisory body of the State for the coordination, monitoring and evaluation of climate change adaptation policies.

Resources

The [Ministry of Environment and Energy](#) coordinates the task of data collection on climate change impacts, and collaborates for data processing with institutes such as the National Technical University of Athens, the National Meteorological Service and the Greek Statistical Authority. There are useful data on climate adaptation to be accessed via decentralised sources, such as the Hellenic Institute of Transport and the University of the Aegean through the [ERA BEACH project](#). Sea level data are available from the Permanent Service for Mean Sea Level (PSMSL) and wave regime data are sourced from the Environmental Monitoring System of the Hellenic Centre for Marine Research. Satellite data are provided by the Greek private company TERRA SPATIUM. For major infrastructure projects implemented in Greece, climate vulnerability and risk assessments are carried out based on the methodology suggested by the guide [Climate Change and Major Projects, EC 2016](#). Other Operational Programmes with Major Projects (excluding phased projects) are expected to be identically addressed. The [Institute of Environmental Research and Sustainable Development](#) of the National Observatory of Athens undertakes climate impact assessments and climate vulnerability assessments. The [Risk and vulnerability assessment](#) presented in the [National Adaptation Strategy](#) used an activity/output based method for allocating regional and sectorial damages, following estimates of the [2011 Bank of Greece study](#). The National Adaptation Strategy provides references for tools that are available in the sectors of biodiversity, water, and health (EMEKA 2015). The [CYPADAPT Multi-Criteria Analysis tool](#) ([direct download link](#)) has been designed to allow for the prioritisation of measures for adapting to climate change impacts. Due to the exceptionally long coastline, and its relation to the tourism industry, a number of tools have been developed in Greece with applicability to coastal areas. The [THALIS - CCSEAWAVS tool](#) is estimating the effects of climate change on sea level and wave climate of the Greek seas, coastal vulnerability, and safety of coastal and marine structures. EU resources are in use, such as the [Guide to Cost-Benefit Analysis of Investment Projects](#), the publication on [Climate Change and Major Projects](#) and the non-paper [Guidelines for Project Managers](#). A recent study on climate adaptation by [Dianeosis \(2017\) "Climate Change Impacts on Development"](#) examined the inclusion of climate adaptation requirements in standards specified by law and applicable to either infrastructure or infrastructure-related environmental studies.

Sectors

The Hellenic Institute of Transport, CERTH-HIT, contributed to the publication of [adaptation strategies for the transport sector](#), in the context of the WEATHER project, while a number of researchers have contributed to the UNECE report from 2013 on [Climate Change Impacts and Adaptation for International Transport Networks](#). The broadband sector is not involved in the federal or regional authority climate change adaptation plans or initiatives organised by governmental bodies. For urban development, the objective of the [Urban Proof project](#) is to strengthen municipal resilience to climate change by providing a powerful tool to support informed decision-making. There is also reference to climate change adaptation in the Integrated Urban Intervention Plan for Athens, Western Athens, Piraeus, and Larissa. In the energy sector, and under the Competitiveness Entrepreneurship and Innovation operational programme, funding is provided for two energy projects, of which both are required to implement climate adaptation measures following the realisation of climate risk and vulnerability assessments. The water sector is lacking extensive adaptation measures for infrastructure projects, but there is a growing body of research to estimate impacts and

suggest adaptations, such as a report in 2014 by the Bank of Greece examining [the effect of climate change in surface and subway water bodies](#). In the waste sector, the Operational Programme "Transport Infrastructure, Environment and Sustainable Development will implement two major projects for the collection and treatment of sewage in the Koropi and Paiania areas. The mandatory vulnerability and risk assessments will offer more insight into the vulnerability of the sector.

Case Studies

There are three case studies identified as infrastructure projects addressing climate change adaptation in Greece; evaluating the use of a [hydropower dam](#), and the adaptation measures through two large transport projects, namely the [Patras-Pyrgos motorway](#), and [Attica Tollway](#).

Hungary

System and Institutional framework

The National Climate Change Strategy (NCCS) of Hungary was amended in 2013 and a new [National Climate Change Strategy \(NCCS II\)](#) came into force in 2017. A National Adaptation plan is anticipated within 2018, and it will be updated every 3 years. The responsible central body for adaptation policy making and coordination is the Climate Policy Department within the Ministry of National Development. The institutions relevant for climate change adaptation are the Ministry of National Development - Ministry of State for Transport Policy, NIF Zrt. (National Infrastructure Development Corporation), MÁV Zrt. (Hungarian State Railways), Ministry of National Development – The Ministry of State for Development and Climate Policy and Key Public Services, Prime Minister's Office – Ministry of State for European Development, and the Institute for Transport Sciences.

Resources

In terms of available resources, the most comprehensive source of information on climate change adaptation is on the website of the [National Adaptation Centre \(NAKFO\)](#), an independent unit of the Geological and Geophysical Institute of Hungary (MFGI). The majority of climate-related data (such as relative humidity, wind and soil data) are found via the [National Meteorological Service](#). There is also useful data on policy and climate finance climate adaptation at the [KLIMAPOLITIKA](#) website. The [Climate Risk Guide](#) developed by the Prime Minister's Office is accompanied by a [Detailed Methodological Description](#) which provides a general description for the estimation of financial costs and benefits of adaptation infrastructure investments to climate change. [Regional climate models](#) to the Carpathian Basin region are being used during the flood control assessments of the Water Management Directorates for the design of culverts, bridges, underpasses and overpasses and during railway line development. Hungary has been actively involved with its neighbouring countries of the Danube macro-region through the project SEERISK which led to the development of [Common guidelines on climate change and risk assessment in the Danube Macro-region](#). This provides guidance on how to perform a common Risk Assessment Methodology and how to take account of the social aspect of climate change in the region. Hungary is following the process for the development of European standards on climate change adaptation by the [Adaptation to Climate Change Coordination Group \(ACC-CG\)](#). There are regulations which consider the effects of the extreme weather conditions (Road and Railway Technical Specifications - RRTS) and which are starting to integrate climate change adaptation. Research institutes, such as the National Adaptation Centre of the Geological and Geophysical Institute of Hungary, the Institute for Transport Sciences and the Academy of sciences, contribute to the improvement of the institutional capacity and the knowledge capacity in Hungary. EU resources are in use, such as the [Guide to Cost-Benefit Analysis of Investment Projects](#),

the publication on [Climate Change and Major Projects](#) and the non-paper [Guidelines for Project Managers](#).

Sectors

Infrastructure sectors are progressing at different speeds regarding climate adaptation. For the transport sector, the report [Climate Change and Hungary: mitigating the hazard and preparing for the impacts](#) outlines the impacts which are affecting the sector. The main resource in the transport sector that are of use to perform climate risk and vulnerability assessment is the Climate Risk Guide and the Detailed Methodological Description, available on the [website of the Széchenyi 2020 Development Programme](#). In the broadband sector, no specific initiatives are identified, but the country is planning to make use of ESI Funds for broadband development. As such, climate adaptation measures will need to be incorporated. In urban development, Hungary has taken steps towards sustainable and resilient cities that are adapted to climate change. Significant information can be found in the publication [Climate-Friendly Cities – The Handbook on the Tasks and Possibilities of European Cities in Relation to Climate Change](#). In the energy sector, the formal authority with primary responsibilities for infrastructure, disaster risk and climate data is the [National Directorate General for Disaster Management](#), and the report [Climate Change and Hungary: mitigating the hazard and preparing for the impacts](#) identifies higher frequency of extreme weather events with potential impact on energy supply. The water sector, and water management is a priority area for climate adaptation, as the annual precipitation distribution is expected to change, which is of particular importance for natural resources (water, biodiversity, forests) and agriculture. The main resources in the water sector that are of use to perform climate risk and vulnerability assessments are the Climate Risk Guide and the Detailed Methodological Description, available on the [website of the Széchenyi 2020 Development Programmes](#). For the waste sector, the primary analytical information on risk and vulnerabilities to the sector is held by the [National Waste Management Directorate](#).

Case Studies

The accompanying country report for Hungary includes two case studies relevant for climate change adaptation: the [National Adaptation Geoinformatic system \(NAGiS\)](#), developed for policy-making and assistance with climate-related decision processes; and a tool for strengthening co-operation at a local level on [urban green infrastructure](#).

Ireland

System and Institutional framework

The [Climate Action and Low Carbon Development Act \(2015\)](#) includes Ireland's National Climate Change Adaptation Framework, which provides the policy background, and determines the development of adaptation projects. The key stakeholders for climate change adaptation in Ireland are the Department of Communications for Climate Action and Environment ([DCCA](#)), local authorities, the Environmental Protection Agency ([EPA](#)), individual sectors and [MET Eireann](#). The [DCCA](#) role is to coordinate, identify key sectors and encourage sectors to make vulnerability and risk assessment for their own areas. [DCCA](#) is now working on a new [Adaptation Framework \(2013\)](#) to replace the 2012 National Plan. Approval is expected in 2018, and sectors will be expected to produce their own plans and strategies for climate change adaptation.

Resources

A number of resources are available for climate adaptation. Ireland's most comprehensive web portal for information on climate change adaptation is [Climate Ireland](#). The majority of present findings are interpreted from scientific research and tailored for individual

sectors. The Climate Change Research Programme (CCRP), (established and administered by the EPA), supports research addressing specific knowledge gaps of direct relevance to the [National Climate Change Strategy](#). In terms of physical climate change-based parameters, [Met Eireann](#) (Met) contains historical data on specific parameters which assess the magnitude of climate change. [Climate Ireland](#) provides a range of tools for supporting climate adaptation assessments, such as the [Local Authority Adaptation Support Wizard](#); [EC Adaptation Support Tool](#); [Case Study Search Tool](#) and [Business Areas Climate Assessment Tool](#). A [Sectoral Adaptation Support Wizard](#) also helps a guide sectors in identifying current and potential future vulnerabilities and assessing available adaptation options. With regard to national reports, the [National Climate Change Adaptation Framework](#) (2012) sets the basis for subsequent guidance. This framework is currently being reviewed with an update expected in 2018, covering both national and sectoral guidance. In developing a national climate change strategy for Ireland, an assessment of vulnerability at an early stage is essential in order to inform subsequent stages of the process. This was carried out in the [Current and Future Vulnerabilities to Climate Change in Ireland](#) (2013) study. Design standards follow a similar style to the guidance documentation; using the [National Adaptation Framework](#) (2012). Despite each sector integrating climate change adaptation consideration into their design standards, on a project case-by-case basis, there is no formal requirement. Ireland's [National Adaptive Capacity Assessment](#) looks at of Ireland's capacity to adapt to climate change. It follows the approach developed by the World Resources Institute. The EPA carried out an analysis of Ireland's institutional capacity, detailed in their [Climate Change Research Programme](#) (2013) report. The report outlines the main findings of the [National Adaptive Capacity Assessment](#) (2013) and makes recommendations on how adaptive capacity may be improved. The [Science Foundation Ireland Investigators Programme](#) supports and encourages researchers to build capacity, expertise, collaborations and relationships in areas of strategic economic importance through themed calls. A liaison officer within the [Met](#) has been employed to raise awareness on institutional capacity for climate change adaptation, with the [ERA4CS project](#) (2015) showing immediate signs of progress. EU resources are in use, such as the [Guide to Cost-Benefit Analysis of Investment Projects](#), the publication on [Climate Change and Major Projects](#) and the non-paper [Guidelines for Project Managers](#).

Sectors

Infrastructure sectors are undertaking actions to adapt to climate change. As with other sectors, assessment of climate change adaptation issues in the transport sector relies on use of [Climate Ireland](#) and its web-portal. The study '[Developing resilience to climate change in the Irish transport sector](#)' published by [DTTAS](#), analysed the vulnerabilities of five transport subsectors (aviation, road, bus, rail and ports) to the impacts of climate change. Broadband infrastructure (particularly fixed assets) may become more vulnerable to climate change, as detailed in the [National Adaptive Capacity Assessment](#) report. For urban development, the [National Spatial Strategy](#), published in 2002, covering the period 2002 - 2020, aims to achieve a better balance of social, economic and physical urban development across Ireland. Regionally, the [UrbanAdapt](#) project seeks to identify the impact of climate change on Dublin and surrounding towns within the Greater Dublin Region. In the energy sector, the draft [Adaptation Plan for Energy](#) is being prepared in the context of the [NCCAF](#) with its objective to identify options for electricity and gas networks infrastructure and services that will help to build resilience against the impacts of climate change. Water supply within Ireland is currently "*under pressure*" and has been deemed "*inadequate*" by [Climate Ireland](#) due to a severe need of renovation. The [Flood Risk Management Climate Change Adaptation Plan](#) (2015) has been prepared under the remit of the [National Climate Change Adaptation Framework](#), setting out the approach to climate change adaptation of the [Office of Public Works](#) (OPW), the lead agency for flood risk management in Ireland. In the waste sector, the [Environmental Protection Agency](#) (EPA) supports a variety of policies specific to the management of waste, and the country complies with the EU [Directive 1999/31/EC on the landfill of waste](#).

Case Studies

The case studies identified in Ireland and which are further developed in the country report, include the EPA funded [Urb-ADAPT](#) project, the [Connecting Nature](#) project, and the Met Éireann [ReAnalysis](#) Project.

Italy

System and Institutional framework

The Italian the [National Adaptation Strategy to Climate Change \(NAS\)](#) was adopted in June 2015. There is also work in progress on development of the National Adaptation Plan for Climate Change (NAP). The review of the NAS is planned for 2020. The development of Regional and Sectorial Adaptation Actions, Strategies and Plans is currently underway in the different regions. The [Ministry for the Environment, Land and Sea](#) has the primary responsibility for elaborating the National Adaptation Strategy and Plan and their coordination through the Institutional Panel, which includes other ministries, regional committees, the National Association of Italian Municipalities and the Union of Italian Province. The [Italian National Institute for Environmental Protection and Research \(ISPRA\)](#) is the formal authority maintaining primary responsibilities for infrastructure, disaster risk and climate data.

Resources

Some resources on climate adaptation are available in Italy, however the country does not have a dedicated national website providing access to climate change adaptation. Weather data can be gathered from [Meteoam](#), the Italian meteorological service, while the [Euro-Mediterranean Centre on Climate Change \(CMCC\)](#) holds more climate-related data. Climate research is supported via a number of research institutes, including the - Institute of Atmospheric Sciences and Climate of the National Research Council ([ISAC](#)), the Institute for Environmental Protection and Research ([ISPRA](#)), and the Lombardy Foundation for the Environment ([FLA](#)). The [INGV-CMCC](#) has performed a set of climate scenario integrations for Italy following the protocol prescribed for the IPCC CMIP3 simulations. A national report ('[Climate change impacts on coastal areas: Economic quantification of impacts and adaptation measures - synthesis of results and methodological indications for future research](#)') produced in 2007, through a partnership between the Italian Agency for Environmental Protection and Technical Services ([APAT](#)) and [CMCC](#), proposed a set of methodologies for the economic assessment of impacts that climate change (i.e. sea level rise, increase of storminess and temperature variations) has on Italian coastal zones. At a regional level, the Abruzzo Region and the National Agency for New Technologies, Energy and Sustainable Economic Development ([ENEA](#)) conducted a [feasibility study](#) in 2011, which focused on the coastal marine environment, coastal zones, mountain areas and production activities. The "[Report on the state of scientific knowledge on impacts, vulnerability and adaptation to climate change in Italy](#)" (2015) presented a comprehensive assessment of climate change impacts and vulnerabilities. The [INTACT](#) risk framework is a methodology adopted in Italy for infrastructure-related projects. This project aims to draw together knowledge from stakeholders and experts, analyses and assessments, to help and make critical infrastructure more resilient to extreme weather. Another tool used within Italy for climate change adaptation projects is [TRUST](#) (Tool for Regional Scale Assessment of Groundwater Storage Improvement in climate change adaptation). Within the urban sector, a range of initiatives were implemented by Provinces, Cities and Municipalities, such as Ancona's [local adaptation plan](#). The national government, with [Italiassicura](#) have developed adaptation methods for overcoming emergencies in key areas for social, cultural and economic activity; such as hydrogeological disruption, water-related infrastructure issues and improving the resilience of school buildings. Regionally, the Faenza municipality implemented a Bio-Neighbourhood [incentive programme](#) for developers within the urban planning regulations to cope with rising temperatures related to climate change. EU resources are in use, such as the [Guide to Cost-Benefit Analysis of Investment Projects](#),

the publication on [Climate Change and Major Projects](#) and the non-paper [Guidelines for Project Managers](#).

Sectors

The present report identifies little information on the adaptation of infrastructure sectors. The transport, energy and waste sectors are not involved in the national or regional authority climate change adaptation plans or initiatives organised by governmental bodies. With regard to EU funding of Italy's broadband infrastructure, there is comprehensive guidance provided in '[European Funding for Broadband 2014 – 2020](#)'. The report states that the 2014 - 2020 total budget for broadband deployment in Italy is approximately €1,161 Million, higher than any other Member State involved. A number of relevant projects are making progress in the field of urban climate adaptation; such as [ACT](#) (Adapting to Climate change in Time), [UHI](#) (Urban Heat Island), [CHAMP](#) (Local Climate Change Response) and [EU Cities Adapt](#) (Adaptation Strategies for European Cities). These focused on developing and implementing an adaptation strategy for local authorities. Two projects related to climate adaptation in the water sector are [ClimWatAdapt](#)⁵², addressing vulnerability assessments and potential key adaptation measures assessment; and [STRADA](#)⁵³, developing adaptation strategies in the Italy Switzerland trans-boundary territory.

Case Studies

Two case studies for climate adaptation in Italy are included in the accompanying country report. These include the [modelling of water scenarios and sectoral impacts for climate adaptation](#), and the [TRUST tool](#) for regional scale assessment of groundwater storage improvement in adaptation to climate change.

Latvia

System and Institutional framework

Latvia has developed its [National Adaptation Strategy](#), which will be an Official Development Planning Document, approved by the Cabinet of Ministers of Latvia. The National Action Plan is being developed by the Head Climate Adaptation Department with a team representing other ministries and departments. The Ministry of Environmental Protection and Regional Development of the Republic of Latvia (VARAM) is responsible for climate change adaptation. Adaptation strategies are being developed at subnational (regional or local) levels. Three Latvian municipalities have signed up to the Covenant of Mayors for Climate and Energy initiative committing to develop local adaptation strategies or plans.

Resources

Various resources are available to support climate adaptation. The [Ministry of Environmental Protection and Regional Development](#) provides [research reports on risk and vulnerability assessment](#) and identification of adaptation measures in six areas, such as landscape and infrastructure planning. It also provides material related to conference and seminar on climate change adaptation. The [Latvian Centre for Environment, Geology and Meteorology](#) (LEGMC) is responsible for continuous climate change data collection as well as monitoring extreme events, data storage and analyses on long-term observation results. The [Central Statistical Database](#) run by the State offers access to a number of data sets including weather patterns at city level. VARAM prepared [research reports](#) on risk and vulnerability assessment and identify adaptation measures in different sectors. Latvia started the preparation of climate change adaptation materials in 2008. A [guide for climate](#)

⁵² (Climate Adaptation - Modelling water scenarios and sectoral impacts

⁵³ (Climate change adaptation strategies for the management of natural hazards in the in trans-boundary areas

change adaptation strategy in Latvia has been published with the purpose of offering suggestions for activities to help prepare the national climate change adaptation strategy in Latvia. The [Latvian Centre for Environment, Geology and Meteorology](#) has developed climate change scenarios for the country running up to 2100 and has created a [climate change analysis tool](#) on their basis. The aim of this tool is to identify and assess past climate change and prepare future scenarios for these changes. EU-level documentation has been taken into account when preparing the NAP, such as the Commission staff working document [SWD\(2013\) 137 on Adapting infrastructure to climate change](#), the DG CLIMA guidelines on [application of economic instruments for adaptation to climate change](#) and the 2011 EcoLogic report on [Climate Proofing of key EU policies](#). There are no specific design standards available relevant to climate change adaptation and policy makers may refer to international resources. For instance the International Organisation for Standardisation has a specific guiding standard for [Vulnerability Assessment](#) and the [British Standards Institute](#) which is currently drafting one on Adaptation to Climate Change – Principles, Requirements and Guidelines. VARAM has good cooperation with Civil Protection, Ambulance and Ministry of Health, which are dealing with people affected by higher flood occurrences linked with climate change. To foster institutional capacity, VARAM is organising [conferences and seminars](#) to build knowledge on climate and environmental issues, including adaptation. The Faculty of Geography and Earth Sciences at the University of Latvia is a leading national and international research structure dealing with climate change studies, working in close cooperation with the Ministry of Environmental Protection and Regional Development and local municipalities.

Sectors

Infrastructure sectors are making use of the above mentioned resources and taking action to adapt to climate change. The report [Risk and vulnerability assessment and identification of adaptation measures in the field of construction and infrastructure planning](#) contains an identification of impacts for the transport sector, comprising of road, rail, air, and water transport. It offers a risk analysis, and identifies adaptation measures. Climate change impacts on floods in urban area have also been developed in the context of the LIFE project on [the current and potential impact of rain and snow-water waters on the flood of the Riga City area](#). The Latvian government has issued a [summary about potential climate risks](#), and has developed a report on [power supply reliability and quality](#) to estimate the cost of eliminating the consequences of electricity supply due to natural hazards, number of damages and capital expenditures. [Flood risk and flood hazard maps](#) are publicly accessible on the LGEC website. Information may also be drawn from projects that have dealt with the [evolution of the Latvian river basins, past floods, the evolution of the resources](#).

Case Studies

One case study has been identified in Latvia for climate adaptation: the electrification of the freight railway transit corridor, SJSC "Latvijas dzelzceļš", which shows that how climate change can be considered for existing infrastructure.

Lithuania

System and Institutional framework

The [National Strategy for Climate Change Management Policy 2013-2050](#) adopted in November 2012 is an integrated strategy which covers both adaptation and mitigation issues and includes implementation considerations. There are no known plans to develop a separate Climate Change Adaptation Strategy. An [Interinstitutional Action Plan](#) on the implementation of the goals and objectives of the Strategy of National Climate Change Management Policy 2013-2020, was adopted in April 2013. The Lithuanian Ministry of Environment is the main coordinating institution responsible for development all of climate change mitigation and adaptation policy. The National Climate Change Committee has been

established for advisory purposes on the development of the Lithuanian climate change policy and coordination of its implementation. Municipalities, are responsible for the implementation of the [Action Plan on the implementation of the goals and objectives of the Strategy of National Climate Change Management Policy 2013-2020](#).

