



**European Committee
of the Regions**

**Commission for
the Environment,
Climate Change and Energy**

ENVE

Climate adaptation: Measuring performance, defining targets and ensuring sustainability



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Table of contents

- Summary.....1**
- 1. Introduction2**
- 2. Planning, implementing and assessing adaptation11**
 - 2.1 Understanding the policy cycle 11
 - 2.2 Preparation of adaptation policy..... 13
 - 2.3 Development of adaptation policy 17
 - 2.4 Implementation..... 20
 - 2.5 Monitoring and evaluation 21
- 3. Practical experiences from five examples33**
 - 3.1 Overview of the examples 33
 - 3.2 Summary of the findings from the examples 39
- 4. Good practices and lessons learned.....50**
 - 4.1 Vertical integration of adaptation measures 50
 - 4.2 Preparation and development of adaptation measures 51
 - 4.3 Implementation and performance assessment of adaptation measures 57
- 5. Recommendations61**
 - 5.1 Local and regional authorities 61
 - 5.2 National and EU policy-makers 67
- List of references.....69**
- Annex 1: Case studies: examples of local and regional adaptation plans.....73**
 - Athens (Greece)..... 73
 - Flanders (Belgium)..... 82
 - Kielce (Poland)..... 90
 - North Rhine-Westphalia (Germany) 102
 - Stockholm (Sweden) 109
- Annex 2: Examples of adaptation indicators122**

List of tables

Table 1: Selection of case studies	10
Table 2: Overview of adaptation measures and targets from the five examples	41
Table 3: Overview of indicators and monitoring frameworks from the five examples.....	45
Table 4: Overview of links between LAPs, RAPs and broad adaptation strategies from five examples.....	49

List of figures

Figure 1: Status of adaptation at the national level.....	4
Figure 2: Simplified policy cycle.....	12
Figure 3: The seven steps of indicator selection.....	24
Figure 4: Example of a monitoring and evaluation matrix.....	29
Figure 5: Recommendations for LRAs designing adaptation plans based on the steps of the policy cycle.....	65
Figure 6: Recommendations for LRAs' adaptation plans based on their experience.....	66

List of boxes

Box 1: Role of LRAs in NAS.....	14
Box 2: Examples of quantitative indicators from the Cities of Athens and Kielce	43
Box 3: NRW Climate Adaptation Law	50
Box 4: Risk assessment in Stockholm	52
Box 5: Adaptation governance in Stockholm	53
Box 6: Financing Athens' adaptation and resilience efforts.....	55
Box 7: Integrated climate mitigation and adaptation plan in Athens.....	56
Box 8: Monitoring implementation in Kielce	57
Box 9: Performance assessment in Flanders.....	59

List of abbreviations

CoR	European Committee of the Regions
EAP	Environment Action Programme
EEA	European Environment Agency
EIB	European Investment Bank
ERDF	European Regional Development Fund
IPCC	Inter-governmental Panel on Climate Change
JRC	Joint Research Centre
LAP	Local Adaptation Plan
LGMA	Local Governments and Municipal Authorities
LRAs	Local and Regional Authorities
NAP	National Adaptation Plan
NAS	National Adaptation Strategy
NCCF	Natural Capital Financing Facility
NRW	North Rhine-Westphalia
PDA	Project Development Assistance
PPP	Public-Private Partnership
RAP	Regional Adaptation Plan
SECAP	Sustainable Energy and Climate Action Plan
UNDRR	United Nations Office for Disaster Risk Reduction
UNFCCC	United Nations Framework Convention on Climate Change

Summary

Adapting to the inevitable impacts of climate changes is unavoidable and action is needed at all levels of governance. Local and regional authorities (LRAs) are increasingly designing and implementing adaptation strategies and/or plans. As different policy-makers progress with their adaptation actions, consistent assessments of progress and performance become more important as also highlighted in the updated EU Adaptation Strategy. This also means that LRAs will be increasingly expected to assess the performance of their adaptation measures.

This study aims to support LRAs by providing practical recommendations on how the performance of adaptation measures can be assessed, progress measured, and targets defined based on insights from existing academic and grey literature as well as from examples of local and regional adaptation plans. For this purpose, the experiences of three cities (Athens, Kielce and Stockholm) and two regions (Flanders and North Rhine-Westphalia) with adaptation plans were researched.

The findings of the study show several important good practices that LRAs should follow at the different stages of their adaptation policy cycles and depending on their previous experience with adaptation plans:

- All stages: consultation of existing guidelines, tools and templates; learning from peers and exchanging experiences.
- Preparation phase: assessment of the context-specific climate risks and vulnerabilities; mapping of relevant stakeholders; set-up of a system for continuous collaboration with stakeholders in the adaptation process.
- Development phase: definition of clear objectives, measures, indicators and monitoring systems; designation of clear responsibilities among stakeholders for implementation, financing and monitoring of the measures; identification of financing sources and development of a financing plan for all measures; identification of synergies between adaptation and other measures; establishment and development of internal capacity on adaptation within the institution(s) responsible for the plan.
- Implementation phase: flexibility to address unexpected developments can be useful.
- Monitoring and evaluation / assessment phase: using a practical approach to assess progress that can be elaborated and made more complex over time (for instance transition from qualitative assessment based on scoreboards/checklists to assessment of output indicators to evaluation of outcomes).

1. Introduction

Despite ambitions to limit the global temperature rise ‘well below 2°C’ as defined in the Paris Agreement and global efforts to mitigate climate change, climate impacts on the Earth’s natural and human systems are unavoidable as a result of the emissions already in the atmosphere. The physical impacts (such as temperature and precipitation changes) of climate change and their associated socio-economic and health effects are wide-reaching but highly specific from country to country and even from region to region. Furthermore, there are differences in how the impacts are felt in urban and rural areas. This means that tailored adaptation responses, suited to address the particular climate change impacts in a given country or region within a country, are required putting LRAs at the frontline of adaptation action. LRAs are increasingly leading adaptation activities in their territories by establishing climate adaptation strategies and/or plans and implementing adaptation measures. Nevertheless, assessing the performance and measuring progress of adaptation measures remains challenging.

This study aims to support LRAs by providing insight (including through local and regional examples) on how the performance of adaptation measures can be assessed, progress measured, and targets defined.

Context of the study

The need to adapt

The European Environment Agency (EEA) summarises the main climate-related hazards in Europe as: heat waves and droughts, forest fires, windstorms, heavy rain and floods, sea level rise and storm surges. These hazards have significant impacts on ecosystems, human health and socio-economic systems but the hazards’ severity, and thus the importance of the impacts, differs per region. Southern Europe suffers from more heat waves and droughts, as Northern and Central Europe are exposed to more heavy rain and flash floods. Rising sea levels increase risks for coastal regions while rising temperatures increase the risks of forest fires even in Scandinavia¹. Moreover, these impacts could be stronger in urban areas as the built environment and high soil sealing create unique microclimates that can worsen the risks of, for example, heatwaves and floods in cities².

¹ European Environment Agency. (2022). *Climate change impacts in Europe*. <https://experience.arcgis.com/experience/5f6596de6c4445a58aec956532b9813d/page/The-European-overview/>.

² European Environment Agency. (2016). *Urban adaptation to climate change in Europe 2016 Transforming cities in a changing climate, EEA Report No 12/2016*. Publications Office of the European Union. , Vandecasteele I., B. C., Siragusa A., Aurbout J.P. (Editors.),. (2019). *The Future of Cities - Opportunities, challenges and the way forward*. Publications Office of the European Union.

The impacts of climate-related hazards on society and economic systems can be diverse. Some of the most significant impacts would be on human health, including: illnesses and mortality due to heatwaves or cold spells; mortality, chemical hazards and poisoning due to extreme weather events, floods or wild fires; new illnesses and spread of communicable diseases due to changing patterns in the activity of pathogens, viruses and parasites. Poor health resulting from these risks can reduce the productivity of the workforce, negatively affecting businesses and industry in all economic sectors, and exacerbate existing vulnerabilities or inequalities. Climate-related hazards will also impact different economic sectors through changes in agricultural productivity, risks to the built environment, energy and transport infrastructure, risks to the supply and quality of drinking water³.

Adaptation in the EU

European climate policies exist in the context of the work lead by the United Nations Framework Convention on Climate Change (UNFCCC) and the ambitions of the Paris Agreement, including the global goal on adaptation. Even before a global goal was formally set, the EU took steps towards adaptation and adopted the first EU Adaptation Strategy⁴ in 2013 to ensure the Union is well prepared and equipped to address the impacts of climate change. The actions were focused at EU and national level, including development of the knowledge base on risk assessment and adaptation and adoption of national adaptation strategies (NAS). Although not obliged to, Member States were encouraged to develop NAS and by 2021 all EU Member States had adopted their NAS (or national adaptation action plans) as reported by the EU platform on adaptation ([Climate-ADAPT](#)) and shown in the following figure. Nevertheless, progress on other relevant aspects was less homogenous. For example, only some Member States had vulnerability assessments or adaptation portals and platforms. The European Commission published a preparedness scoreboard⁵ comparing the adaptation preparedness of the EU Member States⁶ along multiple criteria and found that progress on adaptation was diverse.

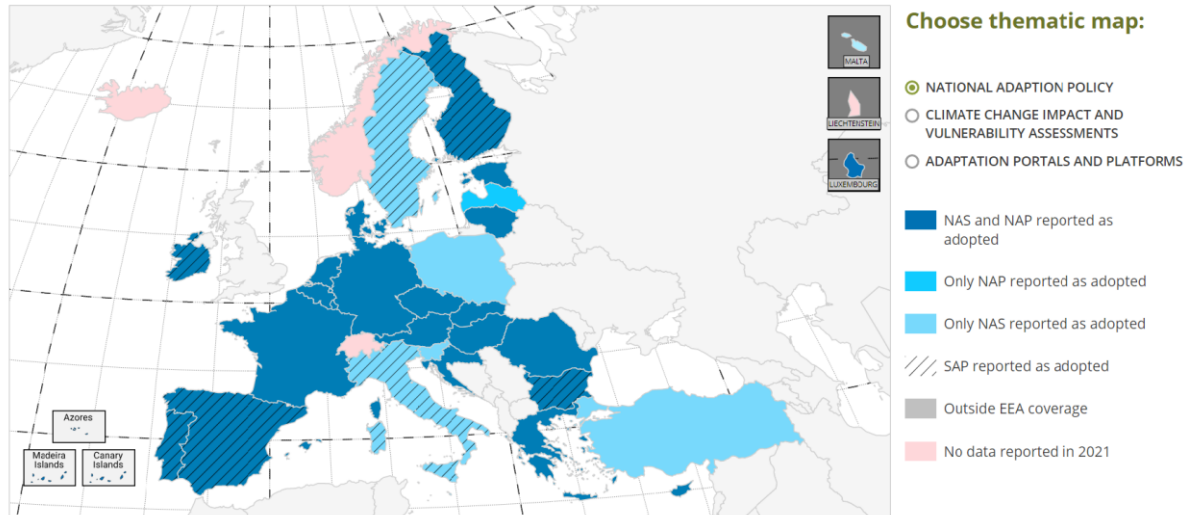
³ Milieu. (2020). *Adapting to climate change: Challenges and opportunities for the EU local and regional authorities, Study for the European Committee of the Regions.*

⁴ European Commission. (2013a). An EU Strategy on adaptation to climate change, COM(2013) 216 final.

⁵ European Commission. (2018a). Annex IX Horizontal assessment of the adaptation preparedness country fiches, part of the Evaluation of the EU Strategy on adaptation to climate change.

⁶ At the time EU28, including the UK.

Figure 1: Status of adaptation at the national level



Source: [Climate-ADAPT Country Profiles](#)

The criteria considered in the preparedness scoreboard⁷ include:

- **Governance:** a little more than half of the Member States had systemic coordination across national, regional and local levels of administration and in almost all Member States vertical coordination can take place during the preparation as well as implementation of NAS; nearly all Member States had a dedicated process for involvement of different types of stakeholders in the preparation of adaptation policies.
- **Risks and vulnerabilities assessment:** around half of the Member States had observation systems to monitor climate change, extreme climate events and their impacts, worked to identify, prioritise and address the knowledge gaps and provided adaptation-related data and information to all stakeholders.
- **Identifying adaptation options:** in nearly all of the Member States detailed risk and/or vulnerability assessments were used to identify adaptation options; consistent funding was available for implementation of adaptation actions in only nine Member States⁸ and only half of the NAS included budget allocations.
- **Implementing adaptation action:** in most Member States adaptation was considered in the national frameworks for environmental impact assessments but only in some were climate change impacts and projects considered in national disaster risks management plans or strategies; at the time most Member States were implementing their NAS but only half had

⁷ European Commission. (2018a). Annex IX Horizontal assessment of the adaptation preparedness country fiches, part of the Evaluation of the EU Strategy on adaptation to climate change.

⁸ DE, DK, EE, ES, FR, LT, PT, RO, SE.

cooperation mechanisms to support adaptation at a local and regional level⁹.

- **Monitoring and evaluation:** around half of the Member States were carrying out monitoring and reporting activities on adaptation and nearly all had planned a periodic review of the NAS; however, only a few had planned activities to evaluate the adaptation policies.

Moreover, the 2018 evaluation¹⁰ of the first EU Adaptation Strategy concluded that the Strategy was generally fit-for-purpose but that there were areas for improvement, including potential for more coherence between adaptation actions at city and national levels and promotion of the adoption of local or regional adaptation strategies. In light of these conclusions, as well as the long-term climate ambitions set in the European Green Deal and enshrined in the European Climate Law, a new EU Adaptation Strategy¹¹ was adopted in 2021. Its general objective is to realise the 2050 vision of a climate-resilient EU ‘*by making adaptation smarter, more systemic, swifter, and by stepping up international action*’.

The new EU Adaptation Strategy sets actions for the European Commission, grouped around three specific objectives¹² including:

- **Smarter adaptation: improving knowledge and managing uncertainty** – actions related to closing the knowledge gaps on adaptation, climate-related risks and losses data.
- **More systemic adaptation: support policy development at all levels and sectors:**
 - Improving adaptation strategies and plans – by stimulating regional and cross-border cooperation and enhancing the guidelines on NAS; upgrading adaptation monitoring, reporting and evaluation by using harmonised standards and indicators; providing tools to better identify benefits and positive impacts of adaptation and prevention projects.
 - Fostering local, individual and just resilience – by increasing support for the planning and implementation of local adaptation and launching an adaptation support facility under the EU Covenant of Mayors.
 - Integrating climate resilience in national fiscal frameworks.

⁹ AT, DE, DK, ES, FI, HU, IE, LT, NL, PL, PT, SE, SK, UK.

¹⁰ European Commission. (2018b). Evaluation of the EU Strategy on adaptation to climate change, SWD(2018) 461 final.

¹¹ European Commission. (2021). Forging a climate-resilient Europe - the new EU Strategy on Adaptation to Climate Change, COM(2021) 82 final.

¹² These include actions in the EU, another objective is focused on improving adaptation globally.

- Promoting nature-based solutions for adaptation.
- **Faster adaptation: Speeding up adaptation across the board:**
 - Accelerating the rollout of adaptation solutions – by implementing Horizon Europe missions on adaptation.
 - Reducing climate-related risk – by enhancing climate proofing.
 - Closing the climate protection gap – by improving the use of insurance.
 - Ensuring the availability and sustainability of freshwater.

Adaptation, specifically ‘*continuous progress in enhancing and mainstreaming adaptive capacity*’, is also one of the objectives in the 8th Environment Action Programme (EAP) of the EU¹³. The monitoring framework for the 8th EAP¹⁴ specifies further how the progress towards this adaptation objective will be tracked. It includes two indicators on climate change adaptation: climate-related economic losses (in EUR billion) and drought impact on ecosystems (area affected in km²).

This stronger emphasis on not only planning but also monitoring and assessing adaptation actions comes in the context of global efforts to ensure consistent reporting on the matter. For example, the Glasgow–Sharm el-Sheikh work programme on the global goal on adaptation¹⁵ aims to develop methodologies, indicators and progress assessments that can facilitate the reporting of national contributions emphasising the importance of having measurable progress on adaptation at the global level.

Adaptation at the local and regional level

Although global efforts focus on actions by national governments as main parties to the Paris Agreement, there is growing recognition of the need to adapt also at the subnational level. The importance of finding adaptation solutions that are best suited to the actors most affected is recognised by the Principles for Locally Led Adaptation¹⁶. The Principles aim to guide ‘the adaptation community as it moves programs, funding and practices towards adaptation that is increasingly owned by local partners’.

¹³ European Commission. (2022b). DECISION (EU) 2022/591 of 6 April 2022 on a General Union Environment Action Programme to 2030.

¹⁴ European Commission. (2022a). Communication on the monitoring framework for the 8th Environment Action Programme: Measuring progress towards the attainment of the Programme's 2030 and 2050 priority objectives, COM(2022) 357 final.