Resources

The [Lithuanian Hydrometeorological Service](#) provides [data on the evolution of climate](#) over the past few decades. At sector level, the [Ministry of Transport and Communications](#) includes the National Programme for Development of Transport for 2014–2020. The [Environmental Protection Agency](#) (EPA) provides a risk assessment on flooding, as well as flood mapping and flood management plans. Within academia, the [Department of Hydrology and Climatology](#) at Vilnius University specialises in researching climate change and meteorology. The Ministry of Environment published a [Study Identifying Vulnerability to Climate Change of Individual Sectors, Risk Assessment and Opportunities to Adapt to Climate Change](#), which identified individual sectors assessed risks, proposed measures that could be implemented. Several publicly available documents provide a methodological framework to integrate the impacts of climate change in different sectors (mainly agriculture). For the scope of this study, the most relevant of these documents is the 2007 [Adaptation to the Impacts of Climate Change at the Lithuanian Seaside](#). A flood map is available to assess the risk posed to the environment, infrastructure, the economy and cultural heritage. This tool, available online, is to be renewed every six years based on updated projections. The Lithuanian Hydrometeorological Services provide useful monitoring [tools](#) to assess the day-to-day climate impacts of precipitation, wind and temperature. This also includes [climatic models with scenarios](#) for changing rainfall based on variations in global temperature. There are also visual aids (maps) presenting rainfall change in Lithuania. EU resources are in use, such as the [Guide to Cost-Benefit Analysis of Investment Projects](#), the publication on [Climate Change and Major Projects](#) and the non-paper [Guidelines for Project Managers](#). The [Baltic Environmental Forum](#) describes strategies adopted by Lithuania for climate change adaptation since 2008, and gives the list of national institutions involved in the process and their assigned responsibilities. The report lists the main challenges in the development of [National Strategy for Climate Change Management Policy of Lithuania](#), one of which is effective coordination and ensuring all responsible stakeholders assume their responsibilities. Within national academic institutes, Kaunas University of Technology, Vilnius University and Vytautas Magnus University are some of the bodies involved within various environmental programmes and research projects.

Sectors

Lithuania's [Sixth National Communication](#) states that rising sea level caused by a warming climate will have serious consequences on the transport sector. The broadband sector is not involved in the federal or regional authority climate change adaptation plans or initiatives organised by governmental bodies. The [Research Institute of Territorial Planning](#) at Vilnius Gediminas Technical University focuses on Geographic Information System (GIS) solution, spatial planning and sustainable urban development. The [Kaunas hydroelectric power station](#) not only efficiently manages the electricity supply to the surrounding areas, but also enables the man-made reservoirs to hold the volume of the Nemunas River runoff, thus reducing the damage associated with the increased risk of flooding in the area. An [Assessment of Flood Hazard and Flood Risk Maps](#) was published in 2014, indicating a lack of up-to-date information. This was subsequently followed by a report published in the Journal of Water and Land Management ("[Methodology for Flood Risk Appraisal in Lithuania](#)", 2015), which highlighted the crucial risk areas of Lithuania (Western and Central). An order from the Ministry of Environment stipulates the [requirements for new infrastructure project design](#), and that natural aspects or other possible natural effects have to be taken into account, for example, how these effects could damage the construction phase.

Case Studies

A case study of transboundary climate change adaptation has been identified in Lithuania: [BaltADAPT](#), which is an integrated project with other countries bordering Lithuania to increase the capacity to assess vulnerability to climate change, and whose actions range from protecting the natural ecosystems through disseminating good practice ideas to the general public.

Luxembourg

System and Institutional framework

The National Adaptation Strategy was adopted by the Council of Ministers of Luxembourg in June 2011 and provides a framework for adaptation to the impacts of climate change. Luxembourg's present (2018) government stresses that the 2011 strategy will be revised and updated. The primary responsible institutional body with regard to climate change adaptation is the [Ministry of Sustainable Development and Infrastructure \(MSDI\)](#), which is divided in four departments (Environment, Spatial Planning and Development, Public Works, and Transport). The [Department of the Environment](#) is responsible for formulating environmental policy and drafting legislation. There is cooperation between the ministries and regular staff meetings and coordination groups, where all stakeholders are involved. Luxembourg has also been actively involved with its neighbour countries France and Germany to develop transnational cooperation to harmonise flood management in the Moselle and Saar basins.

Resources

The [Luxembourg Institute of Science and Technology \(LIST\)](#) stores measured data from different institutions and has a network of five measuring stations that continuously collect and monitor data along Luxembourg's water courses, and updates the [Hydrological Monitoring Network](#) of areas prone to flooding. LIST has also developed a methodology to analyse and evaluate recorded environment data regarding climate change, and the [Hydrological Monitoring Network](#) provides a methodology for refurbishment of natural areas specifically as part of flood defence. LIST uses the [Weather Research and Forecasting Model](#) as well as the [COSMO-CLM model](#) to develop predictions and scenarios. In addition, there is a tool with regard to climate change indicators ([ETCCDI: Expert Team on Climate Change Detection and Indices](#)) that allows the collection of indicators to derive the impacts in various sectors. The urban development and transport sectors have the most comprehensive guidance, namely, the National [Master Programme for Spatial Planning \(PDAT\)](#), which, with focus on spatial planning and urban building, indirectly addresses the issue of adapting to climate change. It also presents the different steps to perform vulnerability assessment importance of understanding regional climate impacts. EU resources are in use, such as the [Guide to Cost-Benefit Analysis of Investment Projects](#), the publication on [Climate Change and Major Projects](#) and the non-paper [Guidelines for Project Managers](#).

Sectors

Evidence of climate adaptation in the main infrastructure sectors was partially observed. The [Integrated Transport and Spatial Planning Concept \(IVL\)](#) was developed to guide the implementation of the main targets set out in the PDAT. For the water sector, the Hydro-Climatological Observatory has established [hydro-climatological database for long-term studies](#), while the [national geoportal of Luxembourg](#) contains flood hazard maps and flood risk maps with information on necessary protective measures in urban areas. Luxembourg has adopted [River Basin management Plans](#) that contain a summary of economic analysis of water use and a programme of measures, and a [Flood Risk Management Plan \(FRMP\)](#), which contains measures to reduce the impacts of flooding hazards. The broadband, energy and waste sectors are not involved in the national or regional authority climate change adaptation plans or initiatives organised by governmental bodies.

Case Studies

Two case studies have been identified in Luxembourg, the first one being a study on the consequences of climate change for the Rhine catchment Area, and the second being the Future Cities Adaptation Compass, a practical tool to check the vulnerability and adaptation options across sectors.

Malta

System and Institutional framework

The current National Adaptation Strategy (NAS) was adopted in 2012 under the authority of the Ministry for Resources and Rural Affairs, and it builds upon the National Strategy for Policy and Abatement Measures Relating to the Reduction of Greenhouse Gas Emissions of 2009, in terms of governance and policy infrastructure. The Maltese Ministry for Sustainable Development, Environment and Climate Change (MSDEC) in Santa Venera is responsible for maintaining resources related to climate change, waste management, the environment, rural development and agriculture, amongst others. Key stakeholders within the Maltese policy and institutional framework include the Environment and Resources Authority (ERA), Malta Resources Authority (MRA) and University of Malta. A National climate change committee established within the MRA is responsible for all climate change adaptation-related activities.

Resources

Malta provides the necessary resources for climate adaptation. Data on climate change adaptation are collected by various organisations and authorities such as the Environment and Resources Authority (ERA), Malta Resources Authority (MRA) and Met Office. The Ministry for Sustainable Development, Environment and Climate Change (MESDCC) also provides general analytical information of climate impacts and vulnerabilities, whilst the Water Services Corporation holds geospatial data with application to the water and wastewater sectors. In terms of the available methodologies, infrastructure projects using EU Structural and Investment Funds adopt a Cost-Benefit Analysis (CBA) approach, and make use of the Guide to Cost-Benefit Analysis of Investment Projects. The methodology does possess limitations however, in that it provides no formal guidance on financial, economic or social impacts, and is not specific to climate change adaptation. Regarding tools, the Water Services Corporation uses GIS (Geospatial Information Systems)-based applications, which are of high value in modelling the effects of floods and designing measures to prevent them. The CLIMSAVE project developed an Impact Assessment Platform tool, which allows stakeholders to assess climate change impacts and vulnerabilities for a range of sectors, including agriculture, forests, biodiversity, coasts, water resources and urban development. Malta makes use of guidance derived from the European level, such as the DG CLIMA Publications: Climate Change and Major Projects and the non-paper Guidelines for Project Managers - Making vulnerable investments climate resilient; and the JASPERS Guidance: The Basics of Climate Change Adaptation Vulnerability and Risk Assessment.

Sectors

Limited resources were identified relating to climate adaptation in infrastructure sectors, other than the water sector. As a result of the 2012 National Climate Change Adaptation Strategy, there were approximately 27 water-related measures with established targets set for implementation. As of today, few targets have been fully or partially met e.g. the water recovery from sewage target. Projects, although usually implemented, meet roadblocks, such as the pricing of groundwater, which caused delays and slowed adaptation. The Preliminary Flood Risk Assessment by the MRA (Malt Resource Authority) states that the National Flood Relief Project sought reduction in the vulnerability of climate

change through the development of infrastructure that is capable of withstanding the uncertainties associated with future flood events, and through the adoption of a holistic catchment based approach to surface runoff management. The National methods of adapting to water-related climate hazards involve water conservation, water recovery, water recycling and treatment of sewage effluent. In the Urban development sector, the [Planning Authority](#) asks for a number of climate change related assessments in the early phases of a project that the architect / engineer would have to carry out. Locally there are guidelines for buildings, but many professionals use industry-wide guidelines, for example [ISO 14001](#) and [ISO 50001](#). Roads and urban infrastructure are built according to design standards written in law. There are guidelines published by the [Building Regulation Office](#), which outlines how the buildings should be constructed.

Case Studies

One case study has been identified in Malta, the [NAQQAS U FFRANKA](#) educational campaign focusing information sessions on water and energy conservation, renewable energy and waste management.

Netherlands

System and Institutional framework

The key legislative documents regarding climate adaptation in the Netherlands are the 'National Climate Strategy' 2016 (NAS), [Make Space for Climate](#), and the [Waterplan 2016-2021](#). On the national level, responsibility for climate adaptation lies with the [Ministry of Infrastructure and Environment](#), which oversees several other governmental bodies that address climate adaptation infrastructure projects, including the [Royal Netherlands Meteorological Institute \(KNMI\)](#), the [Rijkswaterstaat](#), the [Planbureau van de Leefomgeving](#). On the local level, some cities already have long-running climate adaptation programs in place, such as the [Rotterdam Climate initiative \(RCI\)](#) of the city of Rotterdam.

Resources

The main source for information on climate adaptation in the Netherlands is the website www.ruimtelijkeadaptatie.nl, and the main source for [climate scenarios](#) are provided by the Royal Netherlands Meteorological Institute (KNMI). Methodologies addressing climate adaptation are offered as part of a more elaborate methodology to assess sustainability (i.e. the [Environment Compass](#)). There are Dutch climate adaptation tools for the urban development and water sector. Both the [Rotterdam Climate Game](#) and [TEEB.stad](#) are tools focused on the incorporation of climate adaptation into urban development projects. The [Climate Adaptation Toolbox](#) offers a methodology that allows for an evaluation of adaptation strategies or measures targeting area development projects. Design standards that directly address climate adaptation are provided for dikes and dunes in the [Water Law](#). There are also a number of design standards that indirectly address climate impacts for the design of landfills and waste collection systems (not publicly available). The Dutch policy goals concerning climate adaptation are closely monitored and adapted if necessary (e.g. in the case of the [NAS](#), the [Energy Agreement \(SER\)](#), the [impact of SER \(NEV\)](#), the [Deltaprogramma](#) and the [Delta decision on spatial adaptation \(DBRA\)](#). EU resources are in use, such as the [Guide to Cost-Benefit Analysis of Investment Projects](#), the publication on [Climate Change and Major Projects](#) and the non-paper [Guidelines for Project Managers](#).

Sectors

The Executive Agency of the Ministry for Infrastructure and Environment, (Rijkswaterstaat), has been involved in several pilot projects which have integrated adaptation , such as: The Rotterdam-Ruhr corridor, developed within the [RoadApt](#) project, the [New Ringway Utrecht](#), and the [Innova 58](#) road design and research project. For road

infrastructure the [Investigation of the Blue Spots](#) (2012) has identified areas that are susceptible to flooding, while for airport infrastructure there are reports on how to increase resilience for [inland navigation](#) and the [Schiphol airport](#) (2013). The Dutch Broadband sector is characterised by short term investments and flexibility according to the [National Adaptation Strategy](#) which provides an overview of the main impacts on the ICT and Broadband sector. The knowledge portal "[Ruimtelijke Adaptatie](#)" has a search function that allows users to find examples of urban climate change adaptation projects. An online [climate atlas](#) is providing insight on climate impacts at a local level, i.e. for [Rotterdam](#), [Schiedam](#), [Rijnland](#) and [Meerdijk](#). The [National adaptation Strategy](#) (2016) has included the energy sector and provides an overview of the most important potential impacts on the energy sector, as does the report [Evaluation of the impact of the Energy Agreement](#). The main issue identified in the Dutch water sector concerning climate adaptation is water safety (both sea level rise and overflowing rivers). The [National Water Model](#) addresses all water subsectors; the [Multi-Layer Safety Scout](#) offers insight into the potential flood risk of new urban developments; the [Deltaprogramma](#) is one of the main programs in the Netherlands focused on water safety; and [Space for the river](#) is a plan to allow the river to overflow without causing much damage. The waste sector in the Netherlands expects to experience a minimal effect of climate change both in waste collection and processing.

Case Studies

Case studies have been provided in the accompanying country report for three projects: The [New Ringway Utrecht](#) has implemented a method for choosing the exact location of the new road that can be replicated; [Landfill park development Nauerna](#) into a future public nature and recreation area has taken measures on flooding; and the [Aardwarmte Combinatie Luttelgeest BV](#) is a ERDF-funded project with high replicability that took into account scenarios with changing weather circumstances.

Poland

System and Institutional framework

The [Polish National Strategy for Adaptation to Climate Change for sectors and areas sensitive to climate change by 2020 with a vision to 2030](#) (NAS) was adopted in 2013. The project "Development and implementation of a strategic adaptation plan for the sectors and areas vulnerable to climate change" with the acronym [KLIMADA](#), has been the basis for the preparation of a strategic plan for adapting the country to climate change. A number of [local adaptation initiatives](#) are also available at the project website. The responsible authorities on matters of climate change adaptation are the Ministries of Environment, with its Department for Sustainable Development and International Cooperation; and the Ministry of Investments and Development with its Department of Infrastructural Programmes. Supportive services are provided by the Institute of Meteorology and Water Management ([IMGW-PIB](#)), the Institute of Environmental Protection ([IOŚ-PIB](#)), and the Institute for Ecology of Industrial Areas ([IETU](#)).

Resources

Climate change data are gathered by [IMGW-PIB](#) (The Institute of Meteorology and Water Management – National Research Institute). The datasets are available upon request, but not all are currently accessible on a website. Meteorological data though is available through [monthly bulletins](#) and [synoptic maps](#), and through the website [Meteomodel](#) and the website of the [Interdisciplinary Centre for Mathematical and Computer Modelling at the University of Warsaw](#). [KLIMADA](#) holds general information, data on climate change trends and climate change scenarios. Methodologies to estimate the financial costs and benefits of adaptation measures can be found in the [Guide to investment preparation respecting climate change mitigation and adaptation as well as resilience to natural disasters](#) (2015) and the [Guide to the analysis of the cost and benefits of investment projects](#) (2014) –both

being translated from the European Commission [Guide to Cost-Benefit Analysis of Investment Projects](#), and the non-paper [Guidelines for Project Managers](#). A number of tools are available to support adaptation. [Climate map](#) is a source of climate/weather data and refers specifically to urban environments. The tool identifies and describe threats which may occur, using expected global climate change scenarios. The relevant analytical information on risk and vulnerabilities to climate change is provided by the [Institute of Meteorology and Water Management \(IMGW-PIB\)](#) and some of the information is available on the weather website of IMGW-PIB. Various sectors have their own disaster management tools. [Polish National Railways](#) has an in-house system that is not available to the general public. [Tools for strategic planning and management of urban water](#) (2014) highlight the most significant strategic goals and documents associated with water management, green infrastructure and sustainable development. Guidelines for spatial planning are available from the report [Ideal city balanced city spatial planning of urbanised areas and its impact on limiting the effects of climate change](#) (2015) that addresses water, energy and biodiversity in urban areas. The goal of projects such as [CLIMCITIES Adaptation to climate change in small and medium cities](#), [Urban Adaptation Plans](#) and [ADAPTCITY](#) is to increase the institutional capacity of cities and municipalities in terms of adaptation to climate changes. The institutional capacity (human, technical, equipment) relevant to climate change adaptation is currently developing further. One example increasing capacity at local level is [ADAPT CITY](#), where the objective is to reduce the negative impact of climate change on the ecosystem of Warsaw and to encourage adaptation measures in other large cities in Poland.

Sectors

Infrastructure sectors are found to undertake adaptation initiatives. One of the first documents concerning climate change adaptation in infrastructure projects was the report [“Developing transport sector sensitivity indicators for climate change”](#) (2010), this document is a selection of the key elements of the transport system (infrastructure, means of transport, traffic conditions) that are particularly sensitive to climatic events, including impact assessments. For the road sector, the General Director for National Roads and Motorways ([GGDKiA](#)) maps [actual weather conditions](#) on highways, national and regional roads. For Urban development, the project [Urban Adaptation Plans](#) project aims at increasing adaptive capacity in 44 Polish cities. The project takes into consideration the local conditions and problems of the cities, different in terms of nature and structure, as well as of threats and difficulties that they have to cope with. This is the largest project in Poland on climate adaptation involving multiple cities. General information about climate change adaptation in energy can be found in [Polish National Strategy for Adaptation to Climate Change \(NAS 2020\)](#). For the water sector, Polish Waters together with the Regional Water Management Boards (11 institutions) has developed a [Preliminary assessment of flood risk](#), [Flood hazard maps and flood risk maps](#), [Flood risk management plans](#), and the [Development of plans of drought effects in river basin districts](#). A methodology and guidance, the [Sustainable management of water resources and hydrotechnical infrastructure in terms of forecasted climate change](#) (2012) is available. The broadband and waste sectors are not involved in the national or regional authority climate change adaptation plans or initiatives organised by governmental bodies.

Case Studies

Three case studies for Poland have been provided, for [urban adaptation planning](#) as well as guidance documentation for the transport (rail) sector. The relevant EU guidance for climate adaptation has been applied to the major project for [Water supply and wastewater management in Warsaw - Phase V](#), which includes a climate adaptation analysis in the application for co-financing and in the feasibility study.

Portugal

System and Institutional framework

Action on climate change adaptation is framed by the [National Strategy for the Adaptation to Climate Change \(ENAAC\)](#). The Environment Agency (APA) is in charge of national adaptation policy-making and coordination. The implementation of ENAAC 2020 is supported by a coordination group presided by the APA. The [Directorate General for Spatial Planning and Urban Development of Portugal \(DGOTDU\)](#) provides information on Portugal, including objectives, strategic sectors, development and implementation and the role of different stakeholders. There are currently 26 Municipalities with local adaptation plans developed under the [ClimAdaPT.Local](#) project. [Cascais](#), [Sintra](#) and [Almada](#) have developed their own local Adaptation Strategies. [Madeira](#) also has a regional strategy for climate change, whilst [Azores](#) is developing theirs, it is expected to be finalised during 2018.

Resources

A number of resources are available in Portugal to support climate adaptation. The national [Climate Portal](#), developed by the [Portuguese Institute for Sea and Atmosphere \(IPMA\)](#), provides several climate indicators that quantify the occurrence and risk of different atmospheric events, and information to support decision making. The APA is developing a new national adaptation platform that will provide a nationwide repository of every adaptation project in Portugal and a searchable web-database. To evaluate climate change vulnerability, the SIAM and SIAM II projects applied the [UKCIP](#) methodology at a local level. This approach is well implemented in the Urban Development sector. At a local scale, there is evidence of climate adaptation measures already in place: The [Thermos](#) project is a methodology to evaluate economic impacts for the energy sector. The technological tools will be replicated in Cascais as one of the pilot cities. This project will allow the user to make maps based on demographic and urban characteristics, as well as local climatic patterns. There are tools to support decision-making, mainly through providing easy accessible data. The [Climate Portal](#) offers data analysis to support decision making, the [GestAqua.AdaPT](#) provides access to the tools used by the project in the development of climate and hydrological scenarios, the [Soil and Water Assessment Tool](#) has been used to calculate runoff, as well as sediments and nutrients transport to the surface water bodies, and the [CE-Qual-W2 model](#), as a hydrodynamics and water quality model, allowed the simulation of the behaviour of the two reservoirs. Guidance is available through research projects. The [adaptIS](#) project has a repository of information, resources and case studies on climate adaptation for services and industry. Several [handbooks](#) focused on climate change resilient construction are also available. [ClimAdaPT.Local](#) presents several handbooks on how to implement climate change adaptation strategies at a local level. EU resources are in use, such as the [Guide to Cost-Benefit Analysis of Investment Projects](#), the publication on [Climate Change and Major Projects](#) and the non-paper [Guidelines for Project Managers](#). According to the national organisation of standardisation, the IPQ (Instituto Português da Qualidade), there have been no national design standards specifically for climate change adaptation of infrastructure projects. The Portuguese Environment Agency Unit of Adaptation and Monitoring of the Climate Change Department produced a [poster](#) which outlines Portugal's resource capacity for climate change adaptation.

Sectors

The main infrastructure sectors are undertaking actions for climate adaptation. [Infraestruturas de Portugal \(IP, SA\)](#), the public-owned company responsible for the national road and railway infrastructure systems, has been working on the theme of climate change adaptation, mainly through the usual risk management systems and procedures associated with emergency management. The Transport Group under the ENAAC 2020 is coordinated by the [IMTT Institute of Mobility and Transport](#). The [national broadband strategy](#) of 2012 mentions climate change adaptation, but mitigation remains the primary driver. For the urban development sector, [Climate.AdaPT Local](#) provides methodologies

and guidance for all stakeholders. This project also provides climate factsheets for the participating municipalities. The [repository](#) of the adaptIS project presents information regarding the integration of climate change adaptation measures in the construction sector. For the energy sector, the status of implementation of the identified climate change adaptation measures by the major energy infrastructure owners and developers is unknown. It is expected to be updated within 2018 in the context of the interim report of the second phase of ENAAC. In the water sector, [extreme temperatures and a rise in precipitation](#) are of increasing concern in Lisbon, with a particular need for improved urban water cycle management. An adaptation plan for Lisbon is currently under development, and in 2015 a [Drainage Master Plan](#) was approved for the period of 2016-2030. [Flood risk management plans](#) and [flood risk maps](#) are available. In the waste sector, Portugal has transposed the EU [Directive 1999/31/EC on the landfill of waste](#) that requires landfills to be designed in such a way that pollution of the soil, groundwater or surface water is prevented. [Lipor](#) (the Intermunicipal Waste Management of Greater Porto) has developed a [Corporate Strategy](#) for the accomplishment of sustainable waste management.

Case Studies

Three case studies with application of the climate change adaptation criteria are presented in the accompanying country report: on [Municipality of Cascais](#); on the project [ADAPTACLIMA-EPAL](#) providing the Empresa Portuguesa das Águas Livres (EPAL) an adaptation strategy; and the efforts for [adaptation to drought in Alentejo](#).

Romania

System and Institutional framework

The [National Strategy on Climate Change \(2013-2020\)](#) (NAS), deals with mitigation (first part) and adaptation (second part). The implementation of the NAS is done through a 2-year [National Action Plan](#) (NAP). A [National Risk Assessment](#), was conducted in 2016, presenting key actions undertaken to develop a robust risk assessment process for climate change adaptation. The [Ministry of Environment, Water and Forestry](#) and the [National Agencies for Environmental Protection](#) are primarily responsible for the implementation of climate change adaptation agendas. The [National Administration for Meteorology](#) advises the Ministry of Environment, Water and Forestry during policy implementation and on legislation formulation.

Resources

Significant data is available through the [National Administration Romanian Waters](#) (NARW) and the [National Institute for Hydrology and Water Management](#) (NIHWM). The monitoring of climate-related parameters is executed by NARW and the [National Administration for Meteorology](#) (NAM). In the framework of the Opera-Clima project, the Ministry of the Environment, with the support of the World Bank, developed several [sectoral vulnerability assessments](#) to develop [Action Plan on Climate Change for 2016-2020](#). On the availability of guidance, the Ministry of the Environment and Sustainable Development published a [Guide on adaptation to climate change effects](#), which aims to facilitate the identification of adaptation measures and support decision making on climate change policy. The [National Administration for Meteorology](#) published the report [Climate change - from physical bases to risks and adaptation](#) (2015), with the objective to increase Romania's capacity to adapt to the impacts of climate change. Through the Opera-Clima project, the Ministry of the Environment, with the support of the World Bank has developed a [guidance document](#) to support the inclusion of the climate change impact in projects funded through ESI Funds. A series of projects has been planned for 2014 – 2020 under the programme '[2014 - 2020 INTERREG V-A Romania – Bulgaria](#),' which seeks to provide guidance and increase awareness on climate change adaptation throughout the country. Romania is collaborating with Bulgaria to develop local awareness regarding [Risk Management for Large Scale](#)

Infrastructures in their cross-border area, which includes, amongst others, risk linked with climate change impact. The municipalities of Gradinari, Malu and Byala are collaborating across the border to develop a joint risk prevention and management system to address the effects of the climate change upon their environment. Design standards are implemented in legislation by the Government based on recommendations from organisations such as the [National Administration for Meteorology](#). This also includes good practice from other countries. Romania uses both Euro-codes and Romanian standards for infrastructure construction. Romanian design standards are based on [meteorological and seismic maps](#), since Romania is situated within an earthquake zone. EU resources are in use, such as the [Guide to Cost-Benefit Analysis of Investment Projects](#), the publication on [Climate Change and Major Projects](#) and the non-paper [Guidelines for Project Managers](#).

Sectors

There are some ongoing adaptation efforts for infrastructure, but mainly in the water sector. Under the operational programme for Large Infrastructure Programme a number of major projects are planned in the transport for the programming period 2014 – 2020. One example is the highly anticipated [Sebeş - Turda Highway](#), which includes hydraulic works, and the installation of drainage systems and culverts for channelling water underneath the road, designed for climate adaptation. In the framework of the Opera-Clima project, the Ministry of the Environment, with the support of the World Bank, developed several sectorial vulnerability assessments, including the [urban sector](#). For the energy sector, Romania's Sixth National Communication to the UN Framework Convention on Climate Change ([UNFCCC](#)) provides a national assessment of climate risk and vulnerability. The World Bank in published an [energy sector rapid assessment](#), modelling climate change impacts on hydropower under different scenarios. In the water sector, the publication on [Romania: Toward Low Carbon and Climate Resilient Economy](#) used adaptation models to assess the effectiveness of the proposed green policies and infrastructure investments in the sector. The [National Administration for Meteorology](#) also provides both [Guidance](#) for the preparation of drought management, and an [Action Plan](#) for Water Scarcity and Drought Prevention. The broadband and waste sectors are not involved in the national or regional authority climate change adaptation plans or initiatives organised by governmental bodies.

Case Studies

Case studies identified in Romania with application of the climate change adaptation include a [railway project](#), the Construction of [Sebes - Turda Motorway](#), and the weather-management tool [CLIMHYDEX](#) ("Changes in climate extremes and associated impact in hydrological events in Romania").

Slovakia

System and Institutional framework

The [Adaptation Strategy of the Slovak Republic on Adverse Impacts of Climate Change](#) is the framework document for adaptation processes in Slovakia and was approved by the [Government Resolution no. 148/2014](#). It will need to be updated based on experience and new scientific knowledge every five to ten years. The main responsible authority for climate change adaptation is the [Ministry of Environment](#) of the Slovak Republic (MZP SR). Additional responsibilities and competences on climate adaptation lie with the [Ministry of Interior](#), the [Slovak Hydrometeorological Institute](#), the [Water Research Institute](#), the [Slovak Water Management Enterprise](#), the [Ministry of Agriculture and Rural Development](#), the [National Food and Agriculture Centre](#), the [Hydro-meliorations](#), the [Slovak Technical University](#), the [Faculty of Natural Sciences at Comenius University](#), the [Office of the Government](#), the [Global Water Partnership Central and Eastern Europe](#), and other institutions. The High Level Committee for Coordination of the Climate Change Policy was

established in 2012 at the state secretary level. Two special working groups were created under the Coordination Committee: one of these was designed to prepare the Strategy of Adaptation of the Slovak Republic to the Adverse Impacts of Climate Change. At the local level many initiatives have been launched recently. The capital city Bratislava acceded to Mayors Adapt initiative in October 2014. The [adaptation strategy of Bratislava](#) was adopted in September 2014. Other examples of local initiatives are Adaptation strategy of Trnava and Adaptation strategy on heat waves of Košice - Západ districts.

Resources

There are a number of resources available to support climate adaptation. Data to support climate adaptation planning are available through the SHMU ([Slovak Hydrometeorological Institute](#)) and its publication "[Consequences of climate change and possible adaptation measures in individual sectors](#)", which provides long-term scenarios and a lot of detail that has proven to be sufficient under present planning requirements in the Ministry of Transport and Construction. Implementation of the project POVAPSYS2 ensures greater availability of the precipitation data over the territory of the Slovak Republic in real time and provides for high quality of monitoring and forecasting meteorological and hydrological (floods) events. A national methodology has been developed, whose main objective is to help integrate the topic of climate change into the development of strategic infrastructure plans and the subsequent preparation of infrastructure projects: [Assessment of Climate Change - Strengthening the Methodology and Improving the Impact Assessment of Climate Change in Infrastructure Plans / Projects in Existing Processes at the National Level](#). In further scientific detail, Lapin, Melo & Damborská have developed [methods of climate change scenarios projection in Slovakia](#) and present them alongside selected results. The national [Climate change assessment methodology](#) includes tools for vulnerability assessment and risk assessment, and the country is aiming to integrate these in all stages of project development. The national [climate change assessment methodology](#) includes guidance on assessing vulnerability and risk and evaluating the exposure to risky climate phenomena. The document also provides recommendations for the future development of infrastructure, and the main climate risks to take into consideration in the development of transport projects. The Ministry of Transport and Construction of the Slovak Republic periodically improves the binding technical norms that include design standards. The ministry maintains a [database of transport standards](#) for rail, road, shipping, combined transport, and for construction products used in transport. Currently, there are no design standards to safeguard the climate change resilience of infrastructure projects. EU resources are in use, such as the [Guide to Cost-Benefit Analysis of Investment Projects](#), the publication on [Climate Change and Major Projects](#) and the non-paper [Guidelines for Project Managers](#).

Sectors

Climate adaptation actions relevant for infrastructure projects are being undertaken. The Slovak climate change adaptation methodology on [Improving the Impact Assessment of Climate Change in Infrastructure Plans](#) was developed by the Ministry of Transport and Construction is applied. The [Slovak Hydrometeorological Institute](#) issued the publication on [adaptation measures in individual sectors](#), which, in combination with other resources, has been used for projects such as the Ondava for life project, and the modernisation of the Púchov – Považská Teplá rail line, which includes climate adaptation measures. The broadband sector is not addressed in the [National Adaptation Strategy](#), nor in the [Strategic Document for Digital Growth and Next Generation Access Infrastructure \(2014 - 2020\)](#) or the [National strategy for broadband access](#). The vulnerability of the broadband network to floods can however be based on the information provided by the [flood risk and hazard maps](#). Urban development is covered in the 2011 document [Consequences of climate change and possible adaptation measures in individual sectors](#), whilst the capital city of Bratislava has developed an [Adaptation Strategy](#) for its territory; the subsequent Action Plan should be published in 2018. The energy sector is covered in the 2011 document [Consequences of climate change and possible adaptation measures in individual sectors](#), while the national [Climate change assessment methodology](#) includes a section on the

adaptation of the sector and details on how to estimate potential adaptation options. The water sector is addressed with [flood risk and hazard maps](#), and [River Basin Management Plans \(RBMP\)](#). The [National Adaptation Strategy](#) presents the different impacts climate change will have on the hydrologic cycle of the country, and the [EEA Grants](#) climate adaptation programme contributes to improve the resilience and preparedness for both floods and droughts, as well as to increase both the expert capacity and public awareness and understanding of flood protection. The waste sector is not involved in the national or regional authority climate change adaptation plans or initiatives organised by governmental bodies, but is subject to the transposed EU [Directive 1999/31/EC on the landfill of waste](#) which requires that landfills are situated and designed in such a way that pollution of the soil, groundwater or surface water is prevented.

Case Studies

Case studies identified in Romania include the [reconstruction of ecosystem functioning](#) at the upper site the Ondava river catchment area, the modernization of the Púchov – Považská Teplá railway line, and the addressing of [climate risks in the Žilina – Košice railway corridor](#).

Slovenia

System and Institutional framework

The [Strategic Framework for Climate Change Adaptation](#) was adopted in 2016. The Strategy will be followed by an Action Plan of adaptation measures, which will be prepared taking into account the national risk assessments and a comprehensive national climate change vulnerability assessment. The Ministry of Environment and Spatial Planning is responsible for the implementation of climate change adaptation policies, and an Inter-Ministerial Climate Change Adaptation Working Group is responsible for the monitoring of the overall implementation of guidelines. Additional formal authorities include the Ministry of Infrastructure (MZI), the Administration for Civil Protection and Disaster Relief (ACPDR) and the Slovenian Environment Agency (ARSO).

Resources

The Ministry of Environment and Spatial Planning (MOP), the Ministry of Agriculture, Forestry and Food, the Slovenian Environment Agency (ARSO) and the Slovenian Water Agency (DRSV), are the main organisations providing information on climate change. A new portal providing climate data is expected to come online in 2018 and will be managed by the MOP. Also [environmental data](#) for the Municipality of Ljubljana (e.g. hydraulic modelling, designing of the flood protection measures and information on water infrastructure) are publicly available. The online portals [National Meteorological Service of Slovenia](#) and [Environmental Information](#) provide climate-related information on different sectors. These portals provide limited climate data though were identified as key sources of information on climate change adaptation. The TURAS University has developed a methodology for assessing direct and indirect flood based economic losses to allow prioritisation and evaluation of adaptation measures. The Institute for Water of the Republic of Slovenia is part of the project [Danube Sediment Management](#) whose goal is a set of guidelines for sediment management in the Danube River. This will assist in the implementation of the measures stated in [Slovenia's Water Management Plan for the period 2016-2021](#). The project on the [Integral flood Protection Measures of the Vipava River Basin](#) is to prepare guidelines for the integrated flood protection measures in areas of significant impacts of floods on the River Basin scale and a pilot project of implementation of these guidelines in the Vipava River Basin. EU resources are in use, such as the [Guide to Cost-Benefit Analysis of Investment Projects](#), the publication on [Climate Change and Major Projects](#) and the non-paper [Guidelines for Project Managers](#). There are no tools designed specifically for climate change adaptation, although there are several tools available from

different institutions that are used throughout the planning and construction phases of major infrastructure projects, including the ARSO [online portal](#). The [Slovenian Institute for Standardization \(SIST\)](#) is collaborating with the [European Standardisation Organisations in the Adaptation to Climate Change Coordination Group \(ACC-CG\)](#) for standardisation work in the field of adaptation. The Inter-Ministerial Climate Change Adaptation Working Group is becoming operationalised and the Slovenian authorities are taking into consideration the EU requirements to make vulnerable investments climate resilient through the EIA process and through the requirements of ESI Funds.

Sectors

The [Draženci – Gruškovje](#) project is cited as an example of good practice within transport, given the detail of the climate assessment carried out. The broadband sector is not involved in the federal or regional authority climate change adaptation plans or initiatives organised by governmental bodies. Spatial planning in general is important in Slovenia, but because there are only two cities (Ljubljana as a capital is considered medium size and Maribor a small city), urban heat island and other climate change impacts are less significant than with major urban centres. The [Climate Change Adaptation by Spatial Planning in the Alpine Region \(CLISP\)](#) project makes reference to the energy sector, but there are no specific methodologies to increase the climate change resilience of existing infrastructure in the sector. The water sector has the most resources available for climate adaptation. Flood prevention is the responsibility of national government and the Municipality of Ljubljana is active in implementing protection when natural disasters occur. Currently, the Municipality has prepared a Flood Protection Plan; and a Water Retention Project (at Brdnikova) which is being built in response to flooding of the Glinščica River. The construction of all hydropower plants is supposed to take into account extreme weather conditions regarding flood risk and extreme precipitation. With a specific focus on water infrastructure, USAID has developed a [Methodology for Incorporating Climate Change Adaptation in Infrastructure Planning and Design](#), which is used in Slovenia. A project on [waste water collection and treatment in the area of the aquifer of Ljubljansko Polje](#) has been approved to be funded by EU Cohesion Policy funds in the 2014 – 2020 programming period.

Case Studies

Case studies identified in Slovenia include a TUPAS University project on [integral adaptation strategies to mitigate flooding effects](#), demonstrating how to devise climate adaptation strategies in a participatory manner; and the redesign of the Podutik flood reservoir through increasing [ecosystem-based climate adaptation services](#).

Spain

System and Institutional framework

The [National Climate Change Adaptation Plan](#) was approved in 2006 and created a framework to enhance Spain's ability to adapt to climate change. The plan is based on a [Preliminary Evaluation Report of Climate Change Effects in Spain](#), published in 2005. The plan's objectives are carried out through the implementation of Work Programmes. The 3rd Work Programme of the PNACC was adopted in 2013. The Spanish Climate Change Office (OECC), is the administrative body for climate change while the Spanish Ministry of Agriculture and Fishery, Food and Environment is the leading practitioner on integrating climate change adaptation into project development. At a regional level, the Autonomous Communities have developed and are maintaining strategic frameworks, plans and programmes regarding climate change adaptation. On a local level, the [Spanish Network of Cities for the Climate \(RECC\)](#) brings cities and villages together, which are committed to sustainable development and climate protection.

Resources

Spain has adequate resources for climate adaptation. The web portal for information on climate change adaptation, [AdapteCCa](#), compiles this data and makes it easily accessible by means of a cartographic viewer. Climate change data from the [IPCC website](#) is combined with regional data from the Spanish State Meteorological Agency ([AEMET](#)), while sea level and air and water temperature data is made available by the State's ports ([Puertos del Estado](#)), and occasionally data from the [IEO](#) (Spanish Institute of Oceanography). The first Impact Assessment, provided in 2005, is the [Preliminary Evaluation Report of Climate Change Effects in Spain](#). Guidance in Spain primarily given by the OECC, based on the [National Climate Change Adaptation Plan](#). The website on [Environmental Impact Assessment](#) is recommended as guidance by the OECC for considering Climate Change Adaptation. The document on [Climate Change Adaptation Integration into Business Strategy](#) provides guidance for companies to incorporate risks of, and vulnerability to, climate change in their business strategies. The pilot project [Iniciativa ADAPTA](#) is exploring adaptation options and tools to incorporate risk and vulnerability considerations. EU resources are in use, such as the [Guide to Cost-Benefit Analysis of Investment Projects](#), the publication on [Climate Change and Major Projects](#) and the non-paper [Guidelines for Project Managers](#). A number of tools (or more precisely, cartographic viewers) are available to be used during the design phase of major projects, namely the [National cartographic viewer of flood-prone areas \(SNCZI\)](#), [Cartographic viewer C3E on Climate Change at Spanish Coast Areas](#), the [Cartographic viewer for the "Principado de Asturias" region](#), and the [viewer AdapteCCa for climatic scenarios](#). The OECC found that the viewers are not frequently used, because they have a high level of detail, and consequently the data output encompasses a lot of information. Additionally, the [AQUATOOL](#) offers a decision support system for water resources planning and management. The Spanish Association for Standardization ([UNE](#)) is collaborating with the [European Standardisation Organisations](#) in the [Adaptation to Climate Change Coordination Group \(ACC-CG\)](#) to coordinate standardisation work in the field of climate adaptation.

Sectors

The main infrastructure projects are making efforts towards climate adaptation. A working group on the need of climate change adaptation for the Spanish backbone of the transport infrastructure was formed, which consists of the [State Secretary for Infrastructure, Transport and Housing](#), the [State Secretary of Environment](#), [Adif](#), [Renfe](#), [Puertos del Estado](#), [AENA](#), [Ineco](#), [CEDEX](#), [OECC](#), [AEMET](#) and the [European Environment Agency](#). The Spanish urban development sector has access to various online sources of data and information; The [AdapteCCa](#) information exchange and consultation platform provides general information; whilst on a local level, the [Spanish Network of Cities for the Climate \(RECC\)](#) is a platform for technical support for the local administrations. Within the infrastructure sector, most guidance on climate change vulnerability and risk assessment is provided by the national and regional authorities provide guidance for the transport and energy sectors and for ports and coastal areas. The OECC, the [Technological Investigation Institute Comillas \(Madrid\)](#), the [UNE](#) and the [Ihobe](#) identify no specific design standards that specifically incorporate climate change adaptation. An [analysis of the climate change impact on the Spanish energy sector](#) was published in 2015 by the [Pontifical University Comillas \(Madrid\)](#), which provides an explanation on how risk and vulnerability assessment on the energy sector have been performed. The water sector is mainly concerned with the issue of drought and floods. Following the [EU Floods Directive 2007/60/EC](#), Spain has performed flood risk assessments and elaborated [flood hazard and risk maps](#) and [flood risk management plans](#). A [nation-wide cartographic viewer displaying flood-prone regions at coastal and inland areas](#) is available for fluvial and marine flooding risk. The broadband and waste sectors are not involved in the national or regional authority climate change adaptation plans or initiatives organised by governmental bodies.

Case studies

Three detailed case studies that demonstrate how climate change adaptation is being incorporated into infrastructure projects have been highlighted, covering the examples of

ENDESA, GRUPO FERROVIAL and Renfe for integrating climate change adaptation into its business strategy.

Sweden

System and Institutional framework

The Swedish Climate Change Adaptation policy is defined at the national level by the [Ministry of the Environment and Energy](#), which is responsible for the environmental, energy and climate policy of the Government. There is no individual organisation with the primary responsibility for climate change adaptation in Sweden. In 2013 it was established that each county government must carry out surveys of how local regions are working to adapt to climate change, and that they must [develop action plans](#) for climate change adaptation and perform a follow up review. In June 2017, Sweden passed [legislation](#) stating that each county government has an obligation to pursue a climate policy based on the climate goals adopted by the Parliament (Riksdag). An [Action Plan](#) for climate change adaptation is being developed. A white paper, '[Climate Change Adaptation in the Nordic Countries](#)' (2013) by Norden defines the concept, barriers and reviews current climate adaptation policy in Europe and identifies key element for a Nordic Adaptation Strategy. An [Implementation and Evaluation of the Swedish National Adaptation Strategy](#) by SMHI has evaluated the progress of the Programme, whilst outlining the responsibilities and contribution of national authorities, municipalities, Swedish administrative boards, National Centre of Climate Adaptation and other decision makers towards development, implementation and evaluation of the [NAS](#). The presentation explains in detail the EU climate change adaptation process, lists various Swedish climate adaptation initiatives and Swedish regional adaptation action plans.