¹⁵ [UNFCCC - Glasgow–Sharm el-Sheikh work programme on the global goal on adaptation](#)

¹⁶ Global Center on Adaptation [Principles for Locally Led Adaptation Action](#); World Resource Institute [Locally Led Adaptation](#)

In the EU, the Adaptation Strategy emphasises the central role of the EU and NAS to steer adaptation efforts, but LRAs are key actors in the implementation of resilience and adaptation measures. The European Committee of the Regions (CoR) has highlighted that LRAs are responsible for ‘*up to 90% of climate adaptation actions*’¹⁷ making them ‘*the most suitable actors to define adaptation goals, as they retain first-hand knowledge of both the resilience needs and solutions of specific localities*’¹⁸. Moreover, a growing number of citizens see LRAs at the core of climate action¹⁹. Therefore, the CoR has emphasised the need for Member States to involve LRAs in the drafting of NAS in the framework of the EU Adaptation Strategy and to promote the development of regional and local strategies²⁰. The CoR has also repeatedly called for formal recognition and inclusion of subnational governments’ adaptation contributions to national efforts and commitments under the UNFCCC²¹. As part of the Local Governments and Municipal Authorities (LGMA) Constituency the CoR made a formal submission to the UNFCCC highlighting the important role of subnational adaptation efforts and calling for the involvement of LRAs in the Glasgow–Sharm el-Sheikh work programme and national contributions to the global goal on adaptation²².

Even without formal requirements for adaptation at local or regional level, LRAs in the EU are taking action in their territories. Many European regions and municipalities are adopting regional or local adaptation plans (RAPs or LAPs) to plan and implement adaptation measures as part of their commitments to EU and global initiatives. The [Covenant of Mayors for Climate and Energy](#) (in short ‘Covenant of Mayors’) initiative plays a leading role in the EU. It encourages signatory municipalities to adopt Sustainable Energy and Climate Action Plans (SECAPs) with targets and steps for medium and long-term, including on adaptation. For example, over 200 municipalities from 21 Member States have some commitments on adaptation as part of the Covenant of Mayors. Another important initiative is the recently launched Horizon Europe [Mission on Adaptation to Climate Change](#), which will support regions and communities in their adaptation actions. It has 202 LRAs from 24 Member States as signatories to the Charter of the Mission. At the global level, initiatives such as [C40](#), [Resilient](#)

¹⁷ European Committee of the Regions, 2021, Opinion ‘Forging a climate-resilient Europe – the new EU Strategy on Adaptation to Climate Change’ COR-2021-01903.

¹⁸ European Committee of the Regions, 2022, Opinion ‘Towards a structural inclusion of Cities and Regions in UNFCCC COP 27’ COR-2022-02246.

¹⁹ European Committee of the Regions, 2022, Resolution on the State of Regions and Cities in the European Union, COR-2022-04332.

²⁰ European Committee of the Regions, 2021, Opinion ‘Forging a climate-resilient Europe – the new EU Strategy on Adaptation to Climate Change’ COR-2021-01903.

²¹ European Committee of the Regions, 2022, Opinion ‘Towards a structural inclusion of Cities and Regions in UNFCCC COP 27’ COR-2022-02246; European Committee of the Regions, 2022, Resolution on the State of Regions and Cities in the European Union, COR-2022-04332.

²² LGMA, 2022, Submission on adaptation to the UNFCCC Global Stock-Take: [Second meeting of the Technical Dialogue \(TD1.2\), Inputs to Inform the Subsidiary Body for Scientific and Technological Advice First Global Stocktake](#)

[Cities Network](#) and UNFCCC Climate Champions campaign [Race to Resilience](#) encourage mitigation and adaptation actions by the largest cities in the world.

The role of the study

Objective and approach

Given the stronger emphasis on monitoring and evaluation of adaptation activities in the new EU Adaptation Strategy, but also at the global level, it will be important for LRAs to, not only develop and implement LAPs and RAPs, but also step up their efforts in assessing the outcomes of their adaptation policies. Therefore, the overall objective of this study is to support LRAs in the assessment of the performance of adaptation measures. More specifically, the study examines the planning, monitoring and assessment of adaptation policy, including vertical integration between national level and regional or local adaptation actions, to provide evidence from literature and a set of examples and develop recommendations for LRAs.

The study is based on literature review and an assessment of five examples or ‘case studies’ to provide an analysis that covers broad and more generic approaches as well as specific practices and lessons learned for a selection of local and regional adaptation plans. The review covers academic and grey literature that provide a theoretical basis and as well as steps for the development, implementation and assessment of adaptation strategies, plans and measures. Sources include guidance documents and tools developed to support policy-makers and/or local governments in the preparation of adaptation strategies and plans.

The examples cover EU regions and cities which have developed regional or local adaptation strategies/plans and have implemented adaptation measures. The selection of the examples was based on several main criteria: geographical coverage; coverage at both regional and local level; and coverage of examples with existing LAPs/RAPs. Additional considerations included coverage of larger and smaller cities with LAPs as well as plans with a different focus of the measures. Table 1 gives an overview of the final selection and the coverage of the criteria.

Building upon the findings from the literature and the experiences identified in the examples, a draft set of recommendations was developed. The draft recommendations were then refined based on discussions with a senior expert who has experience in developing adaptation strategies for a local government in the United Kingdom.

Structure

The structure of the study is as follows: Section 2 provides findings from the literature review, Section 3 introduces the examples and presents the findings, Section 4 draws lessons learned and good practices, and Section 5 provides recommendations for policy-makers.

Table 1: Selection of case studies

City/ region	Geographical coverage	Level and size	Adaptation plan	Focus of adaptation plan	Other
Athens (Greece)	Southern Europe	Local level Large city	Since 2017	Green and blue infrastructure, water management, heat islands, public health, transport, awareness, access to water and cooling	Member of C40, Resilient Cities Network First Greek city with and integrated Climate Action Plan ²³
Flanders (Belgium)	Western Europe	Regional level	Since 2013	Focuses on Climate and Energy	Signatory to the Mission on Adaptation
Kielce (Poland)	Central-Eastern Europe	Local level Small city	Since 2019	Forecasting and planning, effectiveness assessment, urban guidelines, public procurement, tourism, urban ventilation corridors, green and blue infrastructure, resilience to extreme weather events (e.g., by optimising water resources, sewage systems, flood protection)	Part of the CoR #EUGreenDeal stories ²⁴
North-Rhine Westphalia (Germany)	Central-Western Europe	Regional level	Since 2009	Health, water management/flood protection, Soil, biodiversity, forestry, agriculture, fishery, transport, energy, finance industry, business, tourism, housing, urban development, civil protection, information and education.	First regional climate adaptation law in Germany ²⁵
Stockholm (Sweden)	Northern Europe	Local level Large city	Since 2016	Preparedness and management of extremely heavy rains and heat waves	Member of C40

²³ C40, 2017, [Athens becomes the first city in Greece with an integrated Climate Action Plan](#)

²⁴ Available at: [CoR Stories - Poland](#)

²⁵ NRW Regional Government, 2020, [Cabinet passes tightened climate protection law and nationwide first climate adaptation law](#)

2. Planning, implementing and assessing adaptation

This section is based on literature review and looks at the policy cycle. It is concentrated on the development and implementation of broader adaptation policies such as strategies and action plans that encompass multiple and various adaptation measures. A list of the references used is provided at the end of the report.

2.1 Understanding the policy cycle

The development of any policy is often seen as a cycle that includes multiple inter-connected stages from preparation, planning, through implementation, to monitoring and evaluation. Therefore, many of the adaptation policy guidelines available for policy-makers are structured around the idea of the policy cycle.

There are multiple guidelines and tools on policy cycles for developing climate change adaptation strategies and measures at a local level, including steps to take and aspects to consider. At a European level, notable examples are the ‘*Urban Adaptation Support Tool*’²⁶ and the guide “Adapting to climate change in European cities: Towards smarter, swifter & more systemic action”²⁷ from the Covenant of Mayors, the decision support tools for adaptation of the European project RESIN²⁸ and the Joint Research Centre’s (JRC) Guidebook for development of SECAPs²⁹. The CoR has compiled a Green Deal Going Local Handbook³⁰ as a tool to assist LRAs in finding the right adaptation measures as well as technical and funding assistance opportunities.

Outside the EU, there are the ADEPT guidance for local government³¹, the U.S.

²⁶ Climate-ADAPT. (2022b). *Urban Adaptation Support Tool*. Retrieved 27 October from <https://climate-adapt.eea.europa.eu/en/knowledge/tools/urban-ast/step-0-0>.

²⁷ Covenant of Mayors. (2021). Adapting to climate change in European cities: Towards smarter, swifter & more systemic action. In. Brussels: Covenant of Mayors - Europe Office.

²⁸ Chapman, E., & Nieuwenhuijs, A. (2018). *User guide: The RESIN decision support tools for climate change adaptation*. RESIN Project. https://resin-cities.eu/fileadmin/user_upload/Handbooks/RESIN-D4-3-guide-ENGLISH-www.pdf.

²⁹ Bertoldi P. (editor). (2018a). *Guidebook 'How to develop a Sustainable Energy and Climate Action Plan (SECAP)', Part 1 - The SECAP process, step-by-step towards low carbon and climate resilient cities by 2030* [JRC Science for Policy Report]. Publications Office of the European Union. , Bertoldi P. (editor). (2018b). *Guidebook 'How to develop a Sustainable Energy and Climate Action Plan (SECAP)', Part 2 - Baseline Emission Inventory (BEI) and Risk and Vulnerability Assessment (RVA)* [JRC Science for Policy Report]. Publications Office of the European Union. , Bertoldi P. (editor). (2018c). *Guidebook 'How to develop a Sustainable Energy and Climate Action Plan (SECAP)', Part 3 – Policies, key actions, good practices for mitigation and adaptation to climate change and Financing SECAP(s)* [JRC Science for Policy Report]. Publications Office of the European Union.

³⁰ CoR, [Green Deal Going Local Handbook](#)

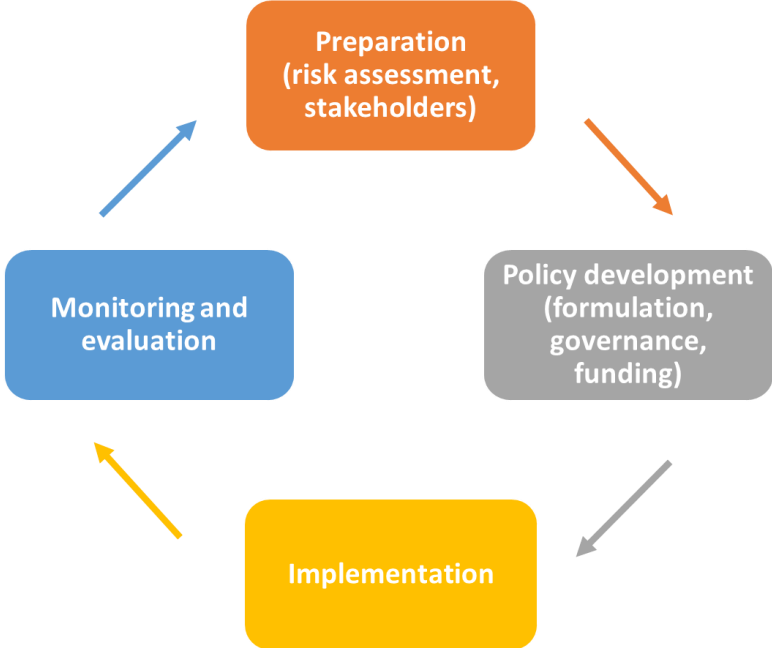
³¹ ADEPT; Defra and the Local Adaptation Advisory Panel. (2019). *Preparing for a changing climate: Good practice guidance for local government* <https://www.adeptnet.org.uk/system/files/documents/Good%20Practice%20Guide%20ADEPT%202019f.pdf>.

Climate Resilience Toolkit³² and the Notre Dame Global Adaptation Initiative (ND-GAIN)³³. At a global level, United Nations Office for Disaster Risk Reduction (UNDRR) has developed the Ten Essentials for Making Cities Resilient³⁴ and a Handbook for Local Government Leaders³⁵.

The main steps proposed in the different guidance documents can be summarised into four principal stages or phases (shown in Figure 2):

- Preparation, including risk and vulnerability assessment and set-up of the systems for stakeholder involvement.
- Policy development, including the identification and selection of the policy options, planning of the concrete adaptation measures, definition of targets and indicators, set-up of a governance structure and division of responsibilities, and identification of funding sources.
- Implementation of the adaptation measures.
- Monitoring and evaluation of progress and results.

Figure 2: Simplified policy cycle



Source: Authors’ own elaboration.

³² National Oceanic and Atmospheric Administration. (2022). *U.S. Climate Resilience Toolkit*. Retrieved 30 October from <https://toolkit.climate.gov/>.
³³ University of Notre Dame - Notre Dame Global Adaptation Initiative (ND-GAIN). (2022). Urban Adaptation Assessment Indicator List. In: Notre Dame Global Adaptation Initiative.
³⁴ UNDRR. (2022). *The Ten Essentials for Making Cities Resilient*. Retrieved 3 October 2022 from <https://mcr2030.undrr.org/ten-essentials-making-cities-resilient>.
³⁵ UNDRR. (2017). *How To Make Cities More Resilient A Handbook For Local Government Leaders*. United Nations. <https://www.preventionweb.net/media/73120/download>.

The Inter-governmental Panel on Climate Change (IPCC) stipulates that monitoring and evaluation is ‘*the systematic process of collecting, analysing and using information to assess the progress of adaptation and evaluate its effects--e.g., risk reduction outcomes, co-benefits and trade-offs--mostly during and after implementation*’. In this sense monitoring can be seen as a continuous process of tracking implementation and informing policy-makers to allow for corrective action, while evaluation can be understood as a more comprehensive assessment of achievements, unintended effects and lessons learned carried out at certain point in time³⁶. Detailed assessment of effects and impacts can be performed both before (ex-ante) or after (ex-post) implementation of the policies, for simplicity in this study evaluation is assumed to be carried out after implementation of adaptation measures. Any ex-ante assessments are assumed to be part of the preparation phase.

Although it is tempting to consider the stages of the policy cycle as separate, they are inter-connected and often iterative. Therefore, it is not always easy to delineate where one phase stops and the next begins. The following sections provide considerations for each of the policy stages with key steps; however, it should be kept in mind that all steps are interconnected.

2.2 Preparation of adaptation policy

The preparation and governance step includes components regarding knowledge, resources, capacity building, delegation of responsibilities, stakeholder mapping and engagement, and coordination. Climate-ADAPT advises local authorities about the importance of identifying available knowledge, resources, and stakeholders to support the process of developing a robust climate adaptation governance³⁷. Enabling conditions for climate change adaptation are described by the IPCC report³⁸ and these include political commitment and follow-through, institutional frameworks, policies and instruments with clear goals and priorities, enhanced knowledge on impacts and solutions, mobilisation of and access to adequate financial resources, monitoring and evaluation, and inclusive governance processes.

³⁶ New, M., Reckien, D., Viner, D., Adler, C., Cheong, S.-M., Conde, C., Constable, A., Coughlan de Perez, E., Lammel, A., Mechler, R., Orlove, B., & Solecki, W. (2022). Decision-making options for managing risk. In *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press. , *ibid*.

³⁷ Climate-ADAPT. (2022c). *Urban Adaptation Support Tool - 1. Preparing the grounds for adaptation*. Retrieved 3 October 2022 from <https://climate-adapt.eea.europa.eu/en/knowledge/tools/urban-ast/step-1-0>.

³⁸ IPCC. (2022). Summary for policymakers. In H.-O. Pörtner, D. C. Roberts, E. S. Poloczanska, K. Mintenbeck, M. Tignor, A. Alegría, M. Craig, S. Langsdorf, S. Lösche, V. Möller, & A. Okem (Eds.), *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.

An important element in the preparation is the establishment of appropriate **governance structures** that can foster adaptation action and connect with all governance levels, both horizontally (i.e. different departments at the same level of governance) and vertically (i.e. across different levels of governance). The JRC includes in their guidance advice on setting up horizontal governance, internal and intermunicipal coordination, data sharing, capacity building, and pooling of resources³⁹. Along with JRC, the UNDRR raise the importance of allocating clear responsibilities for the set-up of a strategy⁴⁰. Horizontal coordination is especially important when adaptation is not within the responsibility of a single institution/department but integrated/mainstreamed in the activities of sectoral departments.

Moreover, local and regional adaptation activities do not exist in a vacuum but are undertaken in the context of global, EU and national adaptation efforts. Consequently, coordination between national, regional and local administrations (i.e. ‘vertically’) is critical. In practice, the cooperation between national, regional and local authorities depends on a country’s traditions and culture in multi-level governance, the availability of funding and political priorities. There is a risk for LRAs that have started voluntary adaptation activities before an official policy at the national level, to not be sufficiently recognised in the development of national policies and support programmes creating incompatibilities between plans and reporting frameworks⁴¹. The following box provides a summary of the LRAs’ responsibilities in the NAS of European countries.

Box 1: Role of LRAs in NAS

In Europe, most NAS recognise the role of local authorities in developing and implementing adaptation action. For instance, local adaptation planning is mandatory in Croatia, Denmark, Ireland, Sweden and larger communities in France. In other cases, local authorities are required to prepare risk and vulnerabilities or damage assessments (Netherlands and Sweden) or consider adaptation in the urban and spatial planning legislation (Slovakia and Slovenia). In Greece, the NAS encourages adaptation planning at the regional and local levels with priorities set through regional adaptation strategies.

Source: European Environment Agency, 2020b, *Urban adaptation in Europe — how cities and towns respond to climate change*, EEA Report No 12/2020.