Resources

All the necessary resources are available to support climate adaptation. The [Swedish Portal for Climate Change Adaptation](#) contains information about the effects of climate change, risk management and guidance for the development of an adaptation plan. This portal summarises Sweden's work with climate change adaptation, ranging from information on roles and responsibilities, best practice, case studies, tools and to function as a hub with links to the various Swedish agencies' and bodies' own databases, strategies, tools, etc. The [Swedish Meteorological and Hydrological Institute \(SMHI\)](#) provides a large amount of data in open access format on climate and the environment, both historical data and future projections. The [Swedish National Knowledge Centre for Climate Change Adaptation](#), based in SMHI, provides tools, [open data](#), and [industry-specific services](#). The Centre collects, develops and shares research, information from authorities and learning examples to facilitate sound decision making. With the help of funds that are being distributed by the Government, SMHI will develop an [Action Plan](#) for climate change adaptation. [National Geotechnical Institute \(SGI\)](#) has also developed a methodology for ensuring [sustainable development of coastal areas](#) where there is a risk of erosion, ravages and floods. Methodologies that support climate adaptation are available. The [Swedish Agency for Marine and Water Management](#) published a [document](#) on water and wastewater planning at municipality level, the [National Geotechnical Institute \(SGI\)](#) has also developed a methodology for ensuring [sustainable development of coastal areas](#), while a methodology is also available from the [Blue Spot Project](#) that provides for a comprehensive risk analysis of the road transport system with emphasis on serious physical hazards. A national study⁵⁴ of the [climate and vulnerability survey \(2007\)](#) was carried by the Government in 2015. This study outlined that, despite awareness of how climate change affects various sectors increasing, there is still a need for sufficient framework guidelines in relation to climate change adaptation. At a [regional](#) level, the Government in 2013 stipulated that each county administration must compile, account for and perform comparisons of what climate change

⁵⁴ 'Skrivelsens huvudsakliga innehåll'

adaptation actions are being taken at a local level in the municipalities. Also included on [Klimatanpassning](#) are [various publications](#) on how to perform cost-benefit analyses within various infrastructure projects. There are no specific design standards available relevant to climate change adaptation in Sweden. EU resources are in use, such as the [Guide to Cost-Benefit Analysis of Investment Projects](#), the publication on [Climate Change and Major Projects](#) and the non-paper [Guidelines for Project Managers](#).

Sectors

Infrastructure sectors are undertaking steps towards climate adaptation. In 2008, the government mandated the Swedish Transport Agency to perform a vulnerability survey on railway tracks which have changed, due to the worsening conditions of climate change. The [Blue Spot Project](#) study developed instructions to create a homogeneous method for the inventory and analysis of serious physical dangers for roads. A [vulnerability survey \(2008\)](#) for railway tracks is available, and Gothenburg and Norrköping have [integrated green structures \(2016\)](#) around tram tracks. In the urban development sector, various tools and guidance related to urban development can be located on [Klimatanpassning](#) such as [Show Adapt](#) and [Geokalkyl](#) – a tool where it is possible to compare costs for different alternative investments of buildings and infrastructure. SGI has developed a methodology for ensuring [sustainable development of coastal areas](#) where there is a risk of erosion, ravages and floods. Within the energy sector, a study on [adaptation to climate change among electricity distribution companies in Norway and Sweden](#), identified that companies have a higher awareness to vulnerability to climate change and have undertaken some adaptation actions. The water sector is presenting a number of initiatives to adapt to climate change. SGI provides a [tool](#) that the emergency water services can use in the event of imminent danger of rain, slurry, sludge and chemical spill in sensitive land, and the report ['A Safe Drinking Water Supply' \(2016\)](#) produced a number of recommendations on adaptation actions. Following the EU Floods Directive 2007/60/EC, Sweden has performed flood risk assessments and elaborated [flood hazard and risk maps](#) and [flood risk management plans](#). Waste is to some extent covered by the [Swedish Environmental Protection Agency](#) but there are few specific guides, tools or other instruments for the waste sector that could assist in addressing climate adaptation. The [Swedish Agency for Marine and Water Management](#) published a [guidance document](#) on water and wastewater planning at municipality level.

Case studies

Three case studies that demonstrate how climate change adaptation is being incorporated into infrastructure projects have been highlighted: an embankments protect against future flooding in [Kristianstad](#), a [green roofs project in Malmo](#) and the identification of [flood-sensitive sections in the road network](#)

UK

System and Institutional framework

The [Climate Change Act \(2008\)](#) created a framework for building the country's ability to adapt to climate change, and mandates the development of a [National Adaptation Programme](#). It includes a number of duties related to climate change adaptation and a [UK-wide Climate Change Risk Assessment](#) that must take place every five years for all devolved administrations (Scotland, Wales and Northern Ireland). The first [Northern Ireland Climate Change Adaptation Programme \(NICCAP\)](#) was adopted in 2014. In Scotland, the [Climate Change \(Scotland\) Act](#) of 2009 requires the Scottish Government to develop an Adaptation Programme. An [Adaptation Sub-Committee \(ASC\)](#) of the independent Committee on Climate Change assesses progress on the government's climate change adaptation programme.

Resources

A large number of resources are available in the UK to support climate adaptation. The [Meteorological Office](#) holds most of the weather-related parameters some of which are freely available and some which require payment. The [Environment Agency](#) provides useful data for flood-related parameters in their Flood Map web Portal, which is widely used in infrastructure development. The [Scottish Environmental Protection Agency](#) provides a similar flood mapping tool as an equivalent service to assist in planning, specifically in Scotland. The [Highways England Adaptation Framework Model](#) (2009) provides a seven-stage process to identify activities that will be affected by the changing climate. The [Scottish Environmental Protection Agency](#) provides a methodology to assess the relative adverse consequences of flooding across Scotland and which can be used to perform a risk assessment that incorporates vulnerability, exposure and value for non-motorway roads and rail links. Various tools exist in the UK; the [BeST \(Benefits of Sustainable Drainage Systems Tool\)](#) is publicly available and enables the user to assess the benefits of sustainable drainage systems. The Environment Agency provides an [Online Flood Map for Planning](#). This is publicly available and allows the user to learn about flooding probability at location as part of development planning. The [Network Rails CV065 Geotechnical Asset Management web site](#) is an example of an in-house tool tailored to assist specific adaptation needs. The 'Progress in preparing for climate change - Report to Parliament (2017)' is a recent evaluation report on the current UK situation provides an objective analysis from a national and global perspective. [Setting price controls for 2015-20 – risk assessment tool supporting documentation](#) (2014) is a national document published by the water regulator Ofwat that addresses the level of risk included in an organisation's business plan and how this risk is allocated between the company and its customers. The [Design Manual for Roads and Bridges](#) (2017) provides for the management of flood risk in the planning process and allows for making predictions for increased precipitation associated with climate change. The [Railway Drainage Systems Manual](#) (2015) sets standards that includes allowances for impacts from future climate in the design of railway assets. The [Design Standard for the Construction of New Electricity Substations](#) (2009) provides guidance on how to improve the resilience of electricity substations to flooding in the energy sector. EU resources are in use, such as the [Guide to Cost-Benefit Analysis of Investment Projects](#), the publication on [Climate Change and Major Projects](#) and the non-paper [Guidelines for Project Managers](#).

Sectors

Infrastructure sectors are undertaking studies and actions to improve their resilience. The report [Adapting Energy, Transport and Water Infrastructure to the Long-term Impacts of Climate Change](#) (2010) provides guidance on the key vulnerabilities and impacts associated with climate change. The [Transport Resilience Review](#) published in 2014 by the Department for Transport provides a review of the resilience of the transport network to extreme weather events. With regards to the rail sector, [Tomorrow's Railway and Climate Change Adaptation: Final Report](#) develops recommendations to improve the climate change resilience of the rail network. For broadband sector infrastructure, from the research conducted, limited resources were identified relating to formal authorities and institutions for addressing climate adaptation. In the energy sector, ETR-138 is used as a design standard for the construction of new electricity substations. This standard provides guidance on how to improve the resilience of electricity substations to flooding. The report, 'Planning for Climate Change – Guidance for Local Authorities' provides specific guidance on the local planning approach for adapting to climate change. The [National Planning Policy Framework](#) (2012) states that Local Plans should take account of climate change over the long term. The [Climate Change Allowances for Flood Risk Assessments](#) (2016) provide a clear design standard for the urban development sector. The water sector is adapting to climate change, and eleven water companies were invited by Defra to produce [progress reports](#) under the climate change adaptation reporting power. Methodologies for a vulnerability assessment and a sensitivity analysis of climate change on options relevant to Water Resource Zones (WRZ) are outlined in the Environment Agency guidance [Climate change approaches in water resources planning – overview of new methods](#).

Comprehensive guidance is provided by the regulator Ofwat in the form of the '[Drainage Strategy Framework: Good practice guidance](#)' (2013) and the Environment Agency on climate adaptation in the water sector. One of the key recommendations highlighted in the report [Increasing the climate resilience of waste infrastructure](#) is that in the climate change adaptation reporting power should be applied in the waste sector to increase awareness of adaptation and assist waste infrastructure operators to build adaptation measures into their assets.

Case studies

Three detailed case studies that demonstrate how climate change adaptation is being incorporated into infrastructure projects have been highlighted: the [High Speed 2](#) railway project, the [Veolia Energy Recovery Facility at Newhaven](#), and the [North West Bicester Eco Development](#).

Case studies of sectoral good practices

This chapter presents a diverse set of case studies to demonstrate the wide variety in climate change adaptation projects and approaches to integrate climate change in project preparation. From the case studies presented in the country reports and based on expert judgment, a number of case studies were selected in line with the following guiding principles:

- geographical spread;
- case studies should be replicable, innovative, have added value and data should be available; and
- case studies demonstrate various aspects such as:
 - examples of varying methodologies;
 - examples of innovative adaptation measures;
 - examples of good practice stakeholder involvement;
 - examples of inclusion of climate change adaptation into projects at varying stages of development (e.g. inclusion in feasibility studies, late stage assessment, etc.)

The selection does not reflect a quality assessment, but merely ensures a spread regarding type of case study and geographical spread.

The case studies cover a number of major projects, while the full list of major projects is accessible on the [website of DG REGIO](#), including information on their financing is also available on the [ESI Funds Open Data Portal](#). All approved projects for the 2014-2020 period have integrated climate change adaptation considerations in order to comply with the funding requirements. Additionally, non-major projects that have integrated climate change adaptation in an interesting manner can serve as inspiration for major projects.

Transport

Data Availability

All Transport Infrastructure

| Urb-ADAPT (Ireland) | |
|---------------------|---|
| Project Description | The EPA funded Urb-ADAPT project (2016-2018) seeks to identify the impact of climate change on Dublin city and surrounding towns across the Eastern and Midlands Region. It involves carrying out climate modelling of temperature, coastal inundation and flash flooding for the relevant regions for the period out to 2060. The project is coordinated by the Marine and Renewable Energy Institute (MaREI), Environmental Research Institute, University College Cork and conducted in partnership with the Eastern and Midlands Regional Assembly (EMRA). Data from the project will be made available through Ireland's Climate |

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| | Information Platform (ICIP), facilitated by Climate Ireland, in addition to a dedicated project website. |
| Budget | N/A |
| Climate Change Vulnerability and Risks | The project aims to identify possible risks to the population living in the Greater Dublin Region and future risks posed under a changing climate for future populations. |
| Climate Change Adaptation Measures | In the context of transport, the findings of this research will be of greatest benefit in the development of adaptation measures concerning identifying flood risk, the risk to transport infrastructure in close proximity to coastlines and the impact of changing temperatures on population health and behaviour. Projected increase in rainfall intensity in Ireland and rise in sea level will undoubtedly pose dangers to critical transport infrastructure in the future. |
| Good Practice | The study will support decision-makers within the transport sector by providing enhanced accuracy in discerning likely areas of vulnerability to pluvial events and coastal flooding, and to outline their response capacity accordingly |
| Further Information | www.urbadapt.com |

Road Infrastructure

Identification of flood-sensitive sections (blue spots) in the Swedish road network (Sweden)

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| Project Description | This project involved identifying flood-sensitive areas in the Swedish road network. Effects of climate change have become one of the focus areas for national road authorities. However, the uncertainties inherent in predictions of future climate make it difficult to precisely quantify the changes in terms of, for example, the magnitude and frequency of rainfall. |
| Budget | Not available |
| Climate Change Vulnerability and Risks | <p>In 2005, the Swedish Road Administration developed instructions to create a homogeneous method for the inventory and analysis of serious physical dangers along a chosen road stretch. The instructions contain a methodology for a comprehensive risk analysis of the road transport system with emphasis on serious physical hazards.</p> <p>A variety of risks are considered for different infrastructure elements, including roads, bridges and risks associated with buildings and constructions in the surrounding area. A focus is placed on landslide and collapse risk, risk for damage on roads and bridges with high water flow, risks due to accidents with dangerous goods and risks of flooding.</p> |
| Good Practice | The model was applied to a Swedish study area with the aim of creating an assessment of TEN-T road sections |

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| | vulnerable to extreme daily precipitation in southern Sweden. Based on topographic identification, the results showed a total of 1,254 blue spots near the TEN-T roads, varying in volume between 10 (minimum) and 2,800,870 m ³ (median 687 m ³). |
| Further Information | https://www.eea.europa.eu/publications/adaptation-of-transport-to-climate |

Methodologies

Rail Transport

| CFR-SA railway project: Simeria – km 614 (Romania) | |
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| Project description | The projects consists of rehabilitation and modernisation works on section Km 614 – Simeria, part of the Pan- European railway Corridor IV. The overall objective of the project is to ensure maximum speeds of 160 km/h for passenger train traffic through the rehabilitation and modernisation of railway infrastructure and superstructure. |
| Budget | 2bn Euro - financed through the Large Infrastructure Operational Programme (LIOP) 2014-2020. |
| Climate Change Vulnerability and Risks | The objective is to assess the vulnerability of the Simeria-Km 614 Railway Project to climate change and weather extreme events and identification of adaptation measures. |
| Climate change adaptation measures | A number of adaptation options have been proposed for identified risks, the latter being subsequently assessed in terms of approach within the project. Much of the proposed options (e.g. creating walls and other constructions to prevent stones from falling on the rail, use of geotextiles and geogrids for embankments, etc.) are already included in the works foreseen within the project. Another set of proposed options are subject to the operating costs associated with the project's operating phase. Further risks mitigation measures include: <ul style="list-style-type: none"> • Taking into consideration record water flows in bridges design; • Construction / rehabilitation of dykes and riverside protection systems; and • Constant monitoring at regional and local level to record in time the effects of meteorological events and the risks to transport activities. |
| Good practice | In the design of this major infrastructure project, climate change has been taken into consideration. Extreme weather events resulting in for instance increased water flow of the river has been considered in the design of bridges, increased storms have been considered in the design of walls and other constructions to prevent stones falling on the rails, etc. |
| Further information | http://summit.railwaypro.com/eur-4-7-billion-for-rail-infrastructure-projects/ |

Railway line no. 1 on the section Częstochowa-Zawiercie (Poland)

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| Project description | The document was prepared for the purpose of environmental impact assessment and obtaining a decision on environmental conditions for this project. |
| Budget | Information not available |
| Climate Change Vulnerability and Risks | <p>The report focuses on the issue of climate change. Featured in:</p> <ul style="list-style-type: none"> • A general assessment of the investment impact on climate and its changes (during implementation and operation phase); • Actual and projected climate change - the available data has been analysed to identify the changing elements that can affect railway infrastructure; • Analysis of current events related to atmospheric phenomena in the project area; the impact of weather conditions on the infrastructure (2013-2015) was reviewed and analysed on the basis of the company's records. The analysis covered all the operated railways; • The methodology for determining climate impact on railway infrastructure is fully described. The methodology for assessing the adaptive capacity of railway infrastructure to atmospheric agents was identified based on certain vulnerability and exposure. For this purpose the methodology from the document was used: Develop sensitivity indicators for the transport sector on climate change. Selection of key elements of transport system (infrastructure, means of transport, traffic conditions) particularly sensitive to climatic phenomena together with impact assessment. This methodology was detailed and extended by experience and information held by PKP Polish Railway Lines S.A. The risk assessment of the phenomenon occurrence has been carried out on the basis of the methodology set out in SMS / MMS-PR-02 - Technical and Operational Risk Assessment (Version 1.1.) dated 21 May 2015, specifying the principles of risk analysis and valuation under the Security Management System - SMS or Maintenance Management System - MMS at PKP Polish Railway Lines Company. The next step was the assessment of the inclusion of predicted climate change, which may increase or decrease the intensity of the occurrence of the individual factors. SRES A1B scenario was used to define the forecasted changes; <p>At the end assessment of the impact of climatic factors on railway infrastructure was conducted.</p> |
| Climate change adaptation measures | In the design process of the railway lines, the information and conclusions of the KLIMAD project has been taken into consideration, Additionally, the nature of the railway pavement and its response to climatic factors and the infiltration conditions of railway trenches. The analyses carried out in the Report and adopted methodology have indicated that there is no need to propose actions / remedial measures for this project. |

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| Good practice | This project is a good example of the implementation of climate change issues for infrastructure projects. The adopted methodologies can be repeated in other projects related to railway infrastructure, though they are the internal assets of PKP Polish Railway Lines Company S.A. and are not publicly available. |
| Further information | / |

Latvian railway network electrification project

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| Project description | <p>Aim of the Project. Freight traffic by railway in East-West transport corridor from CIS countries to the ports of Riga, Ventspils and Liepaja is significant for Latvia's economy. In order to increase the transportation efficiency and strengthen the international competitiveness of the Latvian railway transit corridor, SJSC "Latvijas dzelzceļš" plans to electrify the main network with 25 kV AC technology. Currently, freight transportation is serviced only with diesel traction. The full Latvian railway network electrification programme has been divided into several independent stages, which are intended to be implemented sequentially, evaluating technical restrictions, synergies with other parallel projects and availability of financial resources.</p> <p>Project scope. Stage I is planned to be implemented by 2023, during the EU funds programming period of 2014-2020 and stage II is planned to be finished by 2025. According to MCA two preferred alternatives for Stage I have been separated:</p> <ul style="list-style-type: none"> • Electrification of the Latvian railway in route - Rezekne, Daugavpils – Krustpils – Riga; • Electrification of the Latvian railway in route - Rezekne, Daugavpils – Krustpils – Jelgava – Ventspils. |
| Photograph | N/A |
| Budget | Total estimated budget: €519,043,000 |
| Climate Change Vulnerability and Risks | <p>Climate Change related risks were identified in the Feasibility study, using data on current (using LDz statistics and expert views) and future climate scenarios for Latvia (Latvian Environment, Geology and Meteorology Centre (LEGMC))⁵⁵. The climate change-induced current and future weather patterns were taken into account, and vulnerability and risk assessment performed.</p> <p>The following guidance and information sources were used for preparing CC vulnerability and risk assessment:</p> <ul style="list-style-type: none"> • The LEGMC report as a basic guidance on projected climate changes; • EC guidelines "Climate change and Major Projects"⁵⁶; |

⁵⁵ LVGMC: <http://www2.meteo.lv/klimatariks/zinojums.pdf>

⁵⁶ EC. Climate Change and Major Projects. Outline of the climate change related requirements and guidance for major projects in the 2014-2020 programming period. Available here: https://ec.europa.eu/clima/sites/clima/files/docs/major_projects_en.pdf

- LDz statistical data on time disruptions;

The following climate hazards were assessed under vulnerability assessment: high air temperature, low air temperature, intense precipitation (including risk of flooding), strong winds and storms, loss of snow cover, no or less frost, changes in vegetation and lightning.

Risk assessment results are shown in the table below of identified risk levels for climate change factors.

| Climate factor | Negative impact description | Impact level | Likelihood | Risk level |
|-----------------------|---|---------------------|-------------------|-------------------|
| High air temperature | Negative impact on ICL – sag of overhead line, risk of de-wirement, power cut | 3 | 2 | Moderate |
| High air temperature | Negative impact on TPS – loss of power | 3 | 2 | Moderate |
| Low air temperature | OCL icing | 3 | 2 | Moderate |
| Low air temperature | Damage to pantograph | 3 | 2 | Moderate |
| Strong winds | Damage to OCL, fallen trees | 3 | 2 | Moderate |

| | Climate factor | Impact description | Adaptation measures |
|------------------------------------|--|--|--|
| Climate change adaptation measures | High air temperature | Negative impact on OCL – sag of overhead line, risk of dewirement, power cut | Decrease of train speed. Early notification of event(s). Urgent maintenance according to internal procedures shall be ensured. Regular monitoring of OCL quality. |
| | High air temperature | Negative impact on TPS – loss of power | Reserve capacities installed according to technical design. Early notification of event(s). Urgent maintenance. Secondary electricity supply shall be ensured. |
| | Low air temperature | OCL icing | OHL shall be designed of appropriate materials to minimise icing and/or provided with closed circuit systems for heating of OHL during unfavourable climate conditions. Early notification of event(s). Urgent maintenance must be ensured. Regular monitoring of OCL quality. |
| Climate change adaptation measures | Low air temperature | Damage to pantograph | Early notification. Urgent maintenance shall be ensured. |
| | Strong winds | Damage to OCL, fallen trees | Early notification. Regular monitoring of OCL quality. Urgent maintenance shall be ensured. Regular maintenance of protection belts - with regular cutting of trees, monitoring their height to avoid risk of falling them to the railway tracks etc. |
| Good practice | This case studies shows that climate change can also be considered for existing infrastructure, for instance when modifications are planned. Also in a later stage of a project, significant climate adaptation measures can be implemented. | | |
| Further information | / | | |

Road Transport

| Construction of Sebes - Turda Motorway (Romania) | |
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| Project Description | <p>The new motorway will provide a link between the existing motorway sections A1 Orastie-Sibiu and A3 Gilau - Campia Turzii and will thus offer a quick connection for transit traffic between two important urban agglomerations of Romania: Cluj-Napoca and Sibiu currently using the existing DN1 (E81).</p> <p>The new motorway will have a length of approx. 70 km with a design speed of 120 km/h and it will include seven junctions, four service areas, four rest areas, one maintenance and control centre, one maintenance and monitoring centre and 66 structures.</p> |
| Budget | <p>Total investment for the project "Construction of Lugoj-Deva Motorway lot 2, lot 3 and lot 4 (section Dumbrava – Deva) – phase 2" is EUR 469 580 351, with the EU's Cohesion Fund contributing EUR 336 063 762 through the "Large Infrastructure" Operational Programme for the 2014-2020 programming period.</p> |
| Climate Change Vulnerability and Risks | <p>Sebes - Turda Motorway construction is framed according to Annex no. 1 to EU Regulation no. 215/2014. Although, at the Feasibility Study stage (2007) and Revision (2013), there were done and revised the hydraulic Study, the Hydrology maps and index of water level increase, earthquake movements and other indicators that could involve instability in the project area.</p> <p>According to the guide, the following steps were taken during the assessment: identification of the climate change sensitivities of the project, assessment of the project's exposure to climate change hazards, vulnerability analysis, risk assessment, identification of adaptation options, appraise of the adaptation options.</p> <p>During the evaluation of the environmental impact (EIA) information was provided, in terms of climate issues (drought, floods, changes in watercourses, temperature changes, shifting and habitat changes, landslides, land crashes, fires) on how species and habitats are affected.</p> <p>The analysis of the existing data on climate change has shown an increasing trend for the average annual temperature, extreme temperatures and extreme rainfall, as well as a tendency to decrease for average annual rainfall and wind speeds, observed at project level. At the same time, it should be mentioned that the exposure to climate change in the project area is lower compared to other areas of the country.</p> <p>The vulnerability analysis, based on the sensitivity and exposure assessment analysis, revealed that climate variables that could generate a high vulnerability of the project under current and future conditions are increased temperature extremes, changes in extreme rainfall, floods and ground instability / landslides. The identified risks associated with climate change are both natural risks - related to infrastructure</p> |

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| | elements as well as operational and maintenance risks (e.g. restrictions, disruptions or poor working conditions). |
| Climate Change Adaptation Measures | A number of adaptation options have been proposed for identified risks, the latter being subsequently assessed in terms of approach within the project. Much of the proposed options (e.g. creating walls and other constructions to prevent stones from falling on the motorway, use of geotextiles and geogrids for embankments, etc.) are already included in the works foreseen within the project. Another set of proposed options are subject to the operating costs associated with in operational phase. |
| Good Practice | In the design of this major infrastructure project, climate change has been taken into consideration. Extreme weather events resulting in for instance increased storms have been considered in the design of walls and other constructions to prevent stones falling on the road, flood risk has been considered, etc. |
| Further information | http://ec.europa.eu/regional_policy/en/projects/major/romania/upgrades-made-to-motorway-links-in-western-romania |

Patras – Pyrgos motorway (Greece)

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| Project description | The building of a new high speed motorway from Patras to Pyrgos in western Peloponnese |
| Budget | 64 – 74.4 Million EUR (estimation) |
| Climate Change Vulnerability and Risks | The most common and significant climate change vulnerabilities have been: <ul style="list-style-type: none"> • Damage or total destruction of the infrastructure due to extreme weather events and floods • Damage to road surfaces due to dry weather conditions |
| Climate change adaptation measures | The following measures are incorporated: (a) Suitable construction materials used for road surfaces, (b) Fire protection measures, (c) Design techniques concerning stream and river crossings (long bridges), (d) Design provisions made for at least a 50-year recovery period, (e) Installation of SCADA (Supervisory Control and Data Acquisition) systems. |
| Good practice | Climate adaptation measures have been included in the planning and design of the motorway, such as anticipating on increased water volumes when designing bridges and selecting road surface materials that can cope with extreme temperature fluctuations. |
| Further information | The construction company's website on the project Patras-Pyrgos motorway |

Attiki Odos / Attica Tollway (Greece)

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| Project description | Attica tollway ("Attiki Odos"), one of the most modern roadways in Greece, is located at the greater Athens area. It has a total length of 65 km, within a service/side road network of 150 km. The managing company incorporates effective climate change adaptation measures since the projected climate change will affect road infrastructure, causing asphalt rutting, melting, thermal expansion of bridge joints, landslides, bridge undermining and general structural damage and it is, thus, crucial to prepare for such effects. |
| Budget | N/a |
| Climate Change Vulnerability and Risks | Currently, adaptation responses include flood protection in 67 km of the whole network, pavement maintenance, installation and operation of environmental (e.g. meteorological) monitoring stations and proactive management. |
| Climate change adaptation measures | To address extreme rainfall events and flooding, an extensive stormwater and flood protection scheme have been included in the design for the collection of the superficial runoff, as there are few remaining natural receptors in this area. In addition, a network of meteorological stations positioned along the road provides real-time information on the prevailing weather conditions and keeps records of extreme events. |
| Good practice | Attica tollway is an existing road, and it shows that adaptation measures can also be applied on existing infrastructure, such as in the maintenance of the road and through the installation of monitoring stations. Climate change complicates road asphalt maintenance, as more frequent maintenance cycles are required. Maintenance costs can increase 4 or 5 times in the case of already damaged pavements, so it is important to monitor the state of the road. In addition, a network of meteorological stations positioned along the road provides real-time information on the prevailing weather conditions and keeps records of extreme events. Generally, the approach is proactive, risk factors for different scenarios are assessed and the condition of the road is evaluated on a day-to-day basis, as well as following extreme events. The objective is to create a resilient road through prevention and/or modification of equipment and materials that will be able to minimise impact of climate change effects. |
| Further information | http://en.aodos.gr |

Air Transport

Dubrovnik Airport

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| Project description | The Dubrovnik Airport Development Project is a project to meet future air traffic demands in the Dubrovnik region and |
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| | to improve the safety, technical and operational standards and efficiency of the airport. The project includes construction and upgrading of the airside facilities comprising the runway, taxiways, aprons, strip, fuel farm, ground handling facilities, reconstruction and development of the passenger terminal complex, airport rescue and firefighting facilities, administration facilities, water supply, waste water and waste management facilities, energy supply facilities as well as development of the landslide facilities comprising access roads and car/bus parking. |
| Photograph | N/A |
| Budget | EUR 225.3m |
| Climate Change Vulnerability and Risks | <p>A) Increase in average temperature levels and temperature extremes can cause the degradation of the take-off runway</p> <p>B) Higher frequency of high volumes of rain can damage the runway infrastructure, and cause peak capacity at the rainwater draining system</p> <p>C) Increase in extreme thunderstorms can cause damage to the terminal building, to navigation equipment and signalization</p> |
| Climate change adaptation measures | <p>A) Increase in average temperature levels and temperature extremes and degradation of take-off runway: the study didn't show temperature to have an impact on the runway, so no actions were taken in regards to that.</p> <p>B) Higher frequency of high quantities of rain</p> <ol style="list-style-type: none"> 1. Damage of the take-off runway and other infrastructure: materials should be used that can cope with high quantities of rain without getting damaged. 2. Difficulty for the rainwater draining system to sustain higher quantities of rain: a new draining solution is needed which will store water and then slowly let it into the environment. This should allow for the facilities to be unaffected by the high rain quantities. <p>C) Increase in extreme thunderstorms</p> <ol style="list-style-type: none"> 1. Damage to the terminal building, navigation equipment and signalization: Dubrovnik Airport is made to withhold winds of up to 200 km/h. The calculation of bearing capacity needs to be adapted. |
| Good practice | This project contains a well-executed environmental impact study, risk and vulnerabilities assessments as well as proposed adaptation measures. |
| Further information | / |

Guidance

All Transport Infrastructure

Integration of Climate Change Adaptation into Business Strategy – Pilot case Renfe (Spain)

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| Project Description | <p>Renfe is a public company operating the Spanish national railway network. Prepared by Spanish Ministry for Agriculture, Food and Environment, Spanish Biodiversity Foundation (Fundación de Biodiversidad) and the Spanish Climate Change Office (OECC) in 2014 in Madrid.</p> <p>Detailed analysis of the vulnerability to climate change of the company's activity at the railway which connects the cities Alicante, Valencia, Castellón, Tarragona and Barcelona. According to the OECC, a second phase of this project was completed in the beginning of 2016, proposing adaptation measures, but the result has not been published.</p> |
| Budget | Unknown |
| Climate Change Vulnerability and Risks | Extreme weather events and temperature increase were identified as main risks. |
| Climate Change Adaptation Measures | No adaptation measures were identified during the first stage of the pilot, which is the only one published so far. However, a second stage of the study is reported by the OECC to include an in-depth risk, opportunity and vulnerability analysis, and design and implementation strategy. |
| Good Practice | The outcomes of the second stage of the study (in-depth risk, opportunity and vulnerability analysis, and design and implementation strategy) will include most important steps of climate change adaptation assessment and can serve as a methodological guide for other transport infrastructure projects. |
| Further Information | Website of the AdapteCCa platform: http://www.adaptecca.es/sites/default/files/documentos/renfe.pdf |

Rail Transport

HIGH SPEED 2 (HS2) (UK)

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| Project Description | The UK government is currently planning a new high-speed rail network that will run from London to Birmingham and to Manchester and Leeds, this is known as HS2. The proposed network will be built to accommodate trains up to a speed of 250 miles per hour which will make it the fastest operating rail network in Europe. |
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Photograph



<http://www.regionalbahn.hu/2014/01/nagysebessegu-vonal-vasut-hazajaban-mit.html>

Budget

£56 billion

Climate Change Vulnerability and Risks

The Environmental Statement for HS2 Phase 1 assessed the risks faced from climate change impacts on interdependencies, such as the rail network, electricity supply, and ICT. In addition to these other risks identified were potential flooding of tracks and tunnels, as well as the overheating of tunnels.

With regard to methods the Environmental Statement uses a high-level climate change risk assessment to assess vulnerabilities and in terms of tools/data availability the assessment makes use of the UKCP09 projections web portal to assess the potential future climate.

With regard to scenarios the assessment considers a construction and operation phases of the period 2017-2099. This assessment was conducted in 2013 and further Phases will be assessed in the near future.

Climate Change Adaptation Measures

Engagement with infrastructure operators helped to identify key interdependencies. Recommendations for the design of HS2 include considering: increased redundancy within the system; collaborative working arrangements with local infrastructure operators; the use of 'what if' scenarios; and the use of common standards across sectors/operators where possible.


A 'green infrastructure' approach will be used in development. This approach will result in a landscape that is designed to incorporate flood defense measures which will in turn contribute to decreased vulnerability and increased resilience. Furthermore 'stepping stones' will be incorporated into designs (land areas that connect habitats closely together allowing the movement of fauna), this will provide local fauna the ability to achieve autonomous adaptation e.g. this would allow better species distribution as temperatures increase.

Efforts will also be made to incorporate appropriate landforms and gradients to minimize flood risk. In addition to this drainage will be

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| <p>Good Practice</p> | <p>designed to accommodate for the 1/ 100 year annual rainfall event, which will incorporate a climate change allowance.</p> <p>It is the one of the largest infrastructure projects in Europe and from the sources provided it is clear that adaptation measures are being considered in the planning stage. A good practice is the use of green infrastructure, which will have sustainability benefits for landscape, ecology and people. With regard to adaptation, green infrastructure will result in a landscape that is designed to incorporate flood defense measures and support autonomous adaptation of local fauna to temperature increase.</p> |
| <p>Further Information</p> | <p>Environmental Statement Volume 5. Technical Appendices: Resilience to impacts from climatic conditions [online] https://www.gov.uk/government/publications/hs2-phase-one-environmental-statement-volume-5-climate</p> <p>High Speed Information Paper: Adaptation and Resilience 2013 [online] http://assets.hs2.org.uk/sites/default/files/info_papers/E9%20-%20Climate%20Change%20Adaptation%20and%20Resilience.pdf</p> |

Road Transport

New Ringway Utrecht (the Netherlands)

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| <p>Project Description</p> | <p>During the feasibility studies for the new ringway Utrecht, the project team considered whether climate change impacts were a differentiating factor for choosing the exact location of the new road. The research showed that, while this was not the case, several observations were relevant for the subsequent phases. During the planning process, these observations were further investigated, including an exposure analysis that integrated the climate scenarios. This resulted in the integration of adaptation measures, namely increased water buffering, in the project proposal ('most environment-friendly alternative').</p> |
| <p>Photograph</p> |  <p>The map illustrates the proposed New Ringway in Utrecht, Netherlands. It shows the city's layout with major roads and junctions. Key features include: <ul style="list-style-type: none"> Existing roads: A2 (north-south), A12 (east-west), A28 (north-south), and A27 (south-southwest). Junctions: KNOOPPUNT RIJNSWEERD (north), KNOOPPUNT OUDENRIJN (west), and KNOOPPUNT LUNETTEN (south). Proposed Ringway: A new road network connecting the junctions, shown in blue and orange. Waterways: The Rhine river and other waterways are shown in light blue. </p> |
| <p>Budget</p> | <p>€ 1. 153 ml.</p> |

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| Climate Change Vulnerability and Risks | Exposure to flood, taking the climate scenarios (KNMI) into account. |
| Climate Change Adaptation Measures | Increased water buffering |
| Good Practice | The approach followed in this pilot project will be used in other road development projects by Rijkswaterstaat. The method has been documented and can be replicated. |
| Further Information | https://www.rijkswaterstaat.nl/zakelijk/innovatie-en-duurzame-leefomgeving/duurzame-leefomgeving/energie-en-klimaat/ring-utrecht-aanpassen-aan-klimaatverandering.aspx https://www.rijkswaterstaat.nl/wegen/projectenoverzicht/A27-A12-aanpassing-ring-utrecht/ |

Urban Development

Data Availability

| Smart City Project: Cloud-based Flood Prevention and Monitoring System (Estonia) | |
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| Project Description | The "Floud" technology is based on the employment of ultra-low-cost environmental monitoring devices designed to enable, through a cloud-based data collection mechanism, extensive and real-time monitoring of the status of floods in urban areas, towards increasing the understanding of these phenomena, as well as providing an effective tool for issuing early warnings to the population and improve existing prediction models. |
| Budget | n/a |
| Climate Change Vulnerability and Risks | Current tools for measuring the impact of the consequences of floods do not allow for a good understanding of its implications and indirect costs. Leaders in the market of urban sewerage development and management agree that slow improvement of the design and construction techniques is mainly due to the lack of proper data to provide estimations of the impact of potentially dangerous pollution events. |
| Climate Change Adaptation Measures | The introduction of the technology would result in a new data-collection and analysis mechanism, which could disrupt existing practices (and research field) of flood management in urban areas. The proposed early detection solution is aimed at creating a shift from just dealing with the consequences of a flood towards increasing the time to prepare for a flood and thus reducing the consequential indirect costs. |
| Good Practice | This could result in saved lives and decreased damage to land and property, but also introduce a novel tool for Insurance and Risk Assessment, improved best practice for flood protection equipment providers and rescue services. |

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| Further Information | http://www.flydogmarine.com/products/smart-city/ |
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Methodologies

Connecting Nature


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| Project description | The Connecting Nature project is an international collaboration, represented in Ireland by Trinity College Dublin. The project proposes nature-based solutions for adaptation in urban areas. |
| Photograph | N/A |
| Budget | 12 Million |
| Climate Change Vulnerability and Risks | Ireland has become increasingly urbanised, with almost two-thirds of the population now living in cities, towns and suburbs according to the Census conducted in April 2016. As transport is a derived demand, transport services and infrastructure are highly concentrated in urban areas. |
| Climate change adaptation measures | A focus of study in the project is the creation of 'living' buildings, including urban transport hubs such as train stations and bus depots, by incorporating plant life into building design, which increases the rate of evapo-transpiration. This would serve to regulate temperature, providing a cooling effect on warm days and also a layer of insulation from cold temperatures in winter. |
| Good practice | Using nature to make buildings climate resilient is an innovative approach, which can be replicated in most other buildings. |
| Further information | https://connectingnature.eu/ |

Cascais Municipality (2012-2016) (Portugal)

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| Project Description | This project focused on Cascais' location; highly dependent on its overall climatic conditions for tourism and natural capital, yet highly vulnerable to climate change impacts. |
| Budget | Not available |
| Climate Change Vulnerability and Risks | In the history of the municipality, two types of climatic events stand-out, due to their regularity, impact and importance for the region: floods and fires. In more recent years, heat waves are also a growing concern for public authorities and several awareness raising campaigns have been targeting such issues. |
| Climate Change Adaptation Measures | <ul style="list-style-type: none"> 'Green Corridors' aims to implement in the city of Cascais, through the rehabilitation of the existing riparian galleries and the unification of the parks gardens and florists, a connected and integrated green infrastructure. This should reduce the city vulnerability to floods as well as heat waves while at the same time |

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| | <p>contributes to a greater quality of living and increased sustainability of the municipality;</p> <ul style="list-style-type: none"> • 'Water savings in distribution' aims to implement in Cascais the WONE System – Water Optimisation for Network Efficiency – in order to reduce the water waste in distribution from the current 17% to 6% and by doing so reduce Cascais vulnerability to drought; and • 'Training and Raising Awareness' aims to raise awareness of climate change impacts, scenarios and adaptation possibilities for the municipality workforce as well as specific target groups such as the neighbourhood tutors through participatory workshops and the dissemination of knowledge and information. |
| Good Practice | Various methodologies were used to carry out the work; such as vulnerability measures, a risk assessment and the estimation of potential costs and benefits. |
| Further Information | http://base-adaptation.eu/sites/default/files/case_studies/08_Cascais_CS�D.pdf |

Kettingplein (Belgium)

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| Project Description | <p>The project objective is to design a climate-resilient square. The project is one of a series of pilots for infrastructure projects in the city of Ghent and was set up in the framework of the climate change adaptation plan (2016-2019) for a climate-robust city. For the square, the modelling of climate impacts was based on climate projections for storms with a return period of 50 years, based on data from the Royal Meteorological Institute and University of Leuven (RMI/KUL). With regard to the design process, a participatory approach was established. A climate check of the different design options was incorporated in the process.</p> |
| Photograph |  <p>The photograph shows an aerial view of Kettingplein, a public square in Ghent, Belgium. The square is characterized by its green spaces, including several large trees and grassy areas. Pedestrian paths wind through the square, and there are people walking and a person on a bicycle. The surrounding buildings are multi-story brick structures with traditional European architectural features like gabled roofs and dormer windows. A white car is parked on the left side of the square.</p> |
| Budget | N/A |
| Climate Change | The main issues are heat stress and flood risk |

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| Vulnerability and Risks | |
| Climate Change Adaptation Measures | <p>Currently, three designs are being weighed against each other. They provide a combination of the following measures:</p> <ul style="list-style-type: none"> - Providing shade and a cooler environment through the planting of trees - Water buffering above ground (water square) - Decrease soil sealing by creating natural areas - Choice of specific plants |
| Good Practice | <p>Integration of climate projections and impacts in the criteria for urban development projects.</p> <p>The process of building a knowledge basis and experience through pilot projects provides the city with a solid basis for future decisions on climate change adaptation options. The results from the pilot projects are evaluated in order to acknowledge which measures could become 'requirements' in future projects.</p> |
| Further Information | <p>https://stad.gent/mobiliteit-openbare-werken/openbare-wegenwerken-uw-buurt/openbare-werken-gent-centrum/openbare-werken-ontwerpfase/kettingplein-en-omgeving</p> |

KiezKlima, Berlin (Germany)

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| Project Description | The project aimed to inspire the inhabitants of the Berlin "Brunnenviertel" to get socially involved in matters of development and implementation of climate adaptation measures in their place of residence. |
| Budget | N/A |
| Climate Change Vulnerability and Risks | <p>Because of the extreme topic "Heat Stress" is an urgent matter.</p> <p>Extreme heat conditions have a negative influence on the metabolism of human, animal and herbal organisms, particularly affecting their hydrologic balance (danger of dehydration). The so called "heat stress" represents, mostly for older people and children, a serious health danger (risk to the heart-circulatory system). In the agriculture sector, heat stress could result in profit losses.</p> |
| Climate Change Adaptation Measures | <p>Around 120 ideas for adaptation measures were presented. The proposals included were not only ideas for structural design but also for new networks and sponsorships.</p> <p>Through workshops, the people of the neighborhood raised many ideas for actions and contests for the greening of the neighborhood. The results have provided the basis for the further planning of the adaptation measures with the residential construction company "degewo" and the district council.</p> |
| Good Practice | On the basis of an all-encompassing/unrestricted evaluation of the project process and results, transferable recommendations for other city districts in Germany are prepared. Questions such as the approach and participation of the population are at the forefront. |

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| | <p>This was one of the four case studies to be recognized as an “Adaptation Pioneer” by the Federal Environment Agency (UBA) in the first Blue Compass competition in 2016.</p> <p>This is what the jury says: The KiezKlima project is something innovative. This is how city planning works, because it is not just about adapting to climate change. Rather, the topic is used to shape neighborhood management. The participatory approach, in which different forms of citizens' participation are used creatively, should be highlighted. The social component goes far beyond the aspect of adaptation and thus exposes socio-ecological and demographic challenges of urban development.</p> |
| Further Information | <p>Federal Environment Agency (UBA) official webpage:</p> <p>https://www.umweltbundesamt.de/themen/klima-energie/klimafolgen-anpassung/werkzeuge-der-anpassung/tatenbank/wettbewerb-tatenbank-blauer-kompass#textpart-1</p> <p>http://www.e-p-c.de/kiezklima/2015/</p> <p>https://www.klima.tu-berlin.de/index.php?show=forschung_dch_kiezklima&lan=de</p> |

Tools

| Adaptation Compass – Future Cities (Luxembourg) | |
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| Project description | The Future Cities project partners developed a practical tool to check the vulnerability and adaptation options across sectors |
| Budget | N/A |
| Climate Change Vulnerability and Risks | The tool helps to determine the current vulnerability of a city region or parts of a city with the Vulnerability check . The Assessment of risks and opportunities is a proposed method that uses the results of the vulnerability check and the projected climate change trends. |
| Climate Change Adaptation Measures | The tool offers a module to explore adaptation that offers various adaptation options: especially the combination of different measures based on the practical experiences of the Future Cities partnership. |
| Good Practice | This guide aims to interlink different stakes and to check the vulnerability and adaptation options across sectors. |
| Further Information | |

Guidance

| North West Bicester Eco Development (UK) |
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Project Description

The project is an eco-development (housing) that is situated on the north-west of Bicester in Oxfordshire. It is the UK's very first Eco-town and its long-term vision is to provide 6,000 new sustainable homes for the local area over the next 25-year period.

Photograph



<http://nwbicester.co.uk/about-nw-bicester/>

Budget

£20 million (for the initial stages)

Climate Change Vulnerability and Risks

A methodology was developed in order to undertake a climate change risk analysis based on the UKCP09 Weather Generator tool. This involved the use of UKCP09 projections to model for both medium and high emissions for the 2030s, 2050s and 2080s.