³⁹ Bertoldi P. (editor). (2018a). *Guidebook 'How to develop a Sustainable Energy and Climate Action Plan (SECAP)', Part 1 - The SECAP process, step-by-step towards low carbon and climate resilient cities by 2030* [JRC Science for Policy Report]. Publications Office of the European Union.

⁴⁰ UNDRR. (2017). *How To Make Cities More Resilient A Handbook For Local Government Leaders*. United Nations. <https://www.preventionweb.net/media/73120/download>

⁴¹ European Environment Agency. (2020b). *Urban adaptation in Europe — how cities and towns respond to climate change*, EEA Report No 12/2020. Publications Office of the European Union.

A good practice in all phases of the policy process, which should ideally already be established during the preparation phase, is the establishment of mechanisms for the **inclusion of different stakeholders** affected by and/or involved in the adaptation activities. The European Commission recommends that all stakeholders with a role and responsibility for the implementation of a NAS need to be part of the development, monitoring and evaluation process⁴². The EEA highlights that engagement of stakeholders in the earlier stages of the adaptation policy cycle contributes to collaboration in the monitoring and evaluation of NAS and can deliver good mapping of the state of adaptation, gaps, awareness and capabilities of different regions and communities⁴³. Engaging stakeholders is also an important component of developing indicators to ensure the right indicators are elaborated and gain feedback, knowledge and information on effectiveness of the indicators⁴⁴. Overall, the involvement of stakeholders along the adaptation process tends to foster the sense of ownership of adaptation actions, increase the acceptability of adaptation outcomes, help understand local risks and adaptation needs and facilitate data collection and assessment of progress.

Assessing risks and vulnerabilities is a core component for the following steps of the policy cycle such as identification of appropriate adaptation measures, definition of relevant targets and suitable indicators. A risk assessment should include past, present, and projected trends and impacts to identify main concerns and options⁴⁵. According to UNDRR, local governments should develop their risk assessments in a participatory process, partly to understand and enable strengthened institutional capacity of relevant stakeholders and society at large and identify gaps. Risk assessment should also develop an understanding of possible responses⁴⁶. The RESIN project's user guide suggests further consideration of actions integrated in risk assessment to define goals, commitments, roles, and responsibilities⁴⁷.

⁴² European Commission. (2013b). Guidelines on developing adaptation strategies, SWD(2013) 134 final.

⁴³ European Environment Agency. (2020a). *Monitoring and evaluation of national adaptation policies throughout the policy cycle*, EEA Report No 06/2020. Publications Office of the European Union.

⁴⁴ Solecki, W., Rosenzweig, C., Blake, R., de Sherbinin, A., Matte, T., Moshary, F., Rosenzweig, B., Arend, M., Gaffin, S., Bou-Zeid, E., Rule, K., Sweeny, G. and Dessy, W. . (2015). New York City Panel on Climate Change 2015 Report Chapter 6: Indicators and Monitoring. *Annals of the New York Academy of Sciences*, 1336, 89-106. <https://doi.org/10.1111/nyas.12587>.

⁴⁵ Climate-ADAPT. (2022d). *Urban Adaptation Support Tool - 2. Assessing climate change risks and vulnerabilities*. <https://climate-adapt.eea.europa.eu/en/knowledge/tools/urban-ast/step-2-0>.

⁴⁶ UNDRR. (2017). *How To Make Cities More Resilient A Handbook For Local Government Leaders*. United Nations. <https://www.preventionweb.net/media/73120/download>.

⁴⁷ Chapman, E., & Nieuwenhuijs, A. (2018). *User guide: The RESIN decision support tools for climate change adaptation*. RESIN Project. https://resin-cities.eu/fileadmin/user_upload/Handbooks/RESIN-D4-3-guide-ENGLISH-www.pdf.

Defining targets should start with an assessment of risks and vulnerabilities. The EEA reports that the projected impacts and vulnerabilities vary considerably across regions and depend on adaptive capacity, implying that the suitability of specific measures must be assessed case-by-case⁴⁸. As robust knowledge and understanding of risks and vulnerabilities are crucial for planning climate adaptation actions, conducting climate risk and vulnerability assessments is vital for proper planning⁴⁹.

Local climate risks- and vulnerability assessments that are based on high-quality data are vital for guiding local climate adaptation strategies and measures⁵⁰. Although risks- and vulnerability assessments can be large projects, especially for smaller or resource-weak LRAs, there are several support tools for assessing climate risks:

- The EEA have an interactive website with maps that show how Europe and regions in Europe can be affected by different climate hazards including droughts, floods, forest fires and sea level rise based on different climate scenarios⁵¹. The information displayed may provide a first overview of projected risks of specific regions that come with a changing climate.
- Climate-ADAPT has an Urban Adaptation Map Viewer, which provides for European cities an overview of present and projected climate hazards and context-dependent vulnerabilities and exposures to these hazards for European cities⁵².
- Also, Climate-ADAPT has an Urban Adaptation Support Tool that includes a step-by-step guide on how to assess climate change risks and vulnerabilities⁵³. It considers differences between location and sectors and guides how to identify suitable objectives to respond to risks and vulnerabilities.
- International standard ISO 14091:2021 “Adaptation to climate change — Guidelines on vulnerability, impacts and risk assessment” provides

⁴⁸ European Environment Agency. (2020b). *Urban adaptation in Europe — how cities and towns respond to climate change*, EEA Report No 12/2020. Publications Office of the European Union.

⁴⁹ European Environment Agency. (2020a). *Monitoring and evaluation of national adaptation policies throughout the policy cycle*, EEA Report No 06/2020. Publications Office of the European Union. , p.9.

⁵⁰ Ibid., p.50.

⁵¹ European Environment Agency. (2022). *Climate change impacts in Europe*. <https://experience.arcgis.com/experience/5f6596de6c4445a58aec956532b9813d/page/The-European-overview/>.

⁵² Climate-ADAPT. (2022a). *Urban Adaptation Map Viewer*. Retrieved 28 October from <https://climate-adapt.eea.europa.eu/en/knowledge/tools/urban-adaptation>.

⁵³ Climate-ADAPT. (2022d). *Urban Adaptation Support Tool - 2. Assessing climate change risks and vulnerabilities*. <https://climate-adapt.eea.europa.eu/en/knowledge/tools/urban-ast/step-2-0>.

guidelines for assessing risks and impacts of climate change and provides a basis for planning, implementing, monitoring, and evaluating climate adaptation measures⁵⁴.

- The German Environment Agency has developed recommendations for implementing ISO 14091 of climate risk assessments at the municipal level⁵⁵. It describes how to prepare, implement, and communicate climate risk assessments, including recommendations for small municipalities and those with limited resources.
- The European project Smart Mature Resilience (SMR) has developed a "Risk Systemicity Questionnaire", which asks a set of questions to identify the likelihood of climate-related risks in cities. Risks considered are applied on nine different topics, including social aspects such as inequalities, integration, and public unrest, but also considers infrastructure, flooding, and air pollution⁵⁶.

2.3 Development of adaptation policy

Identification and selection of options concerns identifying and prioritising possible approaches and options suitable for the needs and selecting types of adaptation measures. Climate-ADAPT suggests assessing measures according to certain criteria such as feasibility, cost and effectiveness, synergies and trade-offs⁵⁷. According to the RESIN guide, a selection of measures should come with priorities and defined roles⁵⁸, and according to the UNDRR guide this step should include defining a vision and objectives based on risks identified⁵⁹.

Clear objectives/targets are crucial for enabling proper monitoring and indicators that can reflect and measure progress correctly⁶⁰. In practice, defining targets can

⁵⁴ International Organization for Standardization. (2021). *ISO 14091:2021 Adaptation to climate change — Guidelines on vulnerability, impacts and risk assessment*. Retrieved 28 October from <https://www.iso.org/standard/68508.html>.

⁵⁵ Porst, L., Voß, M., Kahlenborn, W., & Schauser, I. (2022). *Climate Risk Assessments at the Municipal Level: Recommendations for the Implementation of ISO 14091*. Umweltbundesamt - German Environment Agency. https://www.umweltbundesamt.de/sites/default/files/medien/1/publikationen/uba_fachbroschuere_en_bf_220708.pdf.

⁵⁶ Smart Mature Resilience - SMR. (2022). *Risk Systemicity Questionnaire*. Retrieved 28 October from <https://smr-project.eu/tools/risk-systemicity-questionnaire/>.

⁵⁷ Climate-ADAPT. (2022e). *Urban Adaptation Support Tool - 3. Identifying adaptation options*. <https://climate-adapt.eea.europa.eu/en/knowledge/tools/urban-ast/step-3-0>.

⁵⁸ Chapman, E., & Nieuwenhuijs, A. (2018). *User guide: The RESIN decision support tools for climate change adaptation*. RESIN Project. https://resin-cities.eu/fileadmin/user_upload/Handbooks/RESIN-D4-3-guide-ENGLISH-www.pdf.

⁵⁹ UNDRR. (2017). *How To Make Cities More Resilient A Handbook For Local Government Leaders*. United Nations. <https://www.preventionweb.net/media/73120/download>.

⁶⁰ RESIN Project. (2017). *Monitoring And Evaluation*. <http://wiki.resin.itti.com.pl/article/frequently-encountered-challenges/monitoring-and-evaluation/>.

be based on an input-output-outcome scheme, where the outcomes are the desired development, and the targets are a timebound quantifiable degree of fulfilment towards that outcome such as the percentage of a city's buildings being climate proof according to the projected risks. However, finding the right objectives and targets requires robust knowledge of the context-specific risks and vulnerabilities and depends on the feasibility in terms of which measures are possible to implement to achieve those targets.

As stated above, robust knowledge and understanding of risks and vulnerabilities are crucial for planning climate adaptation actions⁶¹. Knowing the risks is a precondition for setting the targets and deciding which measures are needed and available to mitigate the identified risks. However, knowing which measures to implement to mitigate what risks is not always straightforward. Taking inspiration from others and having a knowledge base for which measures that are effective and cost-efficient would facilitate the process. Apart from engaging in national and European networks on climate adaptation, the RESIN project has an Adaptation Option Library for different measures related to specific risks based on criteria including effectiveness and cost efficiency of the individual adaptation options⁶².

The development of adaptation strategies and plans at different levels depends on multiple factors. In 2018, a literature review was performed to analyse the information on local planning for climate change plans, and it highlighted that there is a wide variety in the occurrence and set up of climate adaptation plans throughout Europe: in 2018 around 26 % had an adaptation plan, and 17 % a joint adaptation and mitigation plan (as opposed to 66 % that had a mitigation plan). The larger the city, the higher the change on a stand-alone climate plan, and cities with national climate legislation (predominantly Western-European) are five times more likely to produce local adaptation plans. Plans that are being produced in the framework of international climate networks are the most prevalent in countries where stand-alone plans are found less. The lower number of adaptation plans seems to give the impression that mitigation plans precede adaptation plans; however, this is not always the case⁶³.

⁶¹ European Environment Agency. (2020a). *Monitoring and evaluation of national adaptation policies throughout the policy cycle*, EEA Report No 06/2020. Publications Office of the European Union. , p.9).

⁶² RESIN Project. (2022). *Adaptation Options Library*. Retrieved 28 October from <https://resin-cities.eu/resources/library/>.

⁶³Reckien, D., Salvia, M., Heidrich, O., Church, J. M., Pietrapertosa, F., De Gregorio-Hurtado, S., D'Alonzo, V., Foley, A., Simoes, S. G., Krkoška Lorencová, E., Orru, H., Orru, K., Wejs, A., Flacke, J., Olazabal, M., Geneletti, D., Feliu, E., Vasilie, S., Nador, C., . . . Dawson, R. (2018). How are cities planning to respond to climate change? Assessment of local climate plans from 885 cities in the EU-28. *Journal of Cleaner Production*, 191, 207-219. <https://doi.org/10.1016/j.jclepro.2018.03.220>.

The development of climate plans is influenced by drivers and barriers. Drivers are factors such as membership of climate networks, population size, GDP per capita and adaptive capacity⁶⁴. More specifically for adaptation, were financial incentives via research projects, implementation of EU policies and the increasing frequency of extreme climate events⁶⁵. However, factors such as the unemployment rate, warmer summers, proximity to the coast and projected exposure to future climate impacts⁶⁶ as well as insufficient resources, capacity, political commitment and uncertainty⁶⁷, act as barriers. In terms of content, adaptation plans are based on climatic local risks with flood protection and water management, built environment and urban planning generally prioritised as key adaptation measures. Differing patterns of adaptation planning and adaptive capacity are identified among different regions in Europe⁶⁸.

Another important part of the policy development process is the **identification of financing sources**. The implementation of the adaptation strategies or action plans is conditional upon the availability and access to sufficient financing. Lack of financing, or difficulty to access it, is a common barrier for climate action to different types of stakeholders including LRAs. In the case of adaptation, LRAs in the EU have several key sources of financing to tap into⁶⁹:

- EU funding and project development assistance (PDA): there are multiple EU funds that can support different adaptation-related investments including the European Regional and Development Plan (ERDF), LIFE, Horizon Europe. Certain funds and instruments of the European Investment Bank (EIB) can also provide PDA to support LRAs by providing technical expertise in the preparation of larger investment proposals (this can be relevant for large infrastructure investments where multiple sources of financing may be needed).
- Green bonds and resilience and catastrophe (CAT) bonds: all these types of bonds are used to raise capital from private markets. Green bonds are commitments that the bond issuer will use the capital raised to fund

⁶⁴ Reckien, D., Flacke, J., Olazabal, M., & Heidrich, O. (2015). The influence of drivers and barriers on urban adaptation and mitigation plans—an empirical analysis of European cities. *PloS one*, 10(8). <https://doi.org/10.1371/journal.pone.0135597>.

⁶⁵ Aguiar, F. C., Bentz, J., Silva, J. M., Fonseca, A. L., Swart, R., Santos, F. D., & Penha-Lopes, G. (2018). Adaptation to climate change at local level in Europe: An overview. *Environmental Science & Policy*, 86, 38-63.

⁶⁶ Reckien, D., Flacke, J., Olazabal, M., & Heidrich, O. (2015). The influence of drivers and barriers on urban adaptation and mitigation plans—an empirical analysis of European cities. *PloS one*, 10(8). <https://doi.org/10.1371/journal.pone.0135597>.

⁶⁷ Aguiar, F. C., Bentz, J., Silva, J. M., Fonseca, A. L., Swart, R., Santos, F. D., & Penha-Lopes, G. (2018). Adaptation to climate change at local level in Europe: An overview. *Environmental Science & Policy*, 86, 38-63.

⁶⁸ Ibid.

⁶⁹ Covenant of Mayors. (2021). Adapting to climate change in European cities: Towards smarter, swifter & more systemic action. In. Brussels: Covenant of Mayors - Europe Office.

exclusively environmentally sustainable activities. CAT bonds involve both LRAs and insurance companies as they need to be underwritten by both and are used to insure a city's assets in case of a natural disaster. Resilience bonds work in a similar way as CAT bonds and are used to finance resilient infrastructure.

- National level funding: the budget of the central government can sometimes provide funding for adaptation and resilience projects. In some Member States, national development banks can be other sources of financing.
- Own budget: LRAs can earmark parts of their own budgets for adaptation.
- Financial markets: capital is also available from the financial markets; however, the specificities of an adaptation project (e.g. long time to realise results, no tangible profits can be generated from some projects) can make the financing expensive and difficult to obtain.
- Synergies with climate mitigation financing: there are specific instruments for financing mitigation activities, especially those linked to energy, including energy performance contracting (where an external organisation implements an energy efficiency or renewable energy project and uses the income to repay the costs of the project), local energy cooperatives (where LRAs and other stakeholders can own and/or participate in renewable energy and energy efficiency projects sharing profits within the cooperative) or on-tax financing (deploying private capital as up-front financing to homeowners for retrofits which is recovered an additional charge of a property tax bill). Depending on the nature of adaptation projects, activities can be integrated with mitigation measures and such additional financing sources may be available.

The optimal approach is to combine different sources of financing⁷⁰ and the Covenant of Mayors provides guides for this⁷¹.

2.4 Implementation

The implementation phase should further define and develop selected options and measures and plan in detail how these will be implemented and monitored, including timeframes, financial considerations, delegation of responsibilities, specific indicators, and priorities. Moreover, Climate-ADAPT suggests strategies that go beyond the silos, integrated in general local planning instruments and

⁷⁰ Ibid., *ibid.*

⁷¹ Multiple guides: [Interactive guide on funding](#); [Innovative Financing Schemes](#); [Financial Institutions Instruments](#); [Project Development Assistance](#).

considerations of synergies and trade-offs⁷². In addition, UNDRR suggests further details regarding financial planning and economic instruments to strengthen financial capacity and understand economic impacts. Also, it suggests the preparation of a disaster response including through early warning systems and prepare for post-disaster recovery⁷³.

Nevertheless, progress with the implementation of adaptation plans in Europe is somewhat limited. Some authors found that around half of the LAPs in Europe had begun implementation⁷⁴. However, the EEA reported that only around one-fifth of the Covenant of Mayors signatories reported good progress on implementation and mainstreaming of adaptive actions (by June 2019) and noted that smaller municipalities might be facing more challenges to move from planning to implementation⁷⁵.