This was then combined with a vulnerability assessment of future occupants. The risks identified included the following categories: excessive heat, excessive rainfall, flooding, storms, drought and Ice / snow. The findings of this process were then used to inform an options appraisal of suitable adaptation measures.

The assessment of climate change risk and adaptation measures began in the planning phase of the development.

Climate Change Adaptation Measures

The Design for Future Climate report (see below) contains an extensive list of potential adaptation measures, these include but are not limited to the following:

- Design that incorporates the replacement of pavements and roads with porous, 'cool' materials
- Plans for the planting of heat, drought and pollution tolerant plants
- The incorporation of sustainable drainage systems (SuDS) comprising soakaways, swales and ponds
- All buildings have been designed outside 1/1000 year flood zones

All housing units final floor levels have been designed to be slightly elevated from existing ground level to adapt to potential ground water level changes

Good Practice

It is the first Eco-town in the UK and it sets a strong example for other housing developments by incorporating extensive use of UKCP09 projections as well as proposed adaptation measures.

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| Further Information | Design for Future Climate - Adapting Buildings. NW Bicester Eco Development Programme [online] http://www.arcc-network.org.uk/wp-content/D4FC/D4FC24-Bicester-new-town-full-report.pdf |
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System

Addressing governance challenges that 'cross' administrative boundaries: Supporting 15 municipalities in the Central Denmark Region in adaptation planning (Denmark)

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| Project Description | <p>The cost of inaction on climate change is significant for Denmark and the wider EU. As a result, the Danish government made it mandatory in 2013 for municipalities to draw up climate change adaptation plans. It also encourages the integration of the climate change adaptation action plans into the municipal spatial planning covering all spatial areas including cities and countryside. In this way, it is facilitating compliance with the EU Water Framework Directive and the Floods Directive. The climate change adaptation plans have now been adopted, but their implementation has not been initiated. The C2C CC project will provide a comprehensive base for implementation, evaluating the results and the process, as well as providing local authorities with the tools for better integrated planning, taking into account the uncertainties of future climate change.</p> <p>The Central Denmark Region (CDR) is the second largest regional administrative body in Denmark covering 19 municipalities, of which 15 are associated beneficiaries in the C2C CC project. CDR coordinates regional development within the context of nature, environment, business and tourism.</p> |
| Budget | <p>Total Budget 11,683,058.00 €</p> <p>EU CONTRIBUTION 7,009,893.00 €</p> |
| Climate Change Vulnerability and Risks | <p>The project supports the implementation of 21 municipal climate change adaptation plans and four risk management plans under the Flood Directive in the CDR. It provides decision-makers with a framework for sustainable and integrative climate change adaptation planning, mainstreams climate change adaptation into local planning and integrates other policy areas. A total of 24 specific actions cover capacity building within all themes in the hydrological cycle and improve multi-level management structures. The climate change adaptation plans address cities as well as the countryside and coastlines.</p> |
| Climate Change Adaptation Measures | <p>The objectives of the hydrological cycle related to the challenges documented in the climate change adaptation plans are to:</p> <ul style="list-style-type: none"> • Increase coastal resilience taking into consideration the environmental state and marine biodiversity and to enhance urban resilience; • Increase the resilience of land alongside riverbanks taking into consideration the environmental state and biodiversity; |

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| | <ul style="list-style-type: none"> • Increase resilience and optimising use of rising near-surface groundwater; • Increase urban resilience taking into consideration the synergies with green infrastructure and urban liveability; • Increase resilience through capacity building, strengthened network governance and cross-border coordinated planning; • Increase resilience through enhanced decision-making processes; and • Increase resilience by generating jobs and green investments. |
| Good Practice | <p>Expected results:</p> <ul style="list-style-type: none"> • A 3D model of flooding that combines flood events owing to rainwater, rivers and the sea; • A hydrological model combining rising groundwater with surface water; • New business models that consider climate change adaptation activities; • New methods for city planning that can help prevent flooding (e.g. permeable surfaces); • Warning systems for flooding; • Network governance and integrative planning of large catchment areas; and • A range of capacity building events. |
| Further Information | http://ec.europa.eu/environment/life/project/Projects/index.cfm?fusaction=search.dspPage&n_proj_id=6139 |

Institutional capacity

Development of urban adaptation plans for cities with more than 100,000 inhabitants in Poland (MPA) (Poland)

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| Project Description | <p>This project is a big scale project, which involves 44 of Poland's largest cities (>100,000 citizens, housing about 30% of Polish population and generating about 50% of Polish GDP). The goal of the project is to identify and analyse adaption and mitigation challenges each city may face, draft plans for local authorities, indicate sources of funding and raise awareness for the need of adaptation. This is the only initiative in Europe in which the Ministry of the Environment supports the authorities and local administration in coordinating the activities adapting to the effects of climate change in several dozen cities at the same time. The project is carried out by the consortium of organisations, including the National Research Institute of Environmental Protection, the National Research Institute of Meteorology and Water Management, the Institute of Ecology in Industrialized Areas and a consultancy company. The project implements the outcomes of the strategic adaptation plan for sectors and areas sensitive to climate change in Poland (NAS). This project should contribute to protecting about 30% of the Polish citizens against the climate change effects. The project implementation will initiate similar activities on the local</p> |
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| | level in smaller towns and communes. An important task is to educate and improve awareness on the local level, both among officials and urban communities. Duration: 01.07.2016 till 31.03.2019 |
| Photograph | http://44mpa.pl/urban-adaptation-plans/?lang=en |
| Budget | Total cost: 31 million PLN |
| Climate Change Vulnerability and Risks | Project consists of six stages and each of them has an appropriate methodology and tools to achieve the main objective and develop the urban adaptation plan for 44 cities (44 plans). |
| Climate Change Adaptation Measures | Will be developed within the project. They will differ depending on the local conditions of the cities. |
| Good Practice | This is a good practice in term of developing the documents that will identify the levels of vulnerability, resilience and adaptive capacity of the cities. Based on that, the necessary adaptation measures will be chosen and customised to local conditions. |
| Further Information | http://44mpa.pl/urban-adaptation-plans/?lang=en |

Energy

Methodologies

| Study on hydropower dam and other water uses (Greece) | |
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| Project Description | The Aristotle University of Thessaloniki evaluated the impacts of climate change on a hydro power plant, and on the relevant uses of water for power, irrigation, water supply and natural processes. |
| Photograph | N/A |
| Budget | N/A |
| Climate Change Vulnerability and Risks | Due to climate change, water availability for different uses such as domestic water supply, hydropower production, and agricultural irrigation could be significantly reduced in the near future mainly in regions with arid and semiarid climate. |
| Climate Change Adaptation Measures | The report suggested an adaptation management model, to modernise agriculture irrigation methods, and to create smaller water collection dams downstream to serve secondary uses. |
| Good Practice | The report (and followed methodology) evaluated the economic viability and sustainability of the dam, estimating the necessary capital expenditure and operating expenditure, as well as the compensation to the agriculture |

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| | community and the costs to repair the environmental damage. |
| Further Information | N/A |

Aardwarmte Combinatie Luttelgeest BV – EFRO Project (Netherlands)

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| Project Description | The project is set up by farmers who want to use geothermal energy to heat their greenhouses (depth: ca. 1800m). This will result in a CO ² emission reduction of 18.000 tones and will save 10.6 M. m ³ of natural gas every year. |
| Photograph | |
| Budget | EFRO funding: € 1.200.000,00/ total: € 16.500.000, 00 |
| Climate Change Vulnerability and Risks | A risk-analysis is included in this type of project. Different scenarios with changing weather circumstances are reviewed to check the drilling depth of the pipes. Water was also considered. A scenario with high and low water availability has been studied. This is the case for a series of similar projects that have been funded over the last decade. |
| Climate Change Adaptation Measures | Potentially change depth of pipes, review the volume of water needed. |
| Good Practice | New geothermal projects need to take these considerations into account to mitigate the risk of not having a performing energy system in place. The fact that this has been done in several similar projects, shows the replicability of the practice |
| Further Information | http://www.kansenvoorwest2.nl/nl/projecten/ - offline |

Guidance

Integration of Climate Change Adaptation into Business Strategy – Pilot Case ENDESA (Spain)

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| Project Description | Endesa is a private, energy supply company providing electricity and gas. The pilot case includes a detailed analysis of the vulnerability to climate change for the company activity at the hydroelectric plants in the water reservoirs of Cala (Sevilla) and El Tranco (Jaén), as well as the run-of-the-river station of Mengíbar (Jaén). This was carried out in a first phase and presented in a report in 2014. In a second phase of the pilot, adaptation measures for the three reservoirs in Andalusia were identified. The outcomes of this second phase were published in 2016. |
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| Photograph | N/A |
| Budget | Unknown |
| Climate Change Vulnerability and Risks | <p>Major risks were identified related to increasing temperature, which would lead to major evapo-transpiration of vegetation in the basins and a major need for irrigation water supply. Less precipitation in basins resulting in less hydroelectric production and increase of water selling costs were some of the other risks revealed by the study.</p> <p>Risks related to extreme weather events are considered to be of minor importance.</p> |
| Climate change Adaptation Measures | <p>Proposed adaptation measures:</p> <ul style="list-style-type: none"> • Water demand management: By influencing the demand, optimisation of the management of the hydroelectric installations shall be achieved; • Meteorological and climatological predictions and water reservoir management; • Handling of suspended solids to minimise the accumulation of sediments in the water reservoirs to resolve technical problems of the installations (clogging); and • Adaptation of emergency plans to new climate conditions. |
| Good Practice | <p>Except for implementation, all steps of climate change adaptation assessment have been carried out and are described: The pilot can serve as a methodological guide for other energy infrastructure projects. The pilot can also serve as a methodological guide for other, similar projects.</p> |
| Further Information | <p>Website of the Spanish Ministry for Agriculture and Fishery and Food and Environment: http://www.mapama.gob.es/es/cambio-climatico/publicaciones/publicaciones/adaptacionempresarialcambioclimatico_tcm7-443205.pdf</p> |

Design Standards

Elenia Säävarma Underground Cables (Finland)

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| Project Description | <p>Electricity companies in Finland have been building electricity cables underground as a response to the renewed Electricity Market Act. According to the legislation, the network must be designed so that storms or snow load does not cause more than 6h breakdowns in town areas or more than 36h breakdowns in other areas.</p> |
| Photograph | N/A |
| Budget | <p>In 2017, the investment is planned to be over €120 M for one company.</p> |
| Climate Change Vulnerability and Risks | <p>Electricity network providers have understood that increased storm activity or increased snowloads during winter can be a major issue and cause costs and power</p> |

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| | outages. The current overhead cables are very vulnerable to storms and snow. |
| Climate Change Adaptation Measures | The companies Elenia , Kerava energia and Savonvoima have started building electricity cables underground to mitigate the risks. The company Elenia is planning on having 70% of its electricity network underground by 2028. |
| Good Practice | Making the electrical network climate resilient, e.g. design and construction of an underground cable network. |
| Further Information | / |

Water

Data Availability

Options for sustainable agricultural production and water use in Cyprus under global change ("AGWATER") (Cyprus)

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| Project Description | <p>The Cyprus University of Technology, along with various Partners conducted a two-year study for sustainable water use within Cyprus. The overall goals of this project were:</p> <ul style="list-style-type: none"> • To provide recommendations for climate change adaptation for the agricultural sector in Cyprus and the wider Mediterranean region; and • To establish a consortium of excellence in natural resource management research in Cyprus for tackling the challenges imposed by climate change. <p>The AGWATER project aimed to model agricultural, water productivity and economic indicators for all agricultural production systems in Cyprus, under different policy, economic and climate scenarios, for the 2020-2050 future period. To do so a number of datasets and scenarios were developed in five work packages, as described in this summary:</p> <ul style="list-style-type: none"> • A digital soil map and soil property database of Cyprus at 1:25,000 scale; • An agro-climatological characterisation and agro-meteorological database for Cyprus; • A characterisation of agricultural production systems and an assessment of the effect of climate on potato and barley production, based on long-term research trials; • Policy and economic scenarios for 2020-2050; and • Climate change projections for 2020-2050. |
| Photograph | n/a |
| Budget | €68,440 |
| Climate Change Vulnerability and Risks | Agriculture in Cyprus is constrained by high temperatures and limited and highly variable rainfall. Irrigation water supplies provide an important contribution to crop production, but water resources are limited. This situation is expected to worsen in the future, as a result of climate change. |

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| Climate change Adaptation Measures | A daily soil water balance model was used to compute agricultural production and water use performance indicators for 333,216 registered crop plots in Cyprus. These plots cover a total area of 124,568 ha; 27,678 ha irrigated and 96,890 ha rain-fed. Soil physical data were obtained from the new digital soil maps for each plot. Similarly, a 30-year record of daily precipitation and reference evapo-transpiration data was extracted for the climate grid cell that covered the plot. The climate datasets included a gridded data set developed from observations for the 1980-2010 reference period statistically downscaled climate projections for 2020-2050 of three Regional Climate Models (CNRM, KNMI and METO-HC) for the medium A1B emission scenario. |
| Good Practice | <p>A primary aim of AGWATER was the establishment of a database of the basic daily climatological parameters. Furthermore, the second objective of the work package was the spatial interpolation of the climatic parameters in order to create different climate surfaces.</p> <p>The research outputs are brought together in the Cyprus green-blue-water model, which use a consistent computational framework and modular structure, to analyse the effects of the 3x3x3 matrix of policy and economic scenarios under the climate change projections for 2021-2050. A set of agricultural production and water use performance indicators are computed by the model, including green and blue water use (m³/ha), crop yield (ton/ha), crop water productivity (kg/m³), subsidy support (€/ha), net value of crop production (€/ha) and economic water productivity (€/m³). All indicators are computed and mapped at the field, community, agro-climatic zone and country level, to facilitate the extraction of policy recommendations.</p> |
| Further Information | https://www.cyi.ac.cy/images/AGWATER_Scientific_Reports/Project_Summary_def.pdf |

CLIMHYDEX (Romania)

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| Project Description | The CLIMHYDEX ("Changes in climate extremes and associated impact in hydrological events in Romania") project is supported by the Executive Agency for Higher Education, Research, Development and Innovation Funding (UEFSCDI) as a three-year Complex Exploratory Research Project (PCCE), cod PNII-ID-2011-2-0073), under the contract nr. 5/2012.05.11. |
| Photograph | n/a |
| Budget | Not available |
| Climate Change Vulnerability and Risks | The objective of this project is to improve knowledge in understanding the complex mechanisms controlling the variability of the most important weather/climate extremes occurring in Romania at various time scales, to estimate the uncertainty associated to their projections in the future perturbed climate and to quantify climate change impact on hydrological regime, focusing on extremes events. |
| Climate Change Adaptation Measures | <p>More specific objectives cover the following:</p> <ul style="list-style-type: none"> Identify the main observed variability features of a wide range of climate extremes in Romania mainly connected |

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| | <p>to hydrological extremes (flood and drought) at a spatial and temporal scale never used before;</p> <ul style="list-style-type: none"> • Study in deep the large-scale/regional-scale mechanisms controlling the variability of selected extremes in Romania at various timescales; • Developing improved statistical downscaling models to estimate the local climate extremes and various parameters used in hydrological models; • Estimation of future changes in various climate parameters including extreme indices and associated uncertainty; • Developing of improved hydrological models for pilot hydrological basins at various spatial and temporal scale; • Estimation of future changes in selected hydrological extremes and estimation of the associated uncertainties; and • Quantification of the water resources vulnerability to climatic change and the establishment of the necessary adaptation measures in pilot river basins. |
| Good Practice | <p>SWAT is a watershed scale model, operating with daily steps, developed to evaluate and forecast (for long periods of time) the impact of land management practices on water, sediment and nutrients in ungauged river basins, with different soils, land use and management conditions. It is a physical model using freely available inputs which allows the analysis of changes in land use impacts on water resources. The major components of the model include: climate, hydrology, temperature, and soil properties, plant growth, nutrients, pesticides and land management.</p> |
| Further Information | <p>http://climhydex.meteoromania.ro/sites/default/files/field/image/CLIMHYDEX-REPORT-ENGLEZ-2016-final_V2_0.pdf</p> |

Methodologies

| Future Cities' Green-Blue Corridor, Kamen (Germany) | |
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| Project Description | <p>The Future Cities project aimed to disconnect storm water from the nearby paved areas, as well as to ecologically improve the stream "Heerener Mühlbach" in Kamen, Germany. By combining the effects of green structures with the water system, the potential impacts of climate change would be weakened, and the implemented measures would unfold their potential in every climate change scenario.</p> |
| Photograph |  <p>Before (2007) and after (2012) transformation</p> <p>(https://www.umweltbundesamt.de/sites/default/files/styles/800w400h/public/medien/portale/kompass/massnahmen/bilder/2222_gruen-</p> |

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| | <p>blauer_klimakorridor.jpg?itok=J1NnnFwd and https://www.umweltbundesamt.de/sites/default/files/medien/portale/kompass/massnahmen/bilder/2222_d_gruen-blauer_klimakorridor.jpg)</p> |
| Budget | <p>Based on the results of the feasibility, the costs depended highly on the local situation; the property owners willing to disconnect received from 9 €/m² to 30 €/m² (average range: 16-21 €/m²).</p> |
| Climate Change Vulnerability and Risks | <p>The 50-150 m wide stream "Heerener Mühlbach" was used as an open wastewater system over a straight concrete bed, where waste and storm water got mixed, affecting the ecosystem enormously and preventing biodiversity. Also, the frequently occurring floods led to damages to private as well as industrial buildings located near the canal, which passes over a length of 2 km through a densely built area in Kamen.</p> <p>Extremely heavy rainfall enhances and aggravates the identified risks. The intensity and the frequency of extreme weather events, such as this, are most likely to increase in the future but, because of the uncertainties that come along with climate change, decentralized measures were to be applied, rather than technical solutions (for example, higher dykes or wider sewer, which often lack cost-effectiveness and the acceptance of the public) in order to unfold their potential in every climate change scenario.</p> <p>The green-blue corridor at the "Heerener Mühlbach" was realised within a timeframe of a little over twelve months in 2011/2012. Before the beginning of the project, a sewer pipe was placed underground along the river. Afterwards, the concrete bed was removed (except under the bridges), allowing the river to flow on a new, higher and wider sole than before and in a more natural way. The hard edges of the stream were transformed into nature-like edges, where green plants now have the chance to grow along the blue water body.</p> <p>In total, 72 properties of paved areas nearby, which used to feed the combined sewer system, were disconnected.</p> |
| Climate change adaptation measures | <p>By removing the concrete waterbed, the flood risk in the case of more intense and frequent heavy rainfall was significantly reduced, since the water run-off is now slowed down by natural means (for example the meandering and infiltration of the water through the natural bed and banks of the canal). Whereas the separation of the storm water from nearby paved areas also reduces the risk of floods (because the sewer system must no longer cope with that extra amount of water), the use of the now separated storm water also improved sustainably and ecologically.</p> <p>Due to the use of rain water for the open water body, the water cycle remains intact even in dry periods like summer, and evaporation creates a better microclimate. This means that, while combining water management measures with green corridors in the cities, the ecological functions of the water system are strengthened and the climate in the urban surroundings is improved.</p> |
| Good Practice | <p>This was one of the four case studies to be recognised as an "Adaptation Pioneer" by the Federal Environment Agency (UBA) in the first Blue Compass competition in 2016.</p> <p>As a result of this project, a river has been re-natured (enabling biodiversity and providing recreational space for the local inhabitants), and the residents of the surrounding area have been successfully made aware of</p> |

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| | the water cycle and their own responsibility for sustainable development, also improving their housing environment. |
| Further Information | <p>Federal Environment Agency (UBA) official webpage: https://www.umweltbundesamt.de/themen/klima-energie/klimafolgen-anpassung/werkzeuge-der-anpassung/tatenbank/wettbewerb-tatenbank-blauer-kompass#textpart-1</p> <p>Future Cities official webpage: http://www.future-cities.eu/project/pilot-projects-locations/</p> |

Water management in a new district in Rouen (France)

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| Project description | Development of an eco-district in Rouen. |
| Photograph | N/A |
| Budget | 60€ million |
| Climate Change Vulnerability and Risks | <p>Risk of flooding</p> <ul style="list-style-type: none"> - Changing precipitation patterns - Rising level of the Seine estuary <p>Urban heat island effect</p> <ul style="list-style-type: none"> - Higher average summer temperatures - Increase in the number of heat wave days <p>Source: Adaptation des bâtiments aux changements climatiques – Le changement climatique et ses effets en Haute-Normandie</p> |
| Climate Change Adaptation Measures | <p>Integrating higher risk of flooding from changing rainfall:</p> <ul style="list-style-type: none"> - Creation of a retention basin - Integration of the risk posed by flooding by the Seine due to increase in heavy rain episodes by the development of a flood chamber and the elevation of ground levels <p>Reduction of the urban heat island effect</p> <ul style="list-style-type: none"> - Unearthing existing water streams - Development of green roof <p>Collection of rainwater</p> |
| Good Practice | Makes use of existing resources to offer adaptation solutions. |

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| Further information | Normandie, Development Durable: Luciline–Rives de Seine |
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ADAPTACLIMA-EPAL (2011) (Portugal)

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| Project description | The project ADAPTACLIMA-EPAL aimed to provide to the Empresa Portuguesa das Águas Livres (EPAL) an adaptation strategy in the medium and long term to reduce the vulnerabilities of their activities to climate change. This process involved all entities which are involved in the activity of EPAL (public, private and consumers). |
| Photograph | n/a |
| Budget | Not available |
| Climate Change Vulnerability and Risks | The analysis of scenarios and vulnerabilities identified, selected and evaluated adaptation options of EPAL to climate change, in order to minimise adverse impacts and maximise the new opportunities that may arise. |
| Climate change adaptation measures | The project set priorities for adaptation measures based on a cost-benefits analysis in accordance with criteria established in collaboration with EPAL. Special attention was given to assessment of costs associated with adaptation measures identified, in particular with regard to planning and management of enterprise assets. |
| Good practice | This project uses regionalised climate scenarios which generated the mean and variability of climate variables such as temperature and precipitation. These scenarios are based on global climate models (e.g. HadCM3) and validated with observed climate series in the areas under study. The projections produced enable assessments of the frequency of future extreme weather events, such as high rainfall in short periods of time and prolonged severe droughts. |
| Further information | http://cciam.fc.ul.pt/prj/adaptaclima-epal/?lang=en |

Brdnikova Water Retention (Slovenia)

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| Project description | The redesign of the Podutik flood reservoir is increasing ecosystem-based climate adaptation services by creating a multifunctional blue-green infrastructure |
| Photograph | N/A |
| Budget | N/A |
| Climate Change Vulnerability and Risks | Increased flood risk |
| Climate change adaptation measures | The flood reservoir Podutik has been redesigned into a multifunctional flood reservoir that provides a broad range of ecosystem services through the integration of nature-based technologies (Eco Technologies). |

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| Good practice | Improves and maintains a good ecological status of the nearby watercourses Mitigates floods in the nearby settlements of the city of Ljubljana |
| Further information | http://www.turas-cities.org/pilot/14 |

Embankments protect against future flooding in Kristianstad (Sweden)

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| Project description | The project aims to protect Kristianstad against flooding both in the current climate and in the future. Because of its low-lying position by water, Kristianstad was in constant danger of being flooded. Large parts of the city were close to being flooded in 2002, and work has been underway since then to build embankments and pumping stations to protect the city by preventing the water from flowing in. |
| Photograph | N/A |
| Budget | The whole project cost approximately SEK 300 million, with 60% being government funded. The project reached its half-way point in 2014 and is expected to be completed in 2025. |
| Climate Change Vulnerability and Risks | In 2002, Hammarslundsvallen was almost breached due to a high tide, when water levels were measured at 2.15 metres above the mean. Emergency action had to be taken to protect the embankment. If the embankment had been breached, thousands of people would have been affected and several important public services put out of action, including the main hospital, the water treatment plant and the emergency station. |
| Climate change adaptation measures | To avoid a repetition of this near catastrophe, the municipality decided to reinforce Hammarslundsvallen and at the same time construct new embankments to protect other parts of the city from the River Helge's high tides. |
| Good practice | The embankments are in the form of earth and filter dikes, with an inner core of moraine which will allow a small amount of water to run through. These are reinforced with berms on the landward side that increase the strength of the dikes. This means Kristianstad should be protected against flooding both now and in the future irrespective of climate. |
| Further information | http://www.klimatanpassning.se/en/cases/embankments-protect-against-future-flooding-in-kristianstad-1.97877 |

Tools

Development of data-modelling system and decision support tool (Estonia)

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| Project Description | The objective of the project is to develop data-modelling system and the decision support tool for the integrated marine and |
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| | inland water management for use of institutions related to water management in Estonia. |
| Photograph | N/A |
| Budget | Initial project cost: € 2,044,000 From EEA Grants: € 1,852,068 |
| Climate Change Vulnerability and Risks | The project is necessary to strengthen capability of management of inland waters and coastal waters. |
| Climate Change Adaptation Measures | The outcome of the project is a decision support tool for water policy planning and implementing and more specifically main output is a modelling system for inland water and coastal water management. |
| Good Practice | The project involves partnership of different key stakeholders, including Estonian Environmental Agency (national and international reporting), the Environmental Inspectorate (monitoring), Agricultural Board, Health Board, Estonian Environmental Research Centre, local governments and water enterprises. This will ensure better understanding of the use of an integrated model in adapting to climate change. |
| Further Information | https://eeagrants.org/project-portal/project/EE02-0003 |

Integral adaptation strategies to mitigate flooding effects (Slovenia)

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| Project Description | The TUPAS university is demonstrating how to devise climate adaptation strategies in a participatory manner, and provides decision makers with the necessary building blocks |
| Photograph | N/A |
| Budget | N/A |
| Climate Change Vulnerability and Risks | A Flood Damage Assessment is promoted to provide quantitative monetary estimates of flood consequences and risk, and to gain insight into how the system works (e.g. which components contribute most to risk). A SPRAWL MONITOR tool provides trends and changes on the urban fringe in order to integrate in adaptation strategies related to suburban development and flood risk management |
| Climate Change Adaptation Measures | The GO GREEN module is considering green infrastructure in flood risk management plans and understanding the added value it gives to the functioning of the city. It is also promoting the understanding of decisions involved in the planning process, and sharing good practice in terms of planning, designing, installing and managing urban green infrastructure. An often promoted measure is the Multi-benefit Flood Retention approach of integrated |

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| | measures with multiple co-benefits for the development of an overall flood risk management strategy |
| Good Practice | Integration of integrated planning, stakeholder involvement, public education, ecosystem-based approaches into climate adaptation planning |
| Further information | http://www.turas-cities.org/topical_strategy/5 |

Guidance

Aqua Knowledge and Innovation Transfer for Water Saving in the Mediterranean Basin (AQUA KNIGHT) (Cyprus)

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| Project Description | Mediterranean water resources are under stress, especially in the south and east. Water demand constantly increases, while water use efficiency can still be considered as limited. Policies aiming at improving usage efficiency and reduced losses and poor usage, are urgently needed. AQUAKNIGHT focuses on optimising consumption and minimising the Non-Revenue Water (water not metered or billed to consumers) through the implementation of five pilot projects in the cities of Limassol (Cyprus), Genoa (Italy), Alexandria (Egypt), Tunis (Tunisia) and Aqaba (Jordan). |
| Photograph | n/a |
| Budget | €2 billion |
| Climate Change Vulnerability and Risks | Not specifically carried out |
| Climate Change Adaptation Measures | Development of a manual of best practice for reducing commercial water losses in the water networks of the Mediterranean area Increase of water utilities staff knowledge and capacity to reduce water losses with the consequent benefits in operational and financial terms |
| Good Practice | Application of international best practice to evaluate and control water losses in the selected pilot areas Wide dissemination of best practice to control and manage water losses and make sure that tools reach a wide group of stakeholders in the participating countries and in other Mediterranean countries |
| Further Information | http://www.enpicbmed.eu/ |

Adaptation to drought in Alentejo (Portugal)


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| Project Description | The purpose of the study was to better understand the autonomous adaptation taking place by farmers and communities in the Alentejo region. The study also evaluated the already-implemented adaptation measures with different methods such as cost benefit analysis, INVEST modelling, sharing of experience, literature review and participatory multi-criteria analysis on barriers and opportunities. |
| Photograph | N/A |
| Budget | N/A |
| Climate Change Vulnerability and Risks | Alentejo, a southern region in Portugal is characterised by a semi-arid Mediterranean and is particularly vulnerable to drought and desertification |
| Climate Change Adaptation Measures | The study collected over thirty diverse adaptation measures currently being used by different farmers and organisations in the region. Innovative measures include creating microclimates (with lakes, windbreaks, etc.) or locating crops in specific microclimates in the farm (shade of hills, etc.). Many adaptation responses consisted in implementing good practice to improve general sustainability and farm resilience. Some examples include conservation tilling (no tilling, zone tilling, keyline, contour, etc.), diversification (of crops, species, varieties, genes, creating agro-silvo-pastoral landscapes, etc), improving soil quality (increasing organic matter, mulching, rotating livestock, introducing sewage sludge on soil, etc.). Other measures focus on harvesting rainwater and using water more efficiently such as off-stream dams, water retention landscapes, precision drip irrigation with organic fertiliser, reusing grey water, using renewable energy for water pumping to reduce the costs of irrigation. Finally, several measures focused on raising the adaptive capacity namely with awareness raising about sustainability and climate change, training courses in permaculture, and the development of community plans for an eco-village. |
| Good Practice | Uses indigenous skills and knowledge, enhancing sustainability of the programme |
| Further Information | http://base-adaptation.eu/adaptation-drought-alentejo-portugal |

Water supply and wastewater management in Warsaw - Phase V (Poland)

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| Project Description | Goal of the project was to improve and optimise the existing wastewater treatment and drinking water supply system in Warsaw. This included expanding the system to serve more inhabitants, reducing leakage and infiltration, improving reliability, reducing energy consumption and reducing CO ₂ emissions, adjusting the infrastructure to climate change, etc. |
| Budget | This project is co-financed under Cohesion Fund (CF), Operational Programme Infrastructure and Environment 2014-2020. The total estimated budget is about 850 million PLN, of which about 542 million PLN will be financed by the EU. About 238 million PLN is related to |

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| | operations IV and V, which are also relevant to climate change adaptation. |
| Climate Change Vulnerability and Risks | <p>A detailed risk and vulnerability analysis has been performed. Potential risks for the functioning of the infrastructure project include:</p> <ul style="list-style-type: none"> • Heavy rainfall can negatively impact rain drainage and cause pollution due to sewage overflow. Dilution of wastewater can negatively impact the functioning of wastewater treatment. • Heavy storms and winds can cause interruptions in power supply amongst others. • High temperatures (low water availability) can cause problems for drinking water supply and can negatively impact the functioning of wastewater treatment. <p>The risk for flooding was considered low.</p> |
| Climate Change Adaptation Measures | The project includes a central control system, including the construction of a storage reservoir (operation IV). The control system will be based on mathematical models, GIS and a network of measuring points (operation V). This modern control system will adapt the system to climate change, as it can for instance detect any damage to the system caused by extreme weather events. The new storage reservoir will retain water in case of heavy rainfall. |
| Good Practice | This project was developed in accordance with the Guide to investment preparation respecting climate change mitigation and adaptation as well as resilience to natural disasters . |
| Further Information | N/A |

System

| KerkeBEEK-Flood risk management plan and implementation (Belgium) | |
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| Project Description | Flood risk management plan- in this FRMP, climate scenarios have been integrated. Eight governmental organisations (local municipality to regional administrations) signed a 'river contract' committing themselves to look for solutions to flood risk in the area of the Kerkebeek, together with citizens, companies in the area and other stakeholders and this in a one-year process. A specific project website has been set up. One of its functionalities informs stakeholders on how climate change could change the flood risk they are facing. Over 200 people participated in the workshops to define adaptation measures, including both infrastructure works and 'soft' adaptation measures. |
| Photograph |  |

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| Budget | N/A |
| Climate Change Vulnerability and Risks | The main risk addressed was flood risk. |
| Climate Change Adaptation Measures | More than 120 potential measures were defined by the different stakeholders. In a follow up meeting on October 21, 2017, additional steps will be taken to further define measures and win-wins. One example is to define the different functions a potential water buffer should take on, based on the needs of the local community. |
| Good Practice | The participatory approach provides an answer to dealing with uncertainty and remaining risk, whilst, creating both awareness and creative solutions. Thinking about adaptation together with the different stakeholders has led to an inspiring process that will be replicated in other flood risk management projects. |
| Further Information | https://www.vmm.be/nieuws/archief/ondertekening-charter-eerste-stap-naar-riviercontract-voor-kerkebeek https://www.vmm.be/publicaties/orbp-analyse-west-vlaanderen |

Iterative Climate Risk Management (Austria)

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| Project Description | This project set out to test the concept of iterative climate risk management based on a detailed analysis of current and future flood risk in Austria, with a special focus on the fiscal effects of flood risk. This concept links climate change adaptation and disaster risk management within a process-oriented decision support framework. Additionally, based on the empirical and modeling results, as well as the insights gained from dialogue with key stakeholders, a further goal was to establish a generic framework applicable to other decision contexts. |
| Photograph | N/A |
| Budget | N/A |
| Climate Change Vulnerability and Risks | By continually reviewing and integrating new scientific knowledge on climate change (e.g. emerging early trends and changes in variability that exacerbate existing risks or create new risks), decisions are adjusted over time with scientific and empirical evidence. Hence, disaster risk management in Austria is evolving to include early adaptation to climate change, addressing current variability (and the existing adaptation deficit) while mainstreaming climate change in decision processes. |
| Climate Change Adaptation Measures | <ul style="list-style-type: none"> • Spatial planning is seen as particularly important in areas with a low potential for settlement expansion and where there is a high level of competition for land; • Water management is a key area that has already been impacted by climate change. Measures include the |

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| | <p>erection of dams, newly constructed, reinforced or improved with new technical means;</p> <ul style="list-style-type: none"> • In Graz, additional costs are also accrued through the alternative or additional irrigation of urban trees, as well as from a greater volume of green space planning effort; • A distinction between pure damage repair and further adaptation measures is usually not carried out in the cities. The cities focus mainly on damage elimination after extreme events, with pre-emptive adaptation measures being implemented only occasionally; and • Interviewed city officials, in all four of the cities surveyed, expect a further increase in the number of heat days, longer heat and drought periods, but also an increase in severe rainfall events and a correspondingly rising risk of flooding. |
| Good Practice | <p>The following methods and tools were employed:</p> <ul style="list-style-type: none"> • A broad stakeholder dialogue with Austrian disaster risk management as well as climate change adaptation experts and practitioners; and • Comprehensive budget analyses with a focus on the Austrian disaster fund. <p>State of the art economic flood risk modelling with IIASA's CATastrophe SIMulation (CATSIM) framework.</p> |
| Further Information | <p>http://anpassung.ccca.at/pacinas/wp-content/uploads/sites/3/2017/06/PACINAS_factsheet_2_EN.pdf</p> |

Institutional capacity


Integrated marine and inland water management (Estonia)

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| Project Description | <p>Improving the current status of Estonian marine and inland waters is a priority. Around 74% of Estonian rivers, 50% of lakes, and only two coastal water areas out of 16 can be defined as having good environmental status. The aim of the programme is to assist Estonia in achieving good environmental status in its marine and inland waters. This is in line with Estonia's obligations deriving from EU marine and inland water legislation, the EU Strategy for the Baltic Sea Region and the Helsinki Commission (HELCOM) Baltic Sea Action Plan 2021.</p> |
| Photograph | N/A |
| Budget | €6.9 million |
| Climate Change Vulnerability and Risks | <p>Objectives of the project included:</p> <ul style="list-style-type: none"> - Increased capacity to assess vulnerability to climate change - Increased awareness of and education in climate change adaptation |

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| Climate Change Adaptation Measures | Results of the project included: <ul style="list-style-type: none"> - Establishment of systems for information exchange on climate change adaptation. - Implementation of strategies and measures for adapting to a changing climate. |
| Good Practice | Climate change is considered here in a project that aims for improving the good environmental status of marine environment and inland waters. |
| Further Information | https://eeagrants.org/What-we-do/Programme-areas/Climate-change-and-renewable-energy/Adaptation-to-climate-change |

Waste

Methodologies

| Landfill park development Nauerna (the Netherlands) | |
|--|---|
| Project Description | Redevelopment of the current landfill Nauerna in Assendelft into a future public nature and recreation area. |
| Photograph |  |
| Budget | N/A |
| Climate Change Vulnerability and Risks | Flooding is the main risk. Climate projections have not been included, but extra water drainage capacity has been integrated. |
| Climate Change Adaptation Measures | The design includes the creation of water buffers to accommodate excess rain water |
| Good Practice | While an update to include climate scenarios has not yet been considered, there is a systematic approach to address potential risks of flooding. |
| Further Information | http://www.afvalzorg.nl/over-afvalzorg/onze-locaties/locatie-nauerna.aspx |

| Veolia Energy Recovery Facility at Newhaven (UK) | |
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| Project Description | The Energy Recovery Facility (ERF) was built in 2011 at North Quay, Newhaven. The plant currently processes around 210,000 tons of municipal waste each year that cannot otherwise be reused or recycled. It is situated on the banks of the River Ouse |

which is on the south coast of England and was therefore built in an area which is vulnerable to flooding. The project involved constructing flood protection around the perimeter of the site, in combination with other measures to reduce the rate of flood water flow across of North Quay area.

Photograph



<https://www.gov.uk/government/publications/increasing-the-climate-resilience-of-waste-infrastructure>

Budget

£160 million

Climate Change Vulnerability and Risks

The main vulnerability and risks were associated with building a large plant in an area that is prone to flooding. Also, it was considered that future flood risk from climate change would increase risk/vulnerability of the development. In this case developers used Environment Agency guidance for carrying out their flood risk assessment, this incorporated the requirement to withstand a 1/200 year flood, a 20% climate change factor and a sea level rise scenario (as specified by the Environment Agency). This plant has been operational since 2011 and so is in the post-completion stage.

Climate Change Adaptation Measures

Innovative two-phase construction technique used where the plant was assembled behind a sealed membrane in a location away from river. This was then floated into position and lowered into its foundations. With regards to the design phase, levees were used for flood protection and Sustainable Drainage Systems were utilised to reduce run-off.

Good Practice

The development is a significant project that proves that if successful adaptation is incorporated into the design phase of a project then developers do not have to be restricted by geographical vulnerabilities.

Further Information

Summary of Proposals and results of studies: North Quay Energy Recovery Facility

<https://www.veolia.co.uk/southdowns/sites/>

Increasing the climate resilience of waste infrastructure 2012
<https://www.gov.uk/government/publications/increasing-the-climate-resilience-of-waste-infrastructure>

Conclusions

This study has identified a wealth of resources available to infrastructure project developers to take account for climate adaptation, while it is also clear that there are a number of areas where further resources could be made more accessible. The present publication and the accompanying country reports, which contain more than 1800 references (consisting of studies, websites, tools, or other documentation), have sourced a share of the available information across the EU. Additional publications and information sources relevant to climate adaptation are increasingly becoming available and accessible to varying degrees (i.e. in scientific journals). The ease of access to and availability of quality data, information and guidance material is of crucial importance for enhancing the climate change adaptation preparedness across the EU for infrastructure projects.

The majority of resources and case studies are in the transport, urban development and water sectors. There exist fewer resources and good practice case studies within the energy and waste sectors, with no replicable examples noted for the broadband sector. However, the ESIF requirements are increasing the adaptation of EU infrastructure, thus further improving the EU's resilience.

EU-level findings

A considerable share of information at an EU level is to be found on Climate-ADAPT, the climate change adaptation web portal for the European Commission. The most important tools, methodologies, guidance and other resources are provided on the platform, and are relevant for infrastructure projects. Indicatively, resources from DG REGIO are included, such as [the Major Projects Application Form \(the format is set out in Annex II to Regulation EU/2015/207\)](#) and the [Guide to Cost-Benefit Analysis of Investment Projects](#), which are used by all major project applicants and contain provisions for climate change adaptation. The web portal provides additionally a combination of policy, background information, data and user-friendly data-explorer tools (map viewers), a pool of case-studies, a database of tools, sector related information and (the results from) research projects.

Whilst the Energy, Transport and Water sectors are frequently mentioned, they are often included in publications on 'urban' adaptation. Larger building sites and area development are also under the remit of urban development. For both the Waste and Broadband sectors, there is little qualitative climate change sensitivity information available, nor specific potential climate change adaptation measures or approaches. This is an emerging topic and its practice is in progress and developing as more experience is gained.

Another source of information on data, tools, methodologies and standards applied in the EU Member States can be found in the National and/or regionally developed adaptation strategies. Currently 25 adaptation strategies for Member States have been finalized, with the remaining strategies still under progress. Depending on how the reports are presented (the level of detail, caveats and explanations included), climate reports can be used by project developers and a wider audience.

Requirements in the ESI Funds are delivering results as projects are starting to take climate adaptation into account. Approximately €450 billion of EU funding over the 2014-2020 programme period is allocated to Member States and implemented through nationally co-financed programmes (for more information on funding, please navigate to the [ESI Funds Open Data Portal](#) of DG REGIO). Climate-ADAPT provides information on ESIF funding requirements (e.g. the guidance document for major projects), whilst the DG REGIO portal on ESIF provides general information on managing authorities, beneficiaries, the operational programmes and more.

Member State level findings

There are a multitude of approaches in tackling climate change and increasing resiliency of infrastructure. These include new construction and functional improvements e.g. embankments to cope with sea level rise and storm surges, raising awareness amongst the general public, and research and technology development in monitoring climate change projections. In order to increase the uptake of climate change adaptation in infrastructure projects, Member States make use of Environmental Impact Assessments, Strategic Environmental Assessments and Sustainability Impact Assessments.

Out of the 28 Member States, 25 have developed national adaptation strategies. Most contain background data, climate change impact projections, and assessments for different sectors. Project promoters and ESIF beneficiaries conform with the ESIF requirements for climate adaptation during the projects preparation phase usually by subcontracting consultants who draw on the herewith identified data sources and supporting information. All Member States have data available to support their efforts in climate adaptation, with more detailed data found where there has been a history of significant climate change research and practice. There is a range of methodologies and tools available across the Member States as a whole that are very useful for various aspects of climate adaptation, such as flood defence planning, and determining vulnerabilities through assessing the risks of climate change adaptation.

The provision of guidance documentation on how to use methodologies, or develop the required infrastructure project documentation relating to climate adaptation is crucial when accounting for the uncertainties associated with climate change. The various available tools (i.e. flood maps) are very useful for the project preparation and they help staff without the modelling skills to make use of raw climate data to prepare documentation for climate adaptation for infrastructure projects. Aside from their use in project preparation, they also provide a basis for policy decisions and strategic planning.

Climate-ADAPT contains published reports that inform the legal and institutional frameworks of Member States (e.g. Urban Adaptation to Climate Change in Europe 2016⁵⁷ or the Open European Day⁵⁸), and provides links to other relevant national policy documents and websites.

Resources

This study has assessed the resources available from both the EU and the Member State level for each of the 7 areas of investigation, which are set out below:

- **Data availability** - Climate change data for adaptation is available to varying degrees across Member States. Project planners and interested parties involved in project development are able to make use of these data depending on their accessibility. Detailed and raw data, providing inputs for complex climate modelling / forecasting, risk analysis and vulnerability assessments, are encountered mostly in the context of research projects, and aggregated centrally, i.e. in the **CORDEX** database. Reviewed documents at an EU-level provide an insight in the most important climate change impacts in Europe, with many identified data sources useful at a strategic level for new projects. Member States' climate change web portals usually offer databases at a national and regional level, with the intention of providing developers and citizens with a variety of information to support the successful implementation of adaptation measures in their respective areas of responsibility.