2.5 Monitoring and evaluation

2.5.1 Definition of indicators and monitoring

Climate-ADAPT describe in their Urban Adaptation Support Tool the components of a monitoring and evaluation system⁷⁶. These components include:

- A monitoring framework that includes robust indicators, stakeholder engagement, and knowledge.
- Definition of indicators that reflect the objectives/targets, are relevant, and are possible and easy to follow-up.
- Systematically monitor results to enable revising effectiveness and efficiency of measures and in extension the implementation plan and adaptations strategy itself.

The monitoring system should already be defined in the planning phase to set baselines together with objectives and measures. To assess progress, a list of **monitoring indicators** should be defined, which are linked to the measures and the outcomes these aim towards. Types of indicators can vary and depend on objectives, purpose, source, and context⁷⁷. Climate ADAPT suggests making use of indicators developed in other contexts, by other local governments or based on

⁷² Climate-ADAPT. (2022f). *Urban Adaptation Support Tool - 5. Implementing adaptation*. Retrieved 28 October from <https://climate-adapt.eea.europa.eu/en/knowledge/tools/urban-ast/step-5-0>.

⁷³ UNDRR. (2017). *How To Make Cities More Resilient A Handbook For Local Government Leaders*. United Nations. <https://www.preventionweb.net/media/73120/download>.

⁷⁴ Aguiar, F. C., Bentz, J., Silva, J. M., Fonseca, A. L., Swart, R., Santos, F. D., & Penha-Lopes, G. (2018). Adaptation to climate change at local level in Europe: An overview. *Environmental Science & Policy*, 86, 38-63.

⁷⁵ European Environment Agency. (2020b). *Urban adaptation in Europe — how cities and towns respond to climate change, EEA Report No 12/2020*. Publications Office of the European Union.

⁷⁶ Climate-ADAPT. (2022h). *Urban Adaptation Support Tool - 6. Monitoring and evaluating adaptation*. <https://climate-adapt.eea.europa.eu/en/knowledge/tools/urban-ast/step-6-0>.

⁷⁷ European Environment Agency. (2020a). *Monitoring and evaluation of national adaptation policies throughout the policy cycle, EEA Report No 06/2020*. Publications Office of the European Union. , pp. 135-137).

indicators developed at a higher level of government. These should be based on baselines of existing practices and plans and be able to manage uncertainties⁷⁸. In addition, UNDRR suggests development of a specific monitoring and development tool and reporting system, that can ensure participation and responsible actors throughout the process⁷⁹.

Exact indicators vary across contexts and depend on objectives/target. However, one does not need to reinvent the wheel. There are several indicator examples to take inspiration from (a detailed list is provided in Annex 2):

- The RESIN project⁸⁰ has a comprehensive long list of examples of urban adaptation indicators covering different aspects such as: impacts/consequences on natural and human systems (e.g., disaster losses, deaths due to extreme weather event); sensitivity to climate change (e.g., percentage of climate resilience trees, percentage of buildings retrofitted for resilience); adaptive capacity (e.g., response time for emergency services); stressors (e.g. water loss); exposure (e.g., length of the coastline); hazards (e.g. change in river flooding); and drivers (e.g., frequency of heat waves).
- The Covenant of Mayors⁸¹ has a reporting template to assist local authorities in the reporting of their SECAPs. The template includes steps to identify indicators based on climate hazards (e.g., extreme heat/cold, heavy precipitation, droughts, and water scarcity).
- The New York City Panel on Climate Change lists in their 2015 Report (Chapter 6: Indicators and Monitoring)⁸² potential climate (e.g., number of extreme precipitation events), impact (e.g., heat-related morbidity), social vulnerability (e.g., disparity in households without air conditioning), and resiliency indicators (e.g., change in vegetation cover).

⁷⁸ Climate-ADAPT. (2022g). *Urban Adaptation Support Tool - 6.2 Defining monitoring indicators*. <https://climate-adapt.eea.europa.eu/en/knowledge/tools/urban-ast/step-6-2>.

⁷⁹ UNDRR. (2017). *How To Make Cities More Resilient A Handbook For Local Government Leaders*. United Nations. <https://www.preventionweb.net/media/73120/download>.

⁸⁰ RESIN Project. (2017). *Monitoring And Evaluation*. <http://wiki.resin.itti.com.pl/article/frequently-encountered-challenges/monitoring-and-evaluation/>.

⁸¹ Covenant of Mayors. (2022). *Climate Change Risks and Vulnerabilities Indicators*. Retrieved 28 October from https://www.eumayors.eu/index.php?option=com_attachments&task=download&id=843.

⁸² Solecki, W., Rosenzweig, C., Blake, R., de Sherbinin, A., Matte, T., Moshary, F., Rosenzweig, B., Arend, M., Gaffin, S., Bou-Zeid, E., Rule, K., Sweeny, G. and Dessy, W. . (2015). New York City Panel on Climate Change 2015 Report Chapter 6: Indicators and Monitoring. *Annals of the New York Academy of Sciences*, 1336, 89-106. <https://doi.org/10.1111/nyas.12587>.

- ND-GAIN⁸³ provides examples of risk indicators grouped by climate hazard, vulnerability, and exposure (e.g., percentage of population living in flood plains, number of buildings in flood plains) and readiness indicators (e.g., city revenue/deficit per resident).

No matter what the exact indicators selected are, some general good practices for the development of indicators can be followed. A useful checklist of the criteria that ‘good’ adaptation indicators should meet has been prepared by the RESIN project⁸⁴:

- ✓ Relevance: The indicator should have a strong link to the adaptation goals.
- ✓ Familiarity: The indicators should be easy to understand by the users.
- ✓ Data availability: Data for the indicators should be easily available and be gathered at reasonable costs.
- ✓ Measurability: The identified indicators should be capable of being measured, preferably as objectively as possible.
- ✓ Reliability: The results of the indicators should have a limited degree of uncertainty and margin of error (factors to consider are good quality of the underlying data, clear and specific definition of the indicator and a transparent and direct calculation methodology).
- ✓ Non-redundancy: Indicators within a framework should not measure the same aspect.
- ✓ Completeness: The total set of indicators should consider all aspects that affect the adaptation goals.

Another common checklist for ‘good’ indicators is SMART, which recommends indicators to be Specific, Measurable, Action-oriented, Relevant and Time-bound⁸⁵.

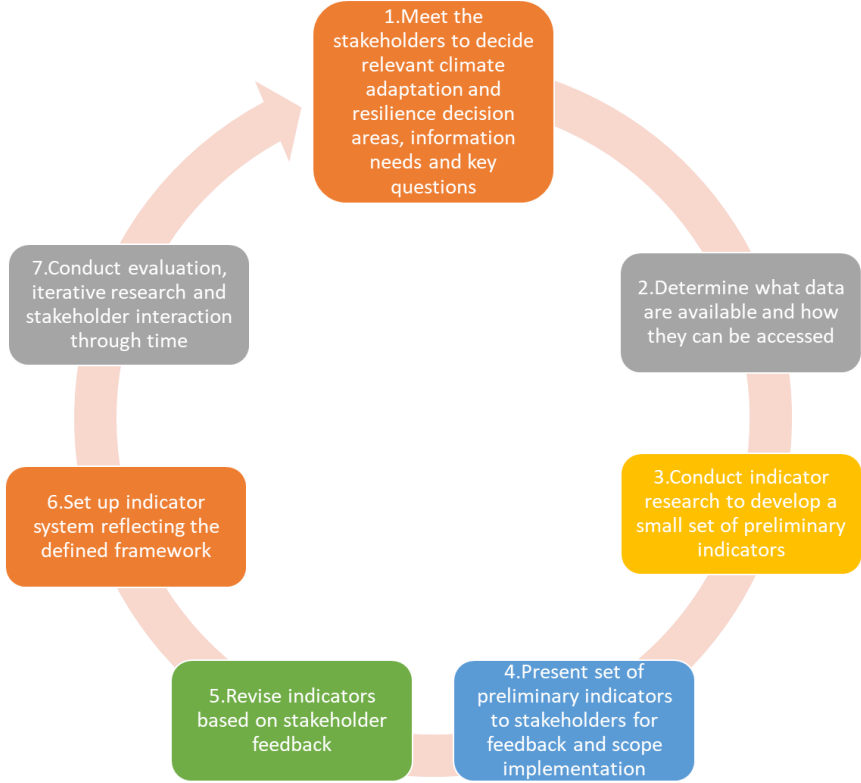
In addition, the process of defining and selecting indicators should be inclusive and allow stakeholder participation. The following figure summarises key steps that can be followed in that process.

⁸³ University of Notre Dame - Notre Dame Global Adaptation Initiative (ND-GAIN). (2022). Urban Adaptation Assessment Indicator List. In: Notre Dame Global Adaptation Initiative.

⁸⁴ RESIN Project. (2017). *Monitoring And Evaluation*. <http://wiki.resin.iti.com.pl/article/frequently-encountered-challenges/monitoring-and-evaluation/>.

⁸⁵ UN Habitat. (2012). *Developing Local Climate Change Plans, A guide for cities in developing countries* United Nations Human Settlements Programme. <https://unhabitat.org/developing-local-climate-change-plans>.

Figure 3: The seven steps of indicator selection



Source: Authors’ own elaboration based on Solecki et al. 2015, *New York City Panel on Climate Change 2015 Report Chapter 6: Indicators and Monitoring*.

2.5.2 Evaluation/assessment

Evaluation is an important stage of the policy process as it allows policymakers, as well as other stakeholders, to assess the outcomes of policies, learn and determine whether the interventions and measures are still appropriate or need to be modified. This is an iterative process that ideally starts at the planning phase and is closely linked to the monitoring phase to ensure that the definition of a monitoring and evaluation framework is suited to the interventions and projects that will be put in place and is a continuation of the risk and vulnerabilities’ assessment thus enabling the assessment of the extent to which the adaptation measures are successful in reducing risks and vulnerabilities⁸⁶.

⁸⁶ Covenant of Mayors. (2021). Adapting to climate change in European cities: Towards smarter, swifter & more systemic action. In. Brussels: Covenant of Mayors - Europe Office, New, M., Reckien, D., Viner, D., Adler, C., Cheong, S.-M., Conde, C., Constable, A., Coughlan de Perez, E., Lammel, A., Mechler, R., Orlove, B., & Solecki, W. (2022). Decision-making options for managing risk. In *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.

Objectives and principles

The Paris Agreement encourages countries to provide information about the ‘adequacy and effectiveness’ of adaptation. In its latest report, the IPCC states that there is a need to assess the outcomes of adaptation for effectiveness, adequacy, justice/equity in both outcomes and processes as well as synergies or trade-offs with mitigation and other societal goals. It suggests that the success of adaptation refers to effectively and substantially reducing vulnerabilities and exposure to climate risks while creating synergies with other policy goals and minimising trade-offs. Alternatively, ‘maladaptation’ can be understood as potential negative consequences of adaptation responses that can lead to increasing climate vulnerabilities of systems, sectors or groups and eroding sustainable development⁸⁷.

The Covenant of Mayors summarises the objectives of the evaluation phase as: tracking progress, assessing the effectiveness of actions, communicating accomplishments, examining tailored adaptation options, and initiating new rounds of the adaptation process⁸⁸.

In its guidelines on the preparation of NAS⁸⁹, the European Commission emphasises the key role evaluation plays in learning what adaptation actions work in which circumstances and for what reasons. This is critical given the high uncertainty associated with climate hazards and risks. Nevertheless, evaluation should be pragmatic, i.e., based on what is possible to evaluate, and clear, i.e., with a clear purpose what the evaluation is expected to achieve.

Another important objective of the evaluation phase is to communicate information about the adaptation activities and their results engaging stakeholders and ensuring support for such activities⁹⁰.

While multiple ways of framing the objective of the evaluation phase suggest looking at the effectiveness of adaptation, there is no uniform definition of its

⁸⁷ New, M., Reckien, D., Viner, D., Adler, C., Cheong, S.-M., Conde, C., Constable, A., Coughlan de Perez, E., Lammel, A., Mechler, R., Orlove, B., & Solecki, W. (2022). Decision-making options for managing risk. In *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.

⁸⁸ Covenant of Mayors. (2021). Adapting to climate change in European cities: Towards smarter, swifter & more systemic action. In. Brussels: Covenant of Mayors - Europe Office.

⁸⁹ European Commission. (2013b). Guidelines on developing adaptation strategies, SWD(2013) 134 final. In.

⁹⁰ Covenant of Mayors. (2021). Adapting to climate change in European cities: Towards smarter, swifter & more systemic action. In. Brussels: Covenant of Mayors - Europe Office. Prutsch, A., Felderer, A., Balas, M., König, M., Clar, C., & Steurer, R. (2014). Methods and Tools for Adaptation to Climate Change. A Handbook for Provinces, Regions and Cities. In. Wien: Environment Agency Austria,.

‘effectiveness’. A meta study⁹¹ of hundreds of academic and grey literature sources found that there are multiple ways of understanding and defining the effectiveness of adaptation:

- Efficiency or utilitarian frame: Adaptation should minimise costs and maximise benefits.
- Improved wellbeing: Adaptation should support achievement of material, subjective and relational wellbeing goals.
- Reduced vulnerability or increased adaptive capacity: Adaptation should reduce vulnerability and/or increase adaptive capacity, especially of the most vulnerable and those most at risk to climate change.
- Enhanced resilience: Adaptation should increase resilience by building functional persistence over long timescales so that systems have the ability to bounce back from climatic shocks.
- Sustainable adaptation: Adaptation should be economically, ecologically, and socially sustainable, explicitly looking at longer-term, cross-generational viability of adaptation actions.
- Avoiding maladaptation: Adaptation should take into account unintended negative consequences and explicitly look at the cross-scalar, long-term impacts of adaptation actions.
- Ecosystem-based adaptation: Adaptation should invest in ecosystem conservation, management and restoration to enhance ecosystem services, and subsequently reduce impacts of climate change on social and ecological systems.
- Community-based adaptation: Adaptation prioritisation, implementation, and monitoring should be co-produced with communities to ensure inclusive and sustainable adaptation.
- Adaptive governance: Adaptation should be orientated towards achieving transparency, accountability and representation in governance through multiscale, participatory, and inclusive processes.

⁹¹ Singh, C., Iyer, S., New, M. G., Few, R., Kuchimanchi, B., Segnon, A. C., & Morchain, D. (2021). Interrogating ‘effectiveness’ in climate change adaptation: 11 guiding principles for adaptation research and practice. *Climate and Development*, 0(0), 1-15. <https://doi.org/10.1080/17565529.2021.1964937>.

- Justice and equitability: Adaptation should be orientated towards socially just and equitable processes and outcomes.
- Transformation: Adaptation should be a process that fundamentally changes human thinking and practices in the face of climate change and overtly challenges the power structures that generate vulnerability.

Building upon these findings the authors⁹² recommend that assessment of adaptation's effectiveness considers 11 principles, which adaptation should meet:

- ✓ Minimising costs and maximising benefits;
- ✓ Supporting the achievement of material, subjective and relational wellbeing goals;
- ✓ Reducing vulnerability and/or increasing adaptation capacity, especially of the most vulnerable;
- ✓ Increasing resilience by developing functional persistence over long timescales so that systems have the ability to bounce back from climatic shocks;
- ✓ Being ecologically, economically and socially sustainable;
- ✓ Taking into account unintended negative consequences;
- ✓ Investing in ecosystem conservation, management and restoration to enhance ecosystem services and reduce climate impacts on human systems;
- ✓ Being co-produced with communities to ensure inclusive and sustainable adaptation;
- ✓ Being orientated towards achieving transparency, accountability and representation in governance;
- ✓ Being orientated towards socially just and equitable processes and outcomes;
- ✓ Being a process that fundamentally changes human thinking and practices in the face of climate change.

Main approaches and tools

As shown above, the assessment of effectiveness can focus on different aspects of adaptation. Commonly this is either the process of adaptation (e.g., institutional set-up, mainstreaming, coordination and planning systems, stakeholder involvement) or the outcomes (e.g., reduced exposure to climate hazards, fewer deaths from extreme events). Depending on the focus of the assessment, there are different approaches available⁹³:

- Process: the assessment can examine the interactions between stakeholders in the adaptation process, the extent to which the capacities of different

⁹² Ibid.

⁹³ Craft, B., & Fisher, S. (2016). Measuring effective and adequate adaptation. In (pp. 20). London: IIED,.

actors to prepare and adapt to climate risks are improved, their vulnerabilities reduced, and resilience increased. Another aspect of the assessment can consider the extent of ‘mainstreaming’ or integrating adaptation objectives into the activities of stakeholders. For example, mainstreaming can encourage the consideration of resilience or adaptation in the policies of sectoral ministries on urban planning, energy, social policy etc.

- **Outcomes:** the assessment would ideally include measurement of progress through indicators based on the monitoring in the previous policy phase to determine how the adaptation measures achieve the objectives and to what extent the objectives are met.

In its guidelines on the preparation of NAS⁹⁴, the European Commission advises that the monitoring and evaluation approach is tailored to the type and scale of the activity. For example, for some objectives and adaptation measures output or result indicators can be established and the evaluation can analyse the process and outcomes based on these indicators. For other activities it may be more appropriate to opt for an aggregate assessment.

The assessment of adequacy has been conceptualised by some authors as a measurement of both quality and quantity of adaptation to determine whether enough has been done along three dimensions⁹⁵:

- **Finance:** analysis of the availability and accessibility of finance for different actors involved in adaptation.
- **Key thresholds:** definition of thresholds where adaptation efforts can be considered as sufficient so that the effects of climate change do not hinder the achievement of policy priorities.
- **Geographical coverage:** analysis of the spread of adaptation across a given territory identifying gaps in coverage, including for social inclusion and environmental justice.

Whichever the approach, an assessment of performance needs a clearly defined baseline against which the performance can be compared⁹⁶. Another key element to any approach is the development of a good evaluation framework for understanding and mapping how the interventions are expected to meet the intended objectives. This is typically done through the elaboration of a theory of

⁹⁴ European Commission. (2013b). Guidelines on developing adaptation strategies, SWD(2013) 134 final.

⁹⁵ Craft, B., & Fisher, S. (2016). Measuring effective and adequate adaptation. In (pp. 20). London: IIED,.

⁹⁶ European Commission. (2013b). Guidelines on developing adaptation strategies, SWD(2013) 134 final.

change (or intervention logic), which outlines the expected causal links or pathways between needs, activities, results, and outcomes. Such theories serve as a basis for deciding which measures to adopt (in the planning phase) and how their success can be understood and assessed (in the evaluation phase)⁹⁷. A well-constructed theory of change can help identify whether the observed results were expected or not, determine any unexpected or unintended consequences of the policy and analyse what contextual factors can influence the performance of the policy.

The tools for assessing the performance of adaptation measures should be practical and adapted to the approach of the evaluation. One possibility is the use of scorecards or scoreboards. The advantage of such tools is that they are simple and offer stakeholders a practical and light-touch approach to analyse adaptation progress. They can combine different data with expert opinions and assess the institutional capacity for adaptation to provide insights into the enabling environment for effective adaptation. Nevertheless, scorecards should be linked to more robust assessments considering the outcomes (through indicators) of the adaptive actions⁹⁸.

Another tool can be a monitoring and evaluation matrix that defines the information necessary for the assessment together with the possible sources and methods to use. This can mitigate risks of having a lot of information collected without regard for the way it is used to address specific evaluation questions⁹⁹. An example of a monitoring and evaluation matrix is shown in the next figure.

Figure 4: Example of a monitoring and evaluation matrix

Indicator	Baseline information requirement and responsibilities	Data-gathering methods and responsibilities	Analysis, reporting and feedback methods and responsibilities
Indicator 1			
Indicator 2			

Source: UN Habitat, 2012, *Developing Local Climate Change Plans, A guide for cities in developing countries*.

⁹⁷ Craft, B., & Fisher, S. (2016). Measuring effective and adequate adaptation. In (pp. 20). London: IIED,, New, M., Reckien, D., Viner, D., Adler, C., Cheong, S.-M., Conde, C., Constable, A., Coughlan de Perez, E., Lammel, A., Mechler, R., Orlove, B., & Solecki, W. (2022). Decision-making options for managing risk. In *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.

⁹⁸ Craft, B., & Fisher, S. (2016). Measuring effective and adequate adaptation. In (pp. 20). London: IIED,.

⁹⁹ UN Habitat. (2012). *Developing Local Climate Change Plans, A guide for cities in developing countries* United Nations Human Settlements Programme. <https://unhabitat.org/developing-local-climate-change-plans>.

2.5.3 Challenges with the monitoring and evaluation of adaptation

The EEA¹⁰⁰ notes that there is limited use of indicators as part of adaptation policy evaluations in Europe. Generally monitoring and evaluation frameworks rely on input, output, and outcome indicators. Experiences with evaluation to date show that progress at the level of adaptation processes is relatively feasible and easy to detect. Analysing progress on other aspects of adaptation, such as the use of resources, the impacts of the measures on vulnerability, exposure or adaptive capacity is more challenging. Describing progress with process/input or output indicators is somewhat simpler and easier than using outcome indicators. In another study the EEA reports that fewer than 5 % of the Covenant of Mayors signatories were regularly monitoring progress or making changes to their adaptation plans based on the results of the monitoring (by June 2019). The EEA highlights that the success of adaptation measures is highly context-dependent and there is limited knowledge about the effectiveness and cost-efficiency of adaptation measures. ‘Low hanging fruits’ in that respect are measures such as early warnings, awareness raising and nature-based solutions, which are considered effective and cost-efficient in most cases¹⁰¹.

The limited uptake of evaluation/assessment of adaptation performance and the focus on processes can be explained by the multiple challenges that make the evaluation of adaptation policies and measures particularly difficult¹⁰²:

- Lack of common indicators or standards for monitoring adaptation – evaluation is closely linked to monitoring as it relies on the information that can be collected through indicators. However, the lack of standard indicators may not be so critical as risks and vulnerabilities are highly localised and specific, which requires definition of monitoring and evaluation frameworks that are tailored to the local needs.

¹⁰⁰ European Environment Agency. (2020a). *Monitoring and evaluation of national adaptation policies throughout the policy cycle, EEA Report No 06/2020*. Publications Office of the European Union.

¹⁰¹ European Environment Agency. (2020b). *Urban adaptation in Europe — how cities and towns respond to climate change, EEA Report No 12/2020*. Publications Office of the European Union.

¹⁰² Covenant of Mayors. (2021). *Adapting to climate change in European cities: Towards smarter, swifter & more systemic action*. In: Brussels: Covenant of Mayors - Europe Office, Craft, B., & Fisher, S. (2016). *Measuring effective and adequate adaptation*. In (pp. 20). London: IIED,, European Environment Agency. (2020a). *Monitoring and evaluation of national adaptation policies throughout the policy cycle, EEA Report No 06/2020*. Publications Office of the European Union. , New, M., Reckien, D., Viner, D., Adler, C., Cheong, S.-M., Conde, C., Constable, A., Coughlan de Perez, E., Lammel, A., Mechler, R., Orlove, B., & Solecki, W. (2022). *Decision-making options for managing risk*. In *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press. , UN Habitat. (2012). *Developing Local Climate Change Plans, A guide for cities in developing countries* United Nations Human Settlements Programme. <https://unhabitat.org/developing-local-climate-change-plans>.

- Long-time horizons – as the impacts of some adaptation activities require a long time to materialise, it can be difficult to measure success in traditional project or policy cycles.
- Difficulty to quantify the success of adaptation measures, compared to mitigation measures – the impacts of mitigation measures can be easily quantified (for instance in terms of greenhouse gas emissions) but the impacts of adaptation measures can be hard to quantify (for example the impact of adaptation measures on reducing health risks is difficult to isolate from that of other measures).
- Uncertainty of climate change trends – with evolving risks and adaptation needs, assessing the effectiveness of adaptation actions to an endpoint or goal can be difficult. Nevertheless, this may not necessarily be an issue as an evaluation process can pinpoint measures that are no longer aligned with the adaptation needs of the local area or region allowing policymakers to take corrective action and to prioritise other adaptation measures.
- Lack of baseline data or shifting baselines – there might gaps in the data available to understand climate trends and forecast risks, which means that there might not be a clear baseline against which to compare the progress of adaptation measures and to assess whether they are successful.
- Multi-sectoral responses and multi-stakeholder interests – adaptation cuts across traditional policy sectors and involves a variety of stakeholders with differing interests, which may present a challenge for collecting data and involving different interest groups in the adaptation process.

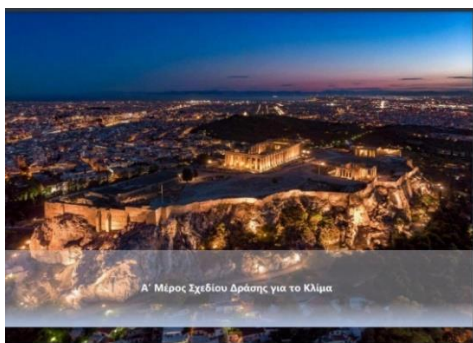
3. Practical experiences from five examples

This section is based on the information collected from the three examples of LAPs and two examples of RAPs. It provides an overview of the experience of the LRAs in these cases and makes comparisons on key elements of adaptation, including measures, indicators and monitoring. It is based on the information collected for each example through desk research (review of relevant strategic and reporting documents) and interviews with stakeholders involved in the preparation and/or implementation of the respective adaptation plans. The detailed information and references for each example are provided in Annex 1.

3.1 Overview of the examples

This section introduces the examples with short summaries of the adaptation plans covered and the status of their implementation.

3.1.1 Athens



Country: Greece

City: Athens

LAP: [Athens Resilience Strategy for 2030](#) including [Climate Action Plan](#)

Adoption: 2017, 2022

Earlier versions: 2017

Key climate hazards in the Mediterranean region (EEA¹⁰³): increase in heat extremes, higher risks of droughts, higher risks of forest fires

Since 2008 the Municipality of Athens has participated in the global climate network of cities [C40](#), including its thematic network ‘Cool Cities’, which deals with the reduction of temperatures in the urban fabric, the urban heat island phenomenon, the adaptation of cities to high temperatures and green infrastructure. In 2016, the Office of Urban Resilience and Sustainability was established under the mayor’s office (now a Department within the Directorate of Strategic Planning, Resilience, Innovation & Documentation) and the development of the Athens Resilience Strategy 2030 started. In 2017, the Municipality of Athens prepared the first integrated Climate Action Plan (for the reduction of greenhouse gas emissions and adaptation to climate change). It consisted of two parts, regarding climate mitigation (part A) and climate adaptation (part B). Also, a resilience strategy was adopted to coordinate the work on the city’s resilience to multiple challenges that the city faces. In 2022, the

¹⁰³ European Environment Agency. (2020b). *Urban adaptation in Europe — how cities and towns respond to climate change*, EEA Report No 12/2020. Publications Office of the European Union. Map 2.1.

Climate Action Plan was updated with targets towards 2030, focusing to a higher extent on climate mitigation but still containing several climate adaptations measures.

The Climate Action Plan contains an objective on 'prevention and response to climate risks', which includes measures on flood protection, fire protection, public health and action plan to address urban overheating. The measures/initiatives were adopted based on the needs of the city of Athens. The 2017 edition of the Climate Action Plan relied heavily on stakeholder engagement and working groups, collaboration between the public and private sectors, as well as civil society involvement. In both 2017 and 2022 Climate Adaptation Plans, participatory planning offered the opportunity to involve stakeholders, issue a first draft, have it assessed by stakeholders and adjust it based on relevant comments. The funding sources identified include EU funding from the ERDF, the National Recovery and Resilience Plan and an EIB loan, as well as funding from the Ministry of Interior, Green Fund and Public-Private Partnerships (PPPs).

Since 2017, Athens has been implementing its first Climate Action Plan under the responsibility of the Municipality of Athens. The 2022 Plan recognises the need for regular re-evaluations to monitor and assess the effectiveness of actions on the goals set. For this purpose, monitoring teams have been established in the city consisting of representatives of the departments and Directorates of the Municipality of Athens involved in the design and implementation of the Actions and coordinated by the Department of Resilience & Sustainability of the Directorate of Strategic Planning, Resilience, Innovation and Documentation.

3.1.2 Flanders

Country: Belgium

Region: Flanders

RAP: [Flemish Climate Adaptation Plan 2021-2030](#)

Adoption: 2022

Earlier versions: 2013

Key climate hazards in the Atlantic region (EEA): increase in heavy precipitation events, higher risks of river and coastal flooding



The first Flemish adaptation plan was adopted in 2013 and covered the period 2013-2020. In October 2022, a new version spanning 2021-2030 was adopted. The adaptation plan is driven by risks and includes six objectives and 14 action points for climate adaptation, including on the development of green-blue infrastructure, reduction of water use, water management, restoration and climate-resilient management of nature, management of public health impacts, and

collaboration and coordination. The plan was prepared by the Flemish Task Force Adaption and coordinated by the Department of Environment of the Flemish government. The main source of support from the EU level comes in the form of technical support provided by the European Commission and EEA and not directly in the form of EU funding. Facilitating exchange in the delivery of studies, the content of which is very relevant, is considered valuable. The opportunity to exchange information between Member States is also appreciated.

The main differences between the previous plan and the current plan are:

- The addition of funding from the Flemish government and the establishment of an investment plan for the 2021-2030 version; whereas the previous plan was fully reliant on budget provided by the authorities responsible for implementation of specific measures.
- The development of a more robust evaluation system, not only measuring progress, but also impact of measures, as well as using indicators.

Implementation of measures from the 2021-2030 adaptation plan has not started yet. However, a number of measures (carried over from the previous adaptation plan such as development of green-blue corridors or coming from other environmental plans) are already being implemented. The implementation of the 2013-2020 climate adaptation plan took place and was assessed by two progress reports, which reported that most actors took climate adaptation seriously and were incorporating it in their regular work. The monitoring focused on whether the measures were being implemented and what progressed was achieved, which was mostly assessed by the responsible bodies themselves and without a clear baseline. This is being improved for the current RAP, which aims to have a more objective manner of monitoring against a clear baseline.

3.1.3 Kielce



Country: Poland

City: Kielce

LAP: [Climate Adaptation Plan for the city of Kielce until 2030](#)

Adoption: 2019

Earlier versions: none

Key climate hazards in the continental region (EEA): increase in heat extremes, reduction in summer precipitation, higher risks of river floods, higher risks of forest fires

The City of Kielce's Climate Adaptation Plan was adopted in October 2019 and includes objectives towards 2030. It was created as part of the project "Development of adaptation plans to climate change in cities with more than

100,000 inhabitants” implemented by the Ministry of the Environment in cooperation with 44 cities. The project was supported with EU funding from the ERDF within the framework of the Operational Programme Infrastructure and Environment.

The overarching objective of the plan is to increase the quality of life for citizens and efficient functioning of the city considering conditions of climate change. The strategic objectives are operationalised into three categories of measures: organisation activities, information and education activities and technical activities. Although Kielce’s adaptation plan has no specific targets, it has a rich set of monitoring indicators, the development of which is supported by the national strategy in Poland.

Regarding the governance of the LAP, the Mayor through the Department of Municipal Economy and Environment, supervises and coordinates the implementation, execution and monitoring of the activities included in the Plan. An interdisciplinary Steering Group is appointed to coordinate the implementation of the Plan. Moreover, various departments of the City Office define and select for implementation tasks that are part of the activities resulting from the Plan.

Total costs of the implementation of the Plan amount to around EUR 103 million. This is a maximum amount which can be allocated to all the planned activities by the city including from its own budget and resources which can be acquired from external sources such as the ERDF and the Cohesion Fund, LIFE, and Horizon Europe or non-EU funds (Norwegian Financial Mechanism and European Economic Area Mechanism). Implementation of the Plan’s activities started at the end of 2019, soon after the adoption of the Plan, and an implementation report on the results of the first activities was published in early 2022.

3.1.4 North Rhine-Westphalia (NRW)

Country: Germany

Region: North Rhine-Westphalia (NRW)

RAP: [North Rhine-Westphalia climate protection plan - climate protection and climate change adaptation](#)

Adoption: 2016

Earlier versions: 2009

Key climate hazards in the continental region (EEA): increase in heat extremes, reduction in summer precipitation, higher risks of river floods, higher risks of forest fires

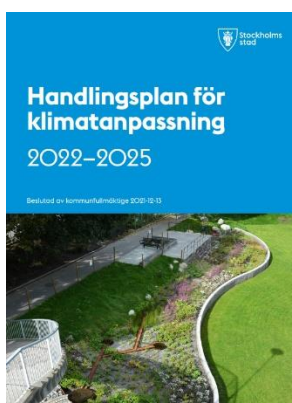


The current strategy of climate adaptation in North Rhine-Westphalia (NRW) was adopted in early 2016 and was complemented in 2020 by a climate adaptation law for the region. The main objectives of the RAP are to fill knowledge gaps, raise awareness, improve governance, reduce vulnerabilities and improve resilience of ecosystems and the built environment. The objectives are operationalised into 66 measures across 13 sectorial and 3 horizontal themes. The horizontal themes consist of information, education, and networks; urban planning; and regional development. The sectorial fields of intervention include economic sectors, infrastructure, transport, housing, natural environment, and disaster management.

All measures are directed to the regional government (self-commitment) and cover a broad range of actions, among others counselling/advice to local level actors or preparation of guidelines to facilitate action at the local level. The concrete adaptation measures are to be implemented at the local level. Thus, the obligation of the regional level consists of the provision of funding to enable the local authorities take adaptation action. The plan differentiates between measures without financing needs, those that are financed through existing budget allocations (mostly regional state funding or EU funding from the ERDF), and those without a set budget allocation (to be determined in the future).

The RAP does not include any concrete quantitative targets or measurable indicators. However, there is a separate monitoring system for monitoring the consequences of climate change in the region, including of local climate, environment, built environment, the economy, and social consequences. Implementation started after the adoption of the plan in 2015 and despite some delays caused by changes in the regional state government, currently, 20-30 measures out of the 66 have been implemented.

3.1.5 Stockholm



Country: Sweden

City: Stockholm

LAP: [Action plan for climate adaptation 2022-2025](#)

Adoption: 2021

Earlier versions: 2016

Key climate hazards in the boreal region (EEA): increase in heavy precipitation, decrease in snow, lake and river ice cover, increase in forest growth and risks of forest pests

Stockholm's action plan for climate adaptation was adopted by the Municipal Council in December 2021 and is based on the subgoals on climate adaptation in the city's Environmental Programme 2020-2023 regarding strengthened ability to

manage the effects of cloudburst and heatwaves. The general objectives are to implement measures to strengthening the city's resilience and decrease the worst effects of cloudburst and heat waves. The action plan includes two general approaches to reach these objectives:

- To inventory risks such as on life and health and damages on critical infrastructure. Thereafter, to address these risks by implementing physical operations, routines, and warning systems.
- To consider climate change in spatial planning and construction projects by ensuring the capacity to manage downpour and by ensuring access to shade.