⁵⁷ <https://www.eea.europa.eu/publications/urban-adaptation-2016>

⁵⁸ <http://resilientcities2016.iclei.org/open-european-day/>

- **Methodologies** – Various methodologies are applied at both an EU and Member State level to fulfil each step of the ESIF requirements (vulnerability and risk assessment, adaptation measures, appraisal, planning) for major projects. The methodologies assess vulnerabilities and the risks of climate change. Additional methodologies, not necessarily aimed at major projects, but establishing management frameworks include DPSIR (Drivers-Pressures-State-Impact-Response), SPM, COSMO, SPIM (South Pacific island), and DESSIN (Demonstrate Ecosystem Services Enabling Innovation in the Water Sector).
- **Tools** – Most of the tools identified provide data, with examples including map viewers such as the Urban Vulnerability Map Book⁵⁹ or the CLIPC-tool⁶⁰. A key objective of climate change adaptation tools are to assist users in developing strategies and providing guidance, links to relevant sources and dedicated support. The most frequent tools identified tend to be focussed on matters relating to flooding, as a response to the EU Floods Directive requirements. The EIA also remains an important tool to ensure that measures to increase resilience to climate change do not have a significant negative impact on other environmental issues, such as landscape preservation or biodiversity. While most of the tools are focused on physical parameters, there are also tools to assist with policy development, as found in the [CYPADAPT](#) and [BaltADAPT](#) projects, with stakeholder participation, and with the integration of ecosystem-based approaches.
- **Guidance** – Climate-ADAPT was found to provide a one-stop portal guiding project planners to make better informed decision-making through addressing knowledge gaps on climate change adaptation across the EU. JASPERS published the guidance document [The Basics of Climate Change Adaptation, Vulnerability and Risk Assessment](#) in 2017. The purpose of this document is to provide advice about what the basic principles of such an assessment are, especially in relation to project development, and what is expected in good practice. Additional EU-level guidance is available in the fact sheet on [Climate Change and Major Projects](#), and intended for those involved in the various development stages of major projects, while it can be usefully applied to a wider range of projects. With regards to cost-benefit analysis, the 2014 European Commission [Guide to Cost-Benefit Analysis of Investment Projects](#) provides guidance on project appraisals, as embodied in the regulations of the European Regional Development Fund (ERDF), the Cohesion Fund (CF), and Instrument for Pre-Accession Assistance (IPA). Member states have adapted these guides, or developed their own, aiming to support project developers in creating climate resilient infrastructure. Sector-specific guidelines also exist, such as the [Drainage Strategy Framework](#) in the UK.
- **Design standards** – Although design standards were not commonplace with regard to climate change adaptation, CEN and CENELEC have developed and published a 'Guide for addressing climate change adaptation in standards'⁶¹. This Guide is intended to help standard writers address the consequences and implications of climate change. Member States are contributing to the development of these standards and are ready to adopt them at a national level. Further available information on design standards for climate adaptation projects has been fairly limited.
- **System and legal framework** - Climate-ADAPT is a good source of the updated relevant EU policy documents and websites for information on the legal framework for EU Member States. The majority (25) of Member States have adopted or recently updated their climate adaptation strategy, developed action plans, and established working groups to monitor mechanisms and cooperation committees between various institutions and stakeholders at a national level. The remaining three Member States are in the process of developing or adopting the national

⁵⁹ <http://climate-adapt.eea.europa.eu/knowledge/tools/urban-adaptation/introduction>

⁶⁰ <http://www.ceda.ac.uk/projects/clipc/>

⁶¹ ftp://ftp.cencenelec.eu/EN/EuropeanStandardization/Guides/32_CENCLCGuide32.pdf

adaptation strategies and actions plans. A number of additional policies and laws support climate adaptation, such as the actions on disaster risk reduction, the requirements of the EU Floods Directive, and the revised Environmental Impact Assessment Directive 2014/52/EU.

- **Institutional Capacity** – It has been noted that all Member States have developed functional legal, financial and executive institutions that must meet the challenge of climate adaptation. The available capacities in terms of financial means, human capital and technological development allow for building resilient infrastructure. There is a high degree of support from the EU level, and a continuous exchange of best practice and cooperation, which is growing as required by the pressing circumstances. There are ongoing efforts to build capacity, develop knowledge and set requirements that support the existing institutions to support building resilient infrastructure.

Sectorial progress in climate adaptation

The study identified a diverse set of case studies from across the EU and across different sectors. The findings for individual sectors within the scope of this study are summarised below:

Transport

The transport sector is actively incorporating climate change adaptation into the preparation of major infrastructure projects. There are a number of case studies identified within sub-sectors of transport, including rail, road and air. The transport sector has been one of the first sectors targeted in relevant research projects, as it is crucial for ensuring the mobility of people and goods across the EU. The vast number of existing socio-economic systems that depend on the functioning of this sector are benefiting from the actions being taken.

Broadband

Limited resources are identified relating to addressing climate adaptation with respect to broadband infrastructure. The ESIF requirements for the 2014 – 2020 period onwards help to create a momentum in the sector, and the existence of EU-wide standardisation organisations can facilitate the fast adoption of measures.

Urban Development

The urban development sector has access to a large number of sources for data and information on climate adaptation. Many research projects have been conducted on the resilience of cities, and long lasting policies, systems and institutions are in place in the Member States to ensure the safety of the urban population and assets, mainly from flooding. The existing engineering experience and the highly developed expertise on the urban environment allow for a swift uptake of adaptation measures, even though the complexity of these systems often sets challenging boundaries. Information and platforms relating to climate adaptation are available at both a national level and regional level in certain Member States, primarily relating to spatial planning.

Energy

Within the identified resources, specific attention has been paid to adaptation in hydropower, and in overhead transmission lines, as the first is impacted by the projected increased variability in river discharge volume and frequency, while the second is exposed to the sheer stresses exerted by higher wind speeds, and the effects of storms. Most countries have an analysis of the vulnerability of the energy sector to climate change, and

a few of them are taking actions to secure the resilience of existing and planned energy infrastructure.

Water

The water sector is active in climate change adaptation in all of the 28 Member States, owing to long lasting institutions and practices around water and waste water management, the development of tools and the existence of available resources. Following the EU Floods Directive 2007/60/EC, all Member States are obliged to take climate change into account in their flood risk maps and flood risk management plans. At a national level, it was found that most Member States have considered the water sector in terms of climate change adaptation, whether it be in irrigation, water supply or flood risk.

Waste

Across the Member States, waste is to some extent covered by the relevant national authorities. However there is more emphasis on mitigation rather than adaptation (as with the Energy sector) and there is very little in the way of specific resources relating to climate change adaptation.

Overview of Case Studies

A variety of case studies are presented in this report, which are considered to be replicable, innovative, and to have added value to the relevant Member State in which they have been implemented. The case studies are presented in overview and demonstrate examples of methodological approaches, innovative adaptation measures, good practice stakeholder involvement, and inclusion of climate change adaptation into projects at varying stages of development (e.g. inclusion in feasibility studies, late stage assessment, etc.).

Following the theme of the sectoral findings, the majority of case studies are in the transport, urban development and water sectors, with a wide coverage of replicable resources (e.g. methodologies, tools) identified. There were fewer good practice case studies within the energy and waste sectors, with no replicable examples noted for the broadband sector. Despite this, case studies of climate change adaptation are present across the EU and with a comprehensive geographical spread and a large number of them are co-financed by ESI Funds. Due to the requirements for ESI Funded projects, climate-adapted infrastructure is expected to become more common and therefore further improve the EU's capacity to adapt in the future.

From the existing case studies it becomes apparent that most project developers are implementing climate adaptation measures because of the requirements of the ESI Funds. The case studies in this report are only scratching the surface of current practice by mentioning the types of analysis conducted and the types of measures implemented. The extent to which these measures are adequate to withstand the foreseeable climate impacts has been beyond the scope of the study. A potentially large number of useful innovations are achievable in the engineering, financing, and participatory approaches being practiced is possible.

Opportunities

The following opportunities are available for all stakeholders involved in climate adaptation to improve existing practice. The present stocktaking of available resources has identified a number of opportunities to fund projects, as well as to develop further the supporting resources, such as methodologies, tools and design standards. Additionally, it is possible to ripen climate adaptation and include practices with multiple benefits, such as ecosystem

based approaches, the increased employment of local knowledge, and the application of novel technologies.

Funding opportunities

Climate adaptation efforts receive funding that is increasing both from the EU budget and from development agencies. Under the broad theme of "Climate Change Adaptation & Risk Prevention" the ESI Funds⁶² invest in a range of investment priorities and union priorities to promoting climate change adaptation, risk prevention and management. Project developers can benefit from the availability of these funds which are applicable for the inclusion on adaptation actions in a wide range of projects, spanning core infrastructure developments (such as road and rail infrastructure), flood and fire protection, and land rehabilitation and risk management.

The [EEA Grants](#) (Iceland, Liechtenstein and Norway support programmes) provide funding to EU Member States to reduce human and ecosystem vulnerability to climate change. Projects are selected following open calls organised by the programme operator in each country. Current beneficiaries are located in the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Portugal, Romania and Slovakia. Bilateral partnerships are sought between public and private institutions, NGOs and research institutions in the donor and beneficiary countries on the theme of climate adaptation.

The European Investment Bank defines under its [priority on Climate Action](#) funding for projects to cut greenhouse-gas emissions but also for those which help adapt to climate change, and [loans](#) are the main source of backing for climate action projects. The European bank for Reconstruction and Development is [investing in climate adaptation](#) through its Sustainable Energy Initiative, while multilateral development banks (including the World Bank, the Inter-American Development Bank and the EBRD) are developing common principles for climate resilience metrics for their investments.

The [fi-compass website](#) is a platform for advisory services on financial instruments under the European Structural and Investment Funds (ESIF) provided by the European Commission in partnership with the European Investment Bank. Fi-compass is designed to support ESIF managing authorities and other interested parties, by providing practical know-how and learning tools on financial instruments.

[LIFE Climate Action](#) is dedicated to developing innovative responses to the challenges of climate change, and has four main instruments relevant for climate adaptation:

1. Grants to mainstream climate objectives at the local level and to support better governance and information on climate policies and action.
2. Ecosystem based approaches for climate change adaptation.
3. Operational grants to non-governmental organisations (NGOs) operating in the field of environment and climate action and policy development at European level.
4. Integrated projects implemented on a large territorial scale (regional, multi-regional, national or trans-national scale) such as plans and strategies required by EU legislation.

Under LIFE Climate Action, funding is made available in the form of [project action grants and operational support to NGOs](#). Funding is also channeled through two pilot [financial instruments](#) that leverage private finance through loans and guarantees via the European Investment Bank and local banks.

⁶² The European Structural and Investment Funds comprise a family of five funds: the European Regional Development Fund (ERDF) and European Territorial Cooperation goal (ETC, which falls under ERDF); the Cohesion Fund (CF); the European Social Fund (ESF); the European Agricultural Fund for Rural Development (EAFRD); and the European Maritime and Fisheries Fund (EMFF).

Horizon 2020, the financial instrument implementing the Innovation Union, includes adaptation to climate change in two societal challenges, or broad research themes: 1) [Climate action](#), including earth observations, nature-based solutions, and systemic eco-innovation; and 2) [Secure societies](#), which aims among others to enhance the resilience of society against natural and man-made disasters.

Opportunities to enhance climate adaptation practice

The resources, best practices and experience gathered in the present stock-taking study, point to the potential to enhance the practice of climate adaptation in infrastructure projects. The following list presents some general guiding opportunities that serve as a good starting point for parties interested to benefit from the growing field of infrastructure adaptation.

1. Adaptability and resilience is based on flexibility and novel approaches, not simply on stronger structures. Developing holistic approaches that combine climate adaptation and ecosystem services ensures the resilience of infrastructure and cities, while at the same time restoring valuable environmental parameters that are essential for supporting the existence of thriving societies. An example of how this could work is [EU-CIRCLE](#): their innovative framework to support resilience across European Infrastructure is based on rising climate pressures, and presents findings in a unified manner within a holistic resilience model.
2. Low awareness of climate adaptation practice poses the risk that projects might only address some of the potential impacts of climate change. One way to address this risk at every stage of the process is to combine the impact-related information with sector-related information through a central repository that can be continually updated by members of the practicing community, in exchange for virtual or monetary remunerations, as proof of their contributing work. A step to this direction is the [KiezKlima](#) project, used to shape neighborhood management through a participatory approach, where various forms of citizen participation are used and analyzed.
3. Novel technologies and digitization allow for the better development of early warning systems, for increased technical capacity and for participatory science that together improve resilience to extreme phenomena and facilitate the planning for, and social acceptance of, infrastructure projects. A case example is the “[Floud](#)” technology in Estonia, whereby the deployment of ultra-low-cost environmental monitoring devices are designed to enable, through a cloud-based data collection mechanism, extensive and real-time monitoring of the status of floods in urban areas, towards increasing the understanding of these phenomena, as well as providing an effective tool for issuing early warnings to the population and improve existing prediction models.
4. The insurance industry could contribute to the financing of climate adaptation projects through Public-Private Partnerships as the sector stands to benefit from lowering the risk of assets being exposed to frequent extreme weather phenomena. The EU’s Strategy on Adaptation to Climate Change lists insurance as a key component in future consideration. The European Commission’s [Green Paper on the insurance of natural and man-made disasters](#) seeks to improve market penetration of natural disaster insurance and to unleash the full potential of insurance pricing and other financial products for risk-awareness prevention and mitigation and for long-term resilience in investment and business decisions.
5. Given differing levels of capabilities and understanding of climate adaptation consideration across Member States, there are opportunities to promote knowledge-sharing and best practice through experienced Member States exporting their working knowledge throughout the EU and adapting that knowledge for local

requirements. [DARECLIMED](#) is a [CYI](#) project which aims to create a climate data repository and knowledge sharing platform, to improve data availability for the Eastern Mediterranean region.

6. Policies and legislations that are relevant for adapting to climate change can be revised using Impact Assessments whose scope includes the future risk and extent of climate change impacts. Mainstreaming climate adaptation into the EU and national legislation can take the form of a concerted effort, as seen by the [CEN-CENELEC coordination group on adaptation](#), which is advancing the relevant standards to increase resilience.

Annexes

Annex I: EU level additional resources

This Annex is found in the attachments

Annex II: References

This Annex is found in the attachments

Annex III: Consulted stakeholders

This Annex is found in the attachments

Annex IV: Member State factsheet reports

This Annex is found in the attachments

Annex V: List of case studies

| Country | Title of the case study | Sector |
|----------|--|-------------------|
| Austria | Cost relevance of adaptation in cities | General |
| | Iteratieve Climate Risk Management | General |
| Belgium | Redevelopment Groenplaats, Antwerpen | General |
| | KerkeBEEK-Flood risk management plan and implementation | Water |
| | Kettingplein | General |
| Bulgaria | OrientGate | General |
| Croatia | Dubrovnik Airport (Croatia) | Transport |
| Cyprus | Creation of a transnational network of innovation and experimentation pools for agriculture in the Mediterranean islands | General |
| | Aqua knowledge and innovation transfer for water saving in the Mediterranean basin (aqua knight) | Water |
| | Options for sustainable agricultural production and water use in Cyprus under global change ("AGWATER") | Water |
| Denmark | The economics of managing heavy rains and storm water in Copenhagen – The Cloudburst Management Plan (2016) | Water |
| | Addressing governance challenges that 'cross' administrative boundaries: Supporting 15 municipalities in the Central Denmark Region in adaptation planning (EU LIFE IP C2C CC) | General |
| Estonia | Integrated marine and inland water management | Water |
| | Development of data-modelling system and decision support tool | Water |
| | Smart City Project: Cloud-based Flood Prevention and Monitoring System | Urban Development |
| | Promoting sustainable urban drainage systems in Estonia - Latvia cross-border area to improve the environment for active and sustainable communities | Urban Development |
| Finland | Elenia Säavarma Underground Cables | Energy |
| | Reducing the overflow of sewage to river Vantaa | Water |
| France | Water management in a new district in Rouen | Water |
| | Bellegarde Railway Station | Transport |
| Germany | Future Citites' Green-Blue corridor, Kamen | Water |
| | Sun-Protection for Bus Stops, Nordhessen | Transport |
| | KiezKlima, Berlin | General |
| Greece | Study on hydropower dam and other water uses | Energy |
| | Patras – Pyrgos motorway | Transport |
| | Attiki odos / Attica tollway | Transport |
| Hungary | Establishing a National Adaptation Geoinformatic System (NAGiS) | General |
| | Urban green infrastructure development, preservation, restoring, expanding and management – tool for optimiSing the experience of living through people, parks and common programMEs | Urban Development |
| Ireland | Urb Adapt | General |
| | Connecting Nature | Urban Development |
| | Met Éireann ReAnalysis Project | General |
| Italy | Landslides in Central and Southern Italy | |
| Latvia | Latvian railway network electrification project | Transport |

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|-----------------|--|-------------------|
| Lithuania | BaltADAPT | General |
| Luxembourg | Study on the consequences of climate change for the Rhine catchment area | Water |
| | Adaptation Compass | Urban Development |
| Malta | ECO GOZO: 'NAQQAS U FFRANKA' | General |
| Poland | Development of urban adaptation plans for cities with more than 100,000 inhabitants in Poland (MPA) | Urban Development |
| | Water supply and wastewater management in Warsaw - Phase V | Water |
| | Railway line no. 1 on the section Częstochowa-Zawiercie | Transport |
| Portugal | Cascais Municipality | Urban Development |
| | ADAPTACLIMA-EPAL | Water |
| | Adaptation to drought in Alentejo, Portugal | Water |
| Romania | CFR-SA railway project: Simeria - km 614 | Transport |
| | Construction of Sebes - Turda Motorway | Transport |
| | CLIMHYDEX | Water |
| Slovakia | Ondava for life - Reconstruction of ecosystem functioning of the landscape within the upper site the Ondava river catchment area | Water |
| | Modernisation Púchov - Považská Teplá (Slovakia) | Transport |
| | Climate risks in the Žilina - Košice railway corridor | Transport |
| Slovenia | Brdnikova Water Retention | Water |
| | Integral adaptation strategies to mitigate flooding effects | Water |
| Spain | Integration of Climate Change Adaption into Business Strategy - Pilot case ENDESA | Energy |
| | Integration of Climate Change Adaption into Business Strategy - Pilot case GRUPO FERROVIAL | Water |
| | Integration of Climate Change Adaption into Business Strategy - Pilot case Renfe | Transport |
| Sweden | Embankments protect against future flooding in Kristianstad | Water |
| | Green roofs - Malmo | General |
| | Identification of flood-sensitive sections (blue spots) in the Swedish road network | General |
| The Netherlands | New ringway Utrecht | Transport |
| | Landfill park development Nauerna | waste |
| | Aardwarmte (<i>Geothermal energy</i>) Combinatie Luttelgeest BV - EFRO project | Energy |
| United Kingdom | HIGH SPEED 2 (HS2) | Transport |
| | Veolia Energy Recovery Facility at Newhaven | Waste |
| | North West Bicester Eco Development | Urban Development |

Annex VI: Abbreviations and Acronyms

| Acronym | Explanation |
|---------------|--|
| ARISCC | Adaptation of Railway Infrastructure To Climate Change |
| BREEAM | Building Research Establishment Environmental Assessment Method |
| C3S | Copernicus Climate Change Service |
| C40 | Climate Leadership Group |
| CCA | Climate Change Impacts |
| CEDR | Conference of European Directors of Roads |
| CEEQUAL | Civil Engineering Environmental Quality Assessment and Award Scheme |
| CEMS | Copernicus Emergency Management Service – Floods |
| CEN | European Committee for Standardization |
| CENELEC | European Committee for Electrotechnical Standardization |
| CF | Cohesion Fund |
| Climate-ADAPT | European Climate Adaptation Platform |
| CLipC | Climate information Portal (FP7 research project) |
| CoM | The Covenant of Mayors |
| CORDEX | Coordinated Regional Climate Downscaling Experiment |
| CRA | Climate Risk Assessment |
| DG CLIMA | Directorate-General Climate Action |
| DG DEVCO | Directorate-General for International Cooperation and Development |
| DG ECHO | Directorate-General for European Civil Protection and Humanitarian Aid Operations |
| DG ENV | Directorate-General Environment |
| DG REGIO | Directorate-General Regional Policy |
| DG RTD | Directorate-General for Research and Innovation |
| DRM | Disaster Risk Management |
| DRMKC | Disaster Risk Management Knowledge Centre |
| EASO | Environmental assessment of sites and organisations |
| EC | European Commission |
| ECMWF | The European Centre for Medium-Range Weather Forecasts |
| EEA | European Environment Agency |
| EFAS | European Flood Awareness |
| EFFIS | The European Forest Fire information system |
| EIA | Environmental Impact Assessment |
| EIB | European investment Bank |
| ERDF | European Regional Development Fund |
| ESDC | European Soil Data Centre |
| ESIF | European Structural Investment Fund |
| ETC | European Topic Centre |
| EU | European Union |
| EU CIRCLE | pan-European Framework for Strengthening Infrastructure Resilience to climate change |
| EUFIWACC | European Financing Institutions Working Group on Adaptation to Climate Change |
| FP7 | Framework Programme 7 |

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|-----------|--|
| GIE | Gas Infrastructure Europe |
| GMES | Global Monitoring for Environment and Security |
| ICLEI | Local Governments for Sustainability |
| IES | Institute for Environment and Sustainability |
| IPA | Instrument for Pre-Accession Assistance |
| ISO | International Standardization Organisation |
| JASPERS | Joint Assistance to Support Projects in European Regions |
| JRC | Joint Research Centre |
| LIFE | the LIFE programme is the EU's funding instrument for the environment and climate action |
| Mediation | Methodology for Effective Decision-making on Impacts and Adaptation |
| NCFF | Natural Capital Financing Facility |
| NEN | Standardization body in the Netherlands (in Dutch: Nederlandse Norm) |
| PLACARD | PLATform for Climate Adaptation and Risk reduction |
| RAMSES | Reconciling Adaptation, Mitigation and Sustainable Development for citiES |
| RESCUE | research project on citizens' resilience in times of crisis |
| RESIN | research project on Climate Resilient Cities and Infrastructures |
| RIMAROCC | Risk Management for Roads in a Changing Climate |
| RPA | Rockefeller Philanthropy Advisors |
| SRA | security Risk Assessment (methodology) |
| SuRe | Standard for Sustainable and Resilient infrastructure |
| Topdad | Tool-Supported Policy-Development for Regional Adaptation |
| TURAS | research project on 'Transitioning Towards Urban Resilience And Sustainability' |
| Urban AST | Urban Adaptation Support tool |
| WeAdapt | a collaborative platform on climate adaptation issues |
| WFD | Water Framework Directive |
| WP | work package |

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