Moreover, these approaches are operationalised into multiple specific "activities". Regarding cloudburst, these activities include several measures on risk assessment, resilience planning, urban planning, construction, and strengthening governance. Regarding heat waves, these activities include several measures on risks mapping, revised heat-mitigating routines, governance, water resources, and buildings.

The action plan does not include any specific quantifiable targets or monitoring indicators. However, the plan delegates clearly which actors are responsible for implementation and monitoring according to their responsibilities and roles in the city's governance structures. The main responsibility is held by the City Executive Board, which is responsible for coordinating and supervising relevant risk and vulnerability analyses. However, it does not micromanage implementation of the action plan. The action plan's function is to serve as a guide and indicate priorities to the city's committees and undertakings, which have the responsibility to implement the city's adaptation measures in line with their delegated roles. Important actors are the Department of Built Environment/Traffic, and the Committee on Environment and Health, which provide key data on heat and water management, supervise the stormwater management, and assist the Committee on City planning in developing detailed planning instruments. Other city committees, administrative departments, and undertakings/companies have specific roles according to their individual competencies.

Financing is integrated in the ordinary budgetary procedures of the city's committees and undertakings with the aim of not expanding costs beyond the existing budgetary frameworks. The responsible actors will have to assess priorities and use cost-benefit considerations. Certain projects may be eligible for external financing, but most are covered by the city's internal budget. The implementation of the plan started after its adoption and the city's different departments have together worked on developing concrete measures. Some of the measures were already ongoing at the time of the adoption of the action plan. By

now, about 25 to 50 % of the action plan's listed activities have started.

3.2 Summary of the findings from the examples

This section summarises the findings from the five cases along several elements of adaptation – the preparation, measures and targets, the indicators and monitoring systems, the integration with national or EU adaptation objectives.

3.2.1 Local and regional adaptation preparation, measures and targets

All five plans cover broad objectives (organised around horizontal issues or specific climate risks) but lack clear quantitative targets. Measures are organised differently in each example but follow the objectives chosen. The main reason why local and regional governments are developing adaptation plans differs: some do it to achieve climatic objectives and reduce associated risks, others to cover societal needs raised by stakeholders and improve governance. In all cases, except for Kielce, a previous version of an adaptation plan existed. An overview of the different drivers, objectives, measures, targets, governance, funding sources and maturity of the adaptation plan is given in Table 2.

Measures and targets

In the plans of Athens and Flanders the measures are directly linked to climate or environmental themes, for example “protection from flooding”. In Kielce and NRW the structuring of the measures follows a more general or organisational approach, with measures such as “information and education activities” (Kielce) and “urban planning and development” (NRW). In Stockholm a mixed approach is used, where both a general approach and a number of specific measures for resilience towards cloudbursts and heatwaves are presented.

In most of the plans, no timebound quantitative targets are presented. In Flanders the RAP has few quantitative targets, but the Local Energy and Climate Pact contains 2030 targets of a square metre of additional green surfaces per inhabitant and a cubic metre of additional rainwater harvesting for reuse, buffering, and harvesting per capita. Athens, on the other hand, presents timebound targets that are set for short term (2021-2025), mid-term (2025-2030) and long-term (2030-2050).

Governance

Despite some similarities, the governance structures in the examples are largely different. In Athens, Kielce, Flanders and NRW, special departments within the

municipality or regional governments are responsible for the development of the adaptation plans. In Athens and in Flanders, the department or task force involved is explicitly dedicated to resilience or adaptation while in Kielce and NRW the departments are broadly responsible for environment and climate. In Athens, Flanders and Kielce, these departments are then also the main institutions responsible for the implementation of the adaptation plans, although specific responsibilities might be delegated also to other institutions. In NRW the implementation of the measures lies with local authorities or sectoral ministries of the regional government rather than environmental department, which developed the RAP. In Stockholm the City Executive Board coordinates the overall processes and the risk and vulnerability analyses, but implementation is delegated to specific committees and undertakings of the city.

Financing sources

For the implementation of their adaptation plans, Flanders and Stockholm rely primarily on 'own' resources from the budget of the institutions responsible for implementing different measures. In Kielce and NRW the main sources of financing for the adaptation plans are a mix of own resources from the city or regional budget as well as funding from EU funds, mainly the ERDF (international funds like the Norwegian Financial Mechanism and European Economic Area Mechanism are also a source of funding in Kielce). In Athens, a mix of funding from EU and national funds is used together with loans, financial instruments, sponsorships and PPPs.

Table 2: Overview of adaptation measures and targets from the five examples

	Athens	Flanders	Kielce	NRW	Stockholm
Drivers behind the development of the adaptation plan	Based on needs. Designed with heavy involvement of stakeholders and working groups	Risk-driven (temperature, heat, flooding, droughts, sea level rise)	Reducing vulnerabilities and implementing a national initiative for developing LAPs	Sustainable development and alignment with European guidelines	Risk-driven (cloudburst/stormwater and heatwaves/droughts)
Maturity (existence of previous versions)	The first climate action plan was published in 2017	The RAP builds upon an earlier plan (2013-2020)	This is the first LAP	The RAP builds upon an earlier plan (from 2009)	The LAP builds upon an earlier plan (from 2016)
Objectives	2 objectives relevant for adaptation: Prevention and response to climate risks and Urban regeneration by integrating green and blue infrastructure	6 objectives: 3 on the use with and of water; 1 on management of nature; 1 on health policy; 1 on collaboration and coordination	5 objectives that all deal with climate change and extreme phenomena (weather and water)	5 strategic objectives on horizontal issues: knowledge gaps, awareness raising, regulatory frameworks, assistance, networks; 2 sectoral objectives on ecosystem services and infrastructure	The 2 objectives follow the main themes of cloudburst and heatwaves
Measures	There are 7 measures that follow the objectives: 4 for climate risks; 3 for infrastructure	The 14 measures follow the objectives: 3 measures on designing green-blue infrastructure in the urban area; 1 on reducing water consumption; 3 on water safety and drought prevention; 2 on restoration and climate-resilient management of nature, forest and open space; 1 on health and disaster	Three categories of measures: organisational activities; information and education activities; technical activities. The 26 measures are organised according to the 5 strategic objectives.	66 measures within 13 sectoral fields and 3 horizontal fields of intervention.	Overall, there are 25 measures: 7 measures for resilience towards cloudburst; 3 for planning and construction; 4 for strengthening governance; 3 for general issues; 1 for mapping risks; 1 for adapting operations/public services; 3 for improving robustness/governance;

		management; and 4 on collaboration and coordination			2 for management of water resources; 1 for action plans for buildings
Targets	Timebound targets are set for short term (2021-2025), mid-term (2025-2030) and long-term (2030-2050)	Most measures are generally described in such a way that they are to be completed in 2030	No timebound quantitative targets. The planned measures pertaining to each specific objective have time horizons specified (by 2023 or by 2030)	No timebound quantitative targets	No timebound quantitative targets
Governance	The Municipality of Athens (Department of Resilience and Sustainability) is the main institution responsible for development and implementation of the adaptation measures	The Flemish government (Department of Environment) is responsible for the development and implementation of the measures; where stated other authorities are responsible for the implementation of specific measures	The Mayor of the City of Kielce (Department of Municipal Economy and Environment) is the main institution responsible for development and implementation of the adaptation measures	Ministry of NRW for climate protection, environment, agriculture, nature conservation and consumer protection is responsible for the development of the RAP but implementation of the measures is a responsibility of local authorities and sectoral ministries of the regional government	- City Executive Board: responsible for coordination and processes as well as the overall risk and vulnerability analyses; -City Executive Office: overall responsibility for communication and coordination - Department for Built Environment: dialogue with other departments
Financing sources	EU funding (ERDF, Recovery and Resilience Facility); EIB loan; national funding; sponsorships, PPPs	The regional government based on an investment plan (to be released); budget of the institutions responsible for implementation; EU funding on project basis	City budget will be the main source, national, EU and international funds can also provide additional finance	Regional government and EU funding on project basis	Budgets of institutions responsible for implementation; national, EU or other funding on project basis

Source: case studies, further details on all aspects are available in Annex 1.

3.2.2 Local and regional indicators and monitoring of adaptation

The implementation of all adaptation plans has started except for the Flemish one, which was updated this year (implementation of measures from the previous version of the plan took place). Nevertheless, the design and practices with monitoring and reporting on implementation varies across the examples.

As shown in Table 3, the City of Athens and the City of Kielce have the most elaborated indicator, monitoring, and evaluation frameworks in place. Both cities have indicators developed to follow the implementation progress per measure defined. The indicators are linked to related values such as costs and expenditure, area covered and share per citizen, number of output items, number of citizens involved, and volume of, e.g., water. A number of quantitative indicators are exemplified in Box 2 below (more details are available in the respective case studies in Annex 1). However, the indicators are not defined in the context of clear input-output-outcome schemes or equivalent. Moreover, both cities' monitoring and assessment frameworks are based on the indicators defined. Also, their plans include information on how, when, and by whom the monitoring and evaluation should be done.

Box 2: Examples of quantitative indicators from the Cities of Athens and Kielce

Athens

Regarding flood protection:

- Annual expenditure on emergency management planning as a percentage of the total city budget
- Stabilised slope area (m²/km²)
- Annual expenditures for stormwater infrastructure upgrades and maintenance as a percentage of the total city budget
- Volume of increased storage capacity (m³) / flow capacity

Regarding Fire Protection:

- Removal of dead plant mass area
- Monitoring network area
- Number of monitoring stations per square kilometre (km²)

Kielce

For the objective *Strengthening of the use of green urban areas in alleviating the impact of climate change*:

- Area covered with green infrastructure following City initiatives
- Number of squares and places transformed into so-called 'climate places' following City initiatives
- Share of citizens living within the range of over 300 meters distance from municipal recreational green areas in total number of citizens.

For the objective *Increasing resilience of the city to extreme meteorological and hydrological phenomena*:

- Number of constructed or modernised water retention reservoirs
- Number of investments implemented by the city concerning the modernisation of sewerage network in order to use or store rainwater

- Water consumption per inhabitant
- Number of buildings owned by the city and its organizational units which have rain gutters disconnected from the sewerage network.

Source: case studies, further details are available in Annex 1.

The regions Flanders and NRW and the City of Stockholm have no defined indicators, monitoring or assessment systems in their climate adaptation plans. While Flanders have conducted two progress reports including recommendations for a revised RAP, NRW and the City of Stockholm have not yet published any dedicated evaluations of their adaptation plans. NRW and the City of Stockholm have a more informal monitoring and assessment system. In NRW, fewer adaptation-specific indicators exist compared to mitigation indicators, and in the City of Stockholm, progress is assessed via the city's environment programme's overall objectives to increase the ability to manage the effect of cloudburst and heatwaves.

Although it has an informal monitoring and assessment system, the City of Stockholm has relatively clear delegated responsibilities for monitoring and evaluating progress of the action plan for climate adaptation. Just as the implementation of the action plan is decentralised, monitoring is too. The overall responsibility to monitor the goal on cloudburst is held by the Committee on Traffic, and the City Executive Board and Stadshus AB Corporation (the parent company of city-owned companies) are responsible for monitoring the goal on heat waves. Moreover, all committees, departments, and undertakings involved in carrying out adaptation measures are responsible for monitoring and reporting when necessary, according to their roles and competencies.

Table 3: Overview of indicators and monitoring frameworks from the five examples

	Athens	Flanders	Kielce	NRW	Stockholm
Implementation	Started	Not yet	Started	Started	Started
Implementation reports or evaluations	No dedicated reports so far	2 implementation reports of the previous RAP	1 implementation report	No dedicated reports so far	No dedicated reports so far
Indicators	A set of indicators to assess the progress is defined for each adaptation measure. Indicator values include expenditure, area, volume, monitoring systems, citizen awareness and participation rate, kilometres, and number of items such as trees.	No specific indicators in use. However, an end report with recommendations for the 2021-2030 adaptation plan specifies plans to use input (e.g., budget and personnel), process (e.g., progress rate), and output indicators (e.g., reports published).	A set of indicators structured according to the strategic objectives and measures of the plan is defined. Measure-relevant values per indicator include number of outputs and related items and activities involved, area covered and share per citizen, volume such as for water consumption, and quality such as for water and biodiversity.	No specific indicators related to adaptation measures in place. Only indicators to track the consequences of climate change.	There are no specific indicators for tracking progress defined in the action plan. General indicators are defined in the city's environmental programme – the ability to manage the effects of cloudburst and heatwaves.
Monitoring framework	Monitoring is based on the indicators developed. Indicators are calculated annually to assess progress and periodically in comparison to new scientific evidence. Monitoring teams have been established in the	Monitoring is described in an end report with recommendations for the 2021-2030 plan. For example, it specifies three learning levels: -progress monitoring of the adaptation process (learning level 1), -monitoring increased	Monitoring of the progress in implementation is carried out biannually based on the indicators. Monitoring is carried out by an administrative unit appointed by the President of the City.	Monitoring is done on an informal basis, without a formalised framework. However, there is a separate monitoring system for monitoring the consequences of climate change. The upcoming adaptation	Monitoring of progress and performance is done via the goals on cloudburst and heat waves in the city's environmental programme. The overall responsibility to monitor the goal on

	city consisting of representatives of responsible departments and directorates.	resilience to the impacts of climate change (learning level 2), -to check whether they are still measuring the right priorities (learning level 3).		plan will develop monitoring processes.	cloudburst is given to the committee on traffic. The parent company of city-owned companies monitors the goal on heat waves.
Assessment of implementation	Evaluation is based on the monitoring of indicators per action. To ensure that the plan is being implemented, regular re-evaluations must be conducted to monitor and assess the effectiveness of actions on the goals set.	The implementation of the previous climate adaptation plan was evaluated by two progress reports, which reported that most actors took climate adaptation seriously and are incorporating it in their regular work.	Evaluations are based on the monitoring. Baseline and target values of indicators were determined in the first year of implementation. The implementation report provides detailed information for each indicator (see Box 8).	No assessment framework in place and no assessment has been made so far.	The yearly follow-up of the action plan is integrated in the follow-up of the city's environmental programme. Feedback and evaluations of routines and methods are done continuously by each actor according to their responsibilities.

Source: case studies, further details on all aspects are available in Annex 1.

3.2.3 Relationship between broad adaptation strategies and local and regional measures from the examples

Although in principle the LAPs and RAPs covered in this study all contribute to the high-level EU objective to step up adaptation efforts at all levels and can support the implementation of the respective NAS, direct or explicit links to EU or national adaptation objectives are made to a limited extent (see Table 4).

Integration with national adaptation objectives and NAS

In all the cases the NAS are older than the respective LAPs or RAPs and the time lapse can explain the absence of explicit integration. While in the cases of Flanders, NRW, Athens and Stockholm the local or regional adaptation plans are updated versions of earlier plans, which were adopted around the same time as the respective NAS, in the case of Kielce the LAPs came six years after the adoption of the NAS. Furthermore, the links between national and regional or local adaptation actions differ in each of the examples.

In Greece and in Poland, the NAS place some responsibilities for development of adaptation plans on LRAs. In Greece, development of regional/local action plans is one of the main objectives of the NAS. Consequently, the 2022 Athens Climate Action Plan includes general information regarding the NAS including reference to its main objectives and targets. In Poland, the Kielce LAP was developed within the implementation of the national strategic objective ‘Preparation of municipal adaptation plans taking into account management of rainwater (or including the climate adaptation component in other strategic documents)’. Although the LAP refers to the NAS there is no direct reference to measures from the NAS.

The objective and targets in the City of Stockholm’s action plan are not directly related to any national targets concerning climate adaptation. However, certain responsibilities that are allocated to municipalities in the Swedish national strategy are clearly covered by the City of Stockholm’s action plan. The Swedish national strategy on climate adaptation puts a major responsibility on municipalities by referring to existing laws on the municipalities’ responsibilities to conduct risk and vulnerability analyses, and responsibilities including for physical planning of land use, provisioning of water and sewer systems, and preventive actions related to natural disasters. Moreover, spatial planning is a main tool to implement the adaptation measures in the City of Stockholm’s action plan.

In Belgium, the NAS works in an overarching manner. The indicators and measures are aimed at coordinating the process of the RAPs that take place in the three “Gewesten” of Belgium: Flanders, Wallonia and Brussels. The Federal state

and the gewesten are on the same level in the juridical structure, but they are responsible for different domains. For example, the regional governments have authority in domains pertaining to the 'space': such as economy, employment, agriculture, water policy, housing, public works, energy, transportation, environment, spatial planning and urban planning, rural renovation, nature conservation.

In Germany, the NAS places municipalities as central actors in adaptation with the main responsibilities for action. The national government supports municipalities with knowledge sharing and advice. Moreover, the NAS includes funding programmes to develop pilot projects at local and regional level for demonstration purposes. The NRW RAP establishes limited links with the NAS measures and the main area of interaction is funding programmes (as both the regional state and the federal governments provide funding to the local level for adaptation) to avoid double funding and ensure complementarity. Nonetheless, there is good collaboration between the relevant departments at federal and regional level, and since 2008 there is a permanent committee for climate adaptation chaired by the federal level to discuss shared issues between federal level and states, but also among different states.

Integration with EU adaptation objectives and activities

With the exception of the Flemish RAP, the local and regional adaptation plans do not make explicit references to the EU Adaptation Strategy or Climate-ADAPT. References to other strategic EU documents, particularly the European Green Deal, are made only in the Athens LAP and the Flemish RAP. More explicit references are made to EU funding as a potential source of financing. While in Flanders and Stockholm the main financing source is the regional or local budget and EU funding plays a small role, EU funds are complementary sources for the implementation of adaptation in Athens, Kielce and NRW. The ERDF is the EU fund cited in all three plans.

Furthermore, even if EU initiatives are not explicitly referenced in the RAP, they are vital for the overall support to push for adaptation at the regional level. The experience with the Flemish RAP and the Stockholm LAP also highlights the importance of EU initiatives for learning and knowledge exchange, in that regard a key source of information is Climate-ADAPT. Authorities involved with the development of the Flemish RAP also point out the role of European working groups, the EEA and transnational projects for knowledge exchange. Hence, in Flanders the main source of support from the EU comes in the form of technical support given by the European Commission and EEA. Similarly, stakeholders involved with the Stockholm LAP explained that knowledge resources from Climate-ADAPT are regularly monitored (even if the platform is not explicitly mentioned in the LAP).

Table 4: Overview of links between LAPs, RAPs and broad adaptation strategies from five examples

	Athens	Flanders	Kielce	NRW	Stockholm
Integration with NAS	The NAS requires the development of RAPs and LAPs. The 2022 Climate Action Plan includes general information regarding the NAS, including reference to the main objectives of the NAS, as well as the national targets set in the NAS.	The NAS coordinates the process of RAP that is taking place in the three Belgian regions. Objectives do not explicitly align between the NAS and the RAP and federal and regional government have separate responsibilities.	The NAS requires development of LAPs and the Kielce adaptation plan was prepared as part of the implementation of this objective. There are some links between NAS recommendations and LAP measures but no direct references.	The NAS places the main responsibility for adaptation with municipalities. Intervention fields between the RAP and the NAS are similar but there is a limited link between measures. The main area of interaction is funding as both the state regional and federal governments provide funding to municipalities.	The NAS and national legislation place certain adaptation-related responsibilities on municipalities, for risk and vulnerability analyses and spatial planning. The LAP includes actions linked to these responsibilities.
Reference to EU Adaptation Strategy or Climate-ADAPT	No explicit reference	The RAP mentions both	No explicit reference	No explicit reference	No explicit reference
Reference to other EU climate and environmental objectives	The LAP takes into consideration: the European Green Deal; the EU Sustainable Finance Taxonomy; and the Recovery and Resilience Facility.	The RAP mentions the European Green Deal and the European Climate and Health Observatory.	No explicit reference but LAP mentions it implements EU priorities and international commitments.	No explicit reference	No explicit reference
Use of EU funding	ERDF, Recovery and Resilience Facility, EIB loan	Not specified, only on project basis	ERDF and Cohesion Fund, LIFE, and Horizon Europe	ERDF	Not specified, only on project basis
Dependency on EU funding	Partial (together with other sources)	Low (main financing source is the regional budget)	Partial (together with city budget and other sources)	High (key source together with regional government budget)	Low (main financing source is the city budget)

Source: case studies, further details on all aspects are available in Annex 1.

4. Good practices and lessons learned

This section provides a discussion of the lessons learned from the literature and the examples studied highlighting good practices.

4.1 Vertical integration of adaptation measures

4.1.1 From national planning to local/regional planning

As seen in section 3.2.3 above, there are different approaches to including LRAs in the national adaptation policy-making and these are highly dependent on the traditions and governance structures of each country. The explicit objective to develop regional and local adaptation strategies/plans in the Greek and Polish NAS can be seen as a good practice. This can create an environment that fosters the development and implementation of adaptation measures by showing there is political will at the highest level of governance and by giving legitimacy to adaptation efforts. In Sweden, the delegation of adaptation responsibilities to local authorities is mainly through legal responsibilities (e.g. risk assessments, water management). Such an approach has the advantage of making local authorities take adaptation action even in the absence of specific adaptation plans. Another notable practice that can enhance this even further is enshrining climate adaptation and obligations to take adaptive actions into law as seen in the case of NRW. It became the first German region to introduce a climate adaptation law in 2021 (see Box 3). Although specific measures are not linked to specific actors, it is an example of broadly defined responsibilities and a clear legal obligation for different institutions to implement adaptation actions.

Box 3: NRW Climate Adaptation Law

In 2021, NRW adopted Germany's first Climate Adaptation Act to improve resilience to negative consequences of climate change in the region, both to nature and society. It is based on projections that NRW might face an increased temperature of between 2.8 and 4.4 °C to 2071-2100. The law stipulates that all authorities must consider climate adaptation when planning and taking decisions according to their competencies. It also stipulates that the region must create climate adaptation strategies every five years per sector such as for health, biodiversity, forests, and urban development. In parallel, the region adopted a climate protection audit, which replaces the Climate Protection Plan from 2015. The audit system will review all measures taken by each authority against effectiveness and efficiency, and require necessary improvements based on the auditing. The audit includes indicators per relevant sector, and will ensure that responsible departments continuously plan, evaluate, improve, and adapt their climate adaptation measures.

Source: NRW Regional Government, 2020, [Cabinet passes tightened climate protection law and nationwide first climate adaptation law](#)

4.1.2 Integration of EU-level objectives and tools

The link between the European level and the local and regional adaptation plans is mainly focused on funding with EU funds cited as potential financing sources in most of the plans. In addition, experience from two of the plans points to the usefulness of EU knowledge exchange. Nevertheless, there is no explicit or systemic references to Climate-ADAPT as a knowledge repository among the five examples. This platform contains a vast amount of open-access guidance documents and tools that can help all kinds of policy makers in any stage of their adaptation efforts. The lack of integration of local and regional adaptation plans with the EU adaptation platform can be seen as a missed opportunity pointing to the need to enhance its visibility.

4.2 Preparation and development of adaptation measures

4.2.1 Assessment of risks and vulnerabilities

Assessing risks and vulnerabilities is a core component for the subsequent steps in a climate adaptation policy cycle such as identification of appropriate measures, relevant targets, and suitable indicators but also mapping of stakeholders concerned. As risks and vulnerabilities vary across context, a local or regional risk assessment is necessary to define the right targets and identify the vulnerabilities of local groups, sectors, and locations.

Among the five examples in this study, most examples do not consider risks or vulnerabilities as a basis for their climate adaptation plans. Flanders and NRW have risk assessments as measures in their RAPs, which is something that could be developed further for updated plans. So far only Stockholm's work on climate adaptation planning and objectives is based on prior risk assessments, which may be explained by the clear legal obligation for local authorities to perform such assessments as defined in Swedish law. These are conducted both prior to the action plan and included as measures in the action plan for complementary risk-mapping to identify high-risk areas that enable enhanced protection of societally important infrastructure and operations (see Box 4). The work on risk and vulnerability assessments has enabled Stockholm to effectively identify appropriate adaptation measures and responsible actors. However, these risks are not operationalised into targets or indicators, which could improve progress-tracking and generate information necessary for identifying improvements. Nevertheless, risk assessment can facilitate working towards the right targets, to prioritise and know what to measure.

Box 4: Risk assessment in Stockholm

The Swedish national strategy on climate adaptation refers to existing laws on the municipalities' responsibilities regarding risk and vulnerability analyses, and responsibilities for physical planning of land use, and preventive actions related to natural disasters. Such responsibilities are clearly reflected in the City of Stockholm's work and objectives on climate adaptation, including on water management, spatial planning, and risk assessments, mainly regarding risks related to cloudbursts and heat waves. Spatial planning is a main tool to implement the adaptation measures in the City of Stockholm's action plan. Local responsibilities for spatial planning are defined in the law and the NAS extended these responsibilities to include climate risks related to damages to the built environment because of, e.g., flooding, and how such risks can be reduced or discontinued. The City of Stockholm's work on climate adaptation has a considerable focus on assessing risks and mitigate the effects of those risks.

One of the main guiding risk assessments is the city's cloudburst modelling. In 2015, Stockholm's public Water and Waste company and the city's environmental department developed a cloudburst modelling to assess flooding risks of intensive cloudburst, considering effect scenarios of climate change until 2100. The modelling aims to:

- Provide an overview of vulnerabilities in events of extreme cloudbursts.
- Show where the flooding risks are.
- Show where in-depth and detailed assessments are needed.
- Provide a basis for the city's work on climate adaptation.

The modelling shows, among other things, variables such as rain scenario, land use per surface type, infiltration per soil type, maximum depths, and water flow paths.

Moreover, the city uses a heat map model to assess risks and vulnerabilities related to heat waves. The model shows temperature differences between different building types, and vegetation. It also considers climate change scenarios of +2 °C and +4 °C.

Risk and vulnerability assessments are also included as measures in the action plan, both regarding cloudbursts and heat waves. For example, an assessment of cloudburst risk management and damage costs as a basis for further work on risks and vulnerability, preparedness, actions, cost- and benefit analysis. Also, risks and vulnerability analysis are delegated according to each actor's responsibility. Risks are continuously overseen by the city's committees and undertakings, which are making priorities integrated in their ordinary operations based on needs and degree of those risks.

Source: case study, further details are available in Annex 1.

4.2.2 Governance

Setting a good governance structure is another important preparatory step in the adaptation process. Depending on the governance system of each country, region, or municipality, planning how to organise and coordinate implementation can be a difficult exercise. Responsibilities to implement different measures must be in the hands of the suitable actor with the competency and capacity to do so. If a plan does not come with clearly defined responsibilities at least over certain sectors or broader adaptation objectives, if not for specific measures, its implementation can be jeopardised.

Establishing the governance in RAPs can pose an additional challenge as links need to be established, not only with the higher national level, but also with the lower municipal level. In the examples examined, responsibilities for the implementation of adaptation measures in both Flanders and NRW are delegated, at least, partly to municipalities. Flanders' latest adaptation plan acknowledges the complex nature of climate adaptation and the over-lapping responsibilities among departments, sectors, and lower tiers of government. In NRW, however, the lack of clear responsibilities for sectoral measures resulted in a lack of resources being dedicated for such measures in sectoral regional government ministries and consequently non-implementation of these measures. Defining roles and creating ownership among all relevant stakeholders was an important lesson for the implementation of this RAP.

The LAPs of Kielce and Stockholm are examples of plans with a more exact allocation of responsible actors per adaptation measure. The City of Kielce also has a monitoring system that links each indicator to a responsible unit within the city (discussed further in the following sections). The City of Stockholm has benefitted from its decentralised governance, with prior clear roles and responsibilities defined for each actor (see Box 5). However, not linking specific measures to specific actors might make it harder to assess progress. Although the City of Stockholm's adaptation plan describes further delegation of exact responsibilities as an action, developing this information in the planning phase would facilitate monitoring structures and learning.

Box 5: Adaptation governance in Stockholm

The City of Stockholm has a decentralised system to implement its climate adaptation measures. Thus, delegation of responsibilities is further trickled down to sub-levels within the city. For example, the delegation of responsibilities for implementing measures to adapt to climate consequences regarding cloudburst and stormwater include the following:

- The city executive board has the responsibility for coordination as well as the overall risk and vulnerability analyses.
- The committee on environment and health supervises stormwater management, develops data and tools on climate and weather statistics, key figures, ecosystem services and green surface factors, coordinates the environmental monitoring and prepares local action plans for good water status.
- Stockholm Water and Waste company is responsible for wastewater treatment, related investments, and provides expertise on the topic.
- The committee on land development has the responsibility to regulate land use, building and infrastructure projects and the city's parks and natural areas.
- The committee on city planning is responsible for fulfilling the city's responsibilities under the Planning and Building Act (2010:900). The committee ensures that strategic planning fulfils the objectives on stormwater and cloudburst.
- The committee on traffic maintains the city's infrastructure and supports the city's work on cloudburst under the action plan on climate adaptation.
- The neighbourhood councils are responsible for managing parks and natural areas

and partly stormwater management.

- The committee on properties is responsible for the work related to buildings in the city together with the city's public housing and public property companies, which work on assessing risks and vulnerabilities related to climate change of their buildings.

Source: case study, further details are available in Annex 1.

4.2.3 Financing

Securing sufficient financing for adaptation should be done during the development of the local or regional adaptation plan, ideally with a detailed investment plan. As highlighted earlier in this study, it is advised to identify financial resources that can cover the plan's costs in the initial planning phase of the policy cycle. Whether planned actions require external funding or not, financial planning is crucial for securing a budget that may cover upcoming activities. A long-term funding plan is necessary, particularly related to more extensive and long-term measures that might come at a higher cost.

As evidenced by the five examples, there is no unique financing strategy to follow, and a good approach is to combine different sources of funding. The financing strategy of the Athens LAP is particularly diverse with funding from EU and national funds, a loan from the EIB (see Box 6), financial instruments, PPPs, as well as sponsorships. The City of Kielce also relies on multiple types of financing. In addition, it had a well-defined financial plan with estimations for the costs of all measures, funding sources that can be accessed, and a plan on how to monitor the costs per activity. This type of exercise can be useful for securing funding throughout the climate adaptation process.

The difficulties in securing funding were something that NRW experienced and learned from during the implementation of their RAP, particularly due to a lack of clear financial commitments and financial ownership for certain measures. This made the regional government under-prioritise climate adaptation measures in the regional budget and this slowed down implementation. Therefore, securing an adaptation budget as early as possible in the planning phase can be necessary to enable implementation. As highlighted by this experience, governance and financing can be closely linked and mutually reinforcing. A clear governance structure and sense of ownership among the actors implementing the measures can help ensure budget is set aside for adaptation.

While the plans from the case studies rely primarily on the budgets of implementing institutions or other public sources of funding to finance the adaptation measures, private financing (e.g. from commercial banks, institutional investors) is another source to explore for boosting the availability of adaptation funding.

Box 6: Financing Athens' adaptation and resilience efforts

The Municipality of Athens has signed a EUR 55 million loan from the EIB to support the implementation of its 2030 resilience strategy. The loan mainly supports energy upgrades, earthquake fortification of municipal buildings, and waste management initiatives. It includes EUR 5 million financing from the Natural Capital Finance Facility (NCFE) – a programme run by the EIB and the European Commission and focused on nature conservation, biodiversity and nature-based solutions for adaptation. In this way, Athens became the first city to be financed under the NCFE with the aim of financing green and blue infrastructure.

The support from NCFE includes technical assistance granted free to the Municipality (to pay for consulting firms aiding the city in the design and development of green infrastructure elements). The financing will be used for four projects as a start:

- the revival of an urban forest, where soil and biodiversity will be stabilised through water management and erosion control;
- the creation of green corridors between city hills;
- greening and pedestrianising an area of city; and
- extensive greening and opening up of surfaces, connecting different parts of the city, while lowering temperatures and improving air quality in these densely built neighbourhoods.

In quantitative terms, the goal of the project is to create at least 25 % more green areas and to introduce eight different climate adaptation measures that will include, among many others, trees, bushes, and birdhouses in some of them.

Source: European Investment Bank, 2019, [Athens bets on green infrastructure and biodiversity](#)

4.2.4 Synergies with other policies

All measures have potential synergies with other policy actions and ‘missing’ these synergies while focusing only on certain types of benefits can be a lost opportunity. That is especially true between climate adaptation and mitigation, but also between adaptation and other environmental, social and economic policies. Experiences show that anticipating these synergies can be helpful, not only to create co-benefits between measures, but also for gaining political support and securing financing. It is easier to ‘sell’ climate adaptation objectives if a broader group feels that they can benefit from the actions. Therefore, planning and assessing both synergies and trade-offs is necessary for making priorities and selecting the most effective measures.

The five examples in this study show multiple potential synergies related to biodiversity, health, economy, employment, human well-being, and energy systems. However, only in Athens are the climate mitigation and adaptation actions integrated in the same plan (see Box 7).

Box 7: Integrated climate mitigation and adaptation plan in Athens

In 2017, the City of Athens developed its resilience strategy in order to make the city more resilient to current and future challenges. The strategy integrates other plans, programmes, and roadmaps, including a climate action plan (later updated in 2022). The climate action plan covers climate change mitigation, adaptation and resilience through actions on waste management, sustainable mobility, energy poverty, sustainable food systems, migration, housing, employment, and crisis preparedness.

Creating synergies between these aspects came from awareness of how integrated these challenges are and the multiple benefits that solutions to these can provide. For example, green infrastructure can provide multiple benefits for air quality, cooling, public health, economy, and social cohesion. The preparatory process for the resilience strategy included a SWOT analysis and collaboration with a wide range of stakeholders and civil society organisations in the city, including 140 organisations and 900 citizens. Hence, anchoring the strategy in experiences and knowledge from a broad part of society, connecting actions for reducing GHG emissions with adaptation. It creates synergies across sectors within the city, but also across levels of government.

Sources: The City of Athens, 2017, *Athens Resilience Strategy for 2030* (further details are available in Annex 1).

4.2.5 Targets, indicators and monitoring systems

As described earlier in this study, the definition of targets and indicators and progress-tracking are interlinked and essential for effective progress on climate adaptation objectives. In addition, involving stakeholders in this process is necessary to understand needs, opportunities and progress and foster cooperation. Among the examples assessed in this study, the City of Athens is the only example that has consistently followed the steps of defining targets, indicators and a monitoring system, while also engaging with stakeholders. Its LAP was developed in consultation with stakeholders and contains quantitative and timebound targets for short-, mid-, and long-term actions and objectives. These are linked to resources available and responsibilities for specific departments within the city. Moreover, indicators are defined and monitoring teams have been established in the city consisting of representatives of responsible departments and directorates to ensure the plan is being implemented and its effectiveness assessed. A possible driver behind this thorough process might be Athens' participation in the global C40 initiative and the learning and experience exchange this allows.

Kielce has the most developed system for monitoring progress among the five case studies (see Box 8). Although Kielce's adaptation plan has no specific targets, it has a rich set of monitoring indicators to track outputs and progress with implementation of the LAP. The reporting summarises progress as initiated, planned, ongoing, or implemented activities and provides information on the costs per activity. In addition, indicators are linked to the responsible unit within the city. One possible success factor is that the development of indicators in the City of Kielce is supported by the national strategy in Poland, which requires local

authorities to monitor the progress of the local adaptation plan. Moreover, the implementation report of measures set out in Kielce's Adaptation Plan is reviewed by the national Ministry of Climate and Environment.

Learning experiences in Flanders and NRW show that the lack of a monitoring framework is a drawback, and the regions plan to rectify that in the future. An important lesson in the Flemish experience is the need to establish an objective monitoring system, rather than having the responsible bodies monitoring and assessing their progress without predefined criteria or a baseline for comparison.

Box 8: Monitoring implementation in Kielce

In Kielce, information on progress of implementation is gathered according to activity categories, i.e., education and information, organisation, technical activities. Reporting is done based on the number of activities that have been either initiated, planned, ongoing, or implemented. Costs per activity are also reported, including internal and external resources. The first implementation report of the plan provides the following information regarding each indicator, structured according to the strategic objectives and measures:

- Value of the indicator.
- Value achieved (for most indicators in terms of increase/decrease compared to the baseline).
- Total cost of activities per measure.
- Costs incurred from own budget.
- Costs covered from other financing sources.
- Status of implementation (whether a measure is implemented, in progress, or planned).
- Implementation deadline.
- Organisation and unit responsible.

Source: case study, further details are available in Annex 1.

4.3 Implementation and performance assessment of adaptation measures

4.3.1 Implementation

Several regional and local examples give the impression that implementation is not something that kick-starts as a result of the adaptation plans' adoption. The implementation of measures can also be a continuation of previous efforts and measures that are updated or might have faced unexpected delays. For instance, Athens and Flanders adopted updated adaptation plans in 2022. In Athens, the measures from the 2022 Climate Adaptation Plan are already being implemented, including as a continuation of pre-existing measures. In Flanders, the 2022 plan is not yet being implemented due to political delays. Political changes also delayed the implementation of the NRW RAP. An important lesson learned is the need for political will and prioritisation of adaptation among relevant political actors in the city or region. In addition, securing broad political support in the planning phase might increase the probability that measures are going to be

implemented, especially regarding the longer-term commitments that must survive changing political majorities. In NRW, it remains to be seen if the adoption of a climate adaptation law for the region will increase the sense of ownership and securing political support.

Experience from Kielce showed that a challenge for implementation can be the shared responsibilities for measures across different the city departments. Implementing measures has required the involvement of multiple city departments per measure and coordinating the actions has been a challenge and a learning experience. This points back to the importance of delegating responsibilities as specifically as possible (e.g. per measure) from the start of the adaptation process, while also allowing for some flexibility to learn and adjust the governance set-up if needed.

4.3.2 Performance assessment/ evaluation

Without comprehensive evaluation of implementation and progress, it is hard to know what to improve for current and future adaptation measures. This is conditional upon good practices taken in the previous phases of the policy process i.e. risk assessments, definition of targets and indicators for the adaptation measures, and division of responsibilities among stakeholders. Of the five examples, none has consistently evaluated the performance of their climate adaptation measures. Nevertheless, some have reported on the implementation and attempted to draw lessons for improvement of the future implementation of measures or development of plans.

The City of Kielce and Flanders are the only two among the five examples in this study that have reported on the implementation of their climate adaptation actions and drawn lessons for future assessments. The City of Kielce's implementation report evaluated the first phase of the 2019 plan, identified further assessment efforts and developed new indicators to improve monitoring and future evaluations. An important lesson learned was that evaluation requires close cooperation between the actors involved in implementation of the LAP. Nevertheless, as shown in the previous section, the assessment remains focused on progress and outputs rather than the broader outcomes or impacts of the adaptation efforts.

In its progress reports assessing the earlier RAP, Flanders learned that an objective evaluation system with predefined criteria and a baseline against which to assess them are crucial, especially if the effectiveness of adaptation measures is to be understood. Therefore, the updated adaptation plan has a revised system that aims to assess the effectiveness of the measures to deliver resilience in addition to tracking progress (see Box 9).

It is important that as LRAs implement and update their adaptation plans, they put in place procedures to assess the effectiveness of the measures to actually meet the adaptation objectives of mitigating climate risks, reducing vulnerabilities or improving resilience. Tracking outputs is useful for making immediate adjustments to an adaptation plan's implementation but understanding the long-term impact and benefit of the measures allows authorities to ensure the plan remains focused on the most relevant adaptation needs (which may evolve over time).

Box 9: Performance assessment in Flanders

Implementation of the earlier RAP was assessed only as completed, on schedule or delayed. However, the updated Flemish RAP defines more ambitious objectives for its monitoring and evaluation process. In addition to a first level of tracking the progress of the implementation, the monitoring and evaluation of the updated RAP will also assess:

- The effectiveness of the measures will be assessed. This will be done by checking whether the measures will improve the resilience of Flanders regarding the effects of climate change. This aims to answer the question of whether the measures that are implemented are done so in the right way.
- The desirability of the measures will be assessed. This concerns whether the focus of the measures is correct, and whether the way the measure is executed is correct (in terms of, for example, available resources, technology, societal priorities).

This approach, which includes two more in-depth levels of detail, does not just look at outputs, but also at the actual results/ impacts that the measures have, and whether Flanders' resilience increases.

Source: case study, further details are available in Annex 1.

5. Recommendations

This section provides practical suggestions/recommendations for LRAs and other relevant policy-makers based on the lessons identified.

5.1 Local and regional authorities

In the development and implementation of adaptation strategies or plans, LRAs should consider the following recommendations:

General aspects:

- Although adaptation requires tailored approaches to the local situation, there is a rich basis of information and data sources, tools, guidelines and templates, as well as previous examples and experiences at national, international or local level. LRAs should use the resources available and learn from peers as much as possible. LRAs need to prepare adaptation plans tailored to the context-specific risks and opportunities, but they do not need to start from scratch. Useful repositories of information include [Climate-ADAPT](#) and the guidance documents/tools mentioned in section 2.1, peer learning and experience exchange is facilitated by existing networks such as [Covenant of Mayors for Climate and Energy](#) (Europe) and the other initiatives mentioned in section 0.

Preparation is key for successful adaptation, as it creates the foundation for the next steps and can determine the extent to which they are successful. There are several critical elements to consider:

- Adaptation should be based on **an assessment of the context-specific risks and vulnerabilities**, which would then help identify the adaptation needs and stakeholders impacted by climate change, suitable actions, targets and monitoring strategies. Ideally, such an assessment should be based on data and analysis of expected climate hazards and risks. Nevertheless, as shown in the ADEPT guidance¹⁰⁴ or in the Covenant of Mayors¹⁰⁵ reporting template, each step of the policy process can be tailored to the city's or region's level of 'maturity' in adaptation. In other words, LRAs that are taking their first steps towards adaptation plans can use a simpler approach starting by mapping the main risks, vulnerabilities and stakeholders affected and identifying the principal adaptation needs (i.e. performing a more general needs' assessment). At a later stage, or during an update of the

¹⁰⁴ ADEPT; Defra and the Local Adaptation Advisory Panel. (2019). *Preparing for a changing climate: Good practice guidance for local government*
<https://www.adeptnet.org.uk/system/files/documents/Good%20Practice%20Guide%20ADEPT%202019f.pdf>.

¹⁰⁵ Covenant of Mayors. (2022). *Climate Change Risks and Vulnerabilities Indicators*. Retrieved 28 October from https://www.eumayors.eu/index.php?option=com_attachments&task=download&id=843.

adaptation plan, they can perform a more in-depth and robust risk and vulnerability assessment, for instance building upon the experience with the more basic approach.

- A critical success factor in all cases is the **involvement of stakeholders**. The most relevant stakeholders, their adaptation needs and potential roles should be mapped as early as possible (e.g. as part of the risk and vulnerabilities assessments). An inclusive process of continuous consultation with stakeholders will allow the leading authority to benefit from community knowledge of risks, opportunities and adaptive solutions as well as existing information or data for the monitoring. Last but not least, stakeholder involvement ensures buy-in and support for adaptation, which is critical for the success of adaptation plans as evidenced by the examples in this study.
- As policy-making is a cycle, the subsequent updates of adaptation plans should use the **lessons learned from previous plans** and integrate findings from the assessment of the plans (see below). Depending on the assessment approaches, lessons can indicate needs to change the timing, financing or governance of the measures but also needs to remove, change or add adaptation measures.

Development of the adaptation plan should build upon the preparatory steps and should involve:

- Definition of **clear objectives, measures, indicators and processes for monitoring and evaluation** from the start. Ideally adaptation plans and their frameworks should be at least partly ‘proactive’ (i.e. based on future expected climate risks) rather than only ‘reactive’ (i.e. based on past extreme events such as floods or heatwaves). The different elements (objectives/targets – measures – indicators) should be clearly defined and linked to financing sources and responsible stakeholders. Plans for monitoring and evaluation should also be established as early as possible (see below for more concrete recommendations).
- **Responsibilities** for implementation and/or monitoring of the adaptation measures should be clearly defined from the start of the process. Ideally, for each measure it should be clear which institution would be responsible for its implementation, which institution for its financing, and which institution for monitoring its progress. This would contribute to stakeholders having a sense of ownership over the measures and avoid situations where unclear division of responsibilities hinders adaptation progress.

- Another relevant aspect is the development of **internal capacity and knowledge** on adaptation within the main institution or department responsible for the adaptation plan. Although this is highly dependent on the structure of each LRA as well as budgetary considerations, investing in the human resources for adaptation is an important precondition as it ensures the municipality or region has good internal knowledge and expertise to design and oversee an adaptation plan. Depending on the maturity of the plan, LRAs can start by providing training for the main experts responsible for the preparation, implementation and monitoring of the adaptation plan. For subsequent updates and transition to more complex plans, dedicated experts or teams of experts on adaptation and resilience can be set up.
- Identification of the main **sources of financing** for the adaptation plan. There is no single best approach, hence, LRAs should consider all possible financing sources and be creative in how they combine them. Much of the available guidance provides tips concerning the EU and other funding that can be accessed for adaptation to climate change. What is important is that LRAs estimate the financial needs of the adaptation plan early on, identify both public and private sources of financing and allocate potential sources of financing for each measure.
- To the extent possible, **synergies** between the adaptation measures and other measures should be sought. The achievement (and promotion) of multiple benefits of adaptation measures has the added advantage of building broader stakeholder support for adaptation overall and boosting the priority given to adaptation strategies/plans. Examples of such synergies include measures to address heatwaves in the urban environment (e.g. installation of shading), which can improve health and social inclusion in addition to increasing resilience. Consultations with different types of stakeholders can be a good way to identify such synergies.

There is no single best approach to the **implementation** of adaptation measures, but allowing for some flexibility to adjust processes when necessary, might be beneficial. As seen in the case studies, drawbacks during implementation might stem from deficiencies in the preparation phase (e.g. lack of sufficient engagement from relevant stakeholders, lack of political will). Therefore, possibilities to address such deficiencies as soon as they are identified should be sought.

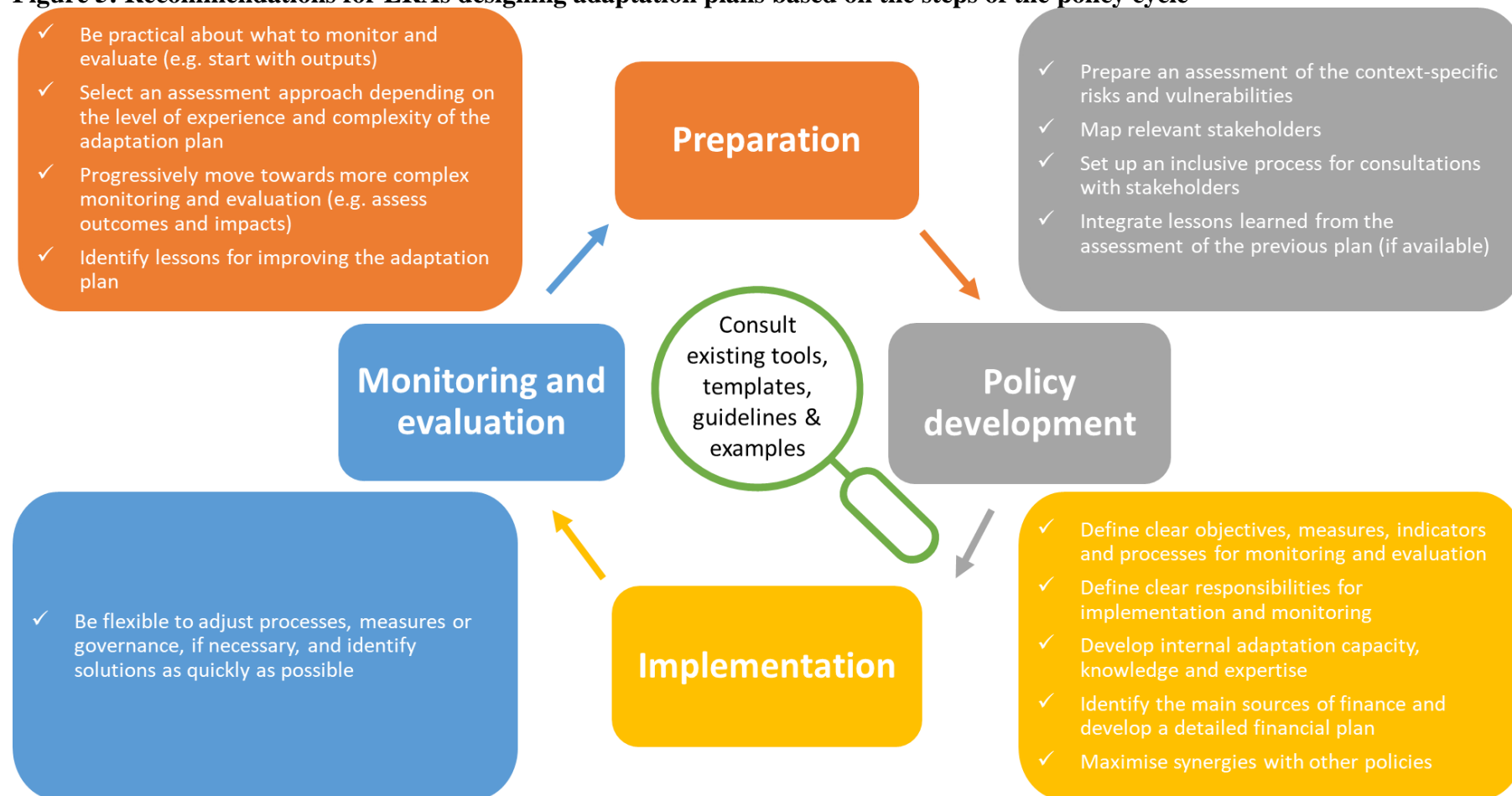
The **assessment of performance** of adaptation measures is becoming more important and LRAs should put in place monitoring and evaluation systems that can facilitate this. Ideally, such an assessment should provide information on the effectiveness of adaptation measures to deliver on their objectives and

improve resilience, but there are intermediate steps that can be very useful too. Thus, LRAs should:

- Be practical about **what to monitor and evaluate**. Particular issues with adaptation measures can be the long time needed for some of their impacts to be observed and the difficulty to distinguish impacts of adaptation measures from those of other policies such as health, social etc. Therefore, aspects that are more straight-forward to measure or which can be observed in a short time frame should be prioritised. For example, measuring outputs such as coverage of the green area or number of persons reached by a measure can be simpler than assessing outcomes (e.g. improvement of resilience or disaster preparedness) and is a realistic starting point. Nonetheless, as LRAs gain experience, it is important to start examining not only the progress and outputs of the adaptation measures but also their effectiveness in terms of meeting the objectives defined and delivering benefits by evaluating the longer-term outcomes and impacts of the measures.
- Select **an assessment approach** depending on the level of experience and complexity of the adaptation plan. It is good to start with a simple assessment framework based, for example, on a scoreboard, qualitative information or reporting of outputs to acknowledge what has been done. As the adaptation plan becomes more elaborate and the LRA gains more experience, it would be worthwhile to develop a more complex and robust assessment based on quantitative indicators, reporting of outcomes/results as well as regular internal and external reviews.. While internal assessments are necessary as they allow learning, conducting regular external reviews (e.g. every five years) is also useful to gain a more independent look at the progress and performance of the adaptation actions.
- One of the main goals of assessing the performance of the adaptation measures is to identify **areas for improvement**. Hence, any kind of assessment should identify lessons learned and areas for improvement in future updates of the adaptation plans.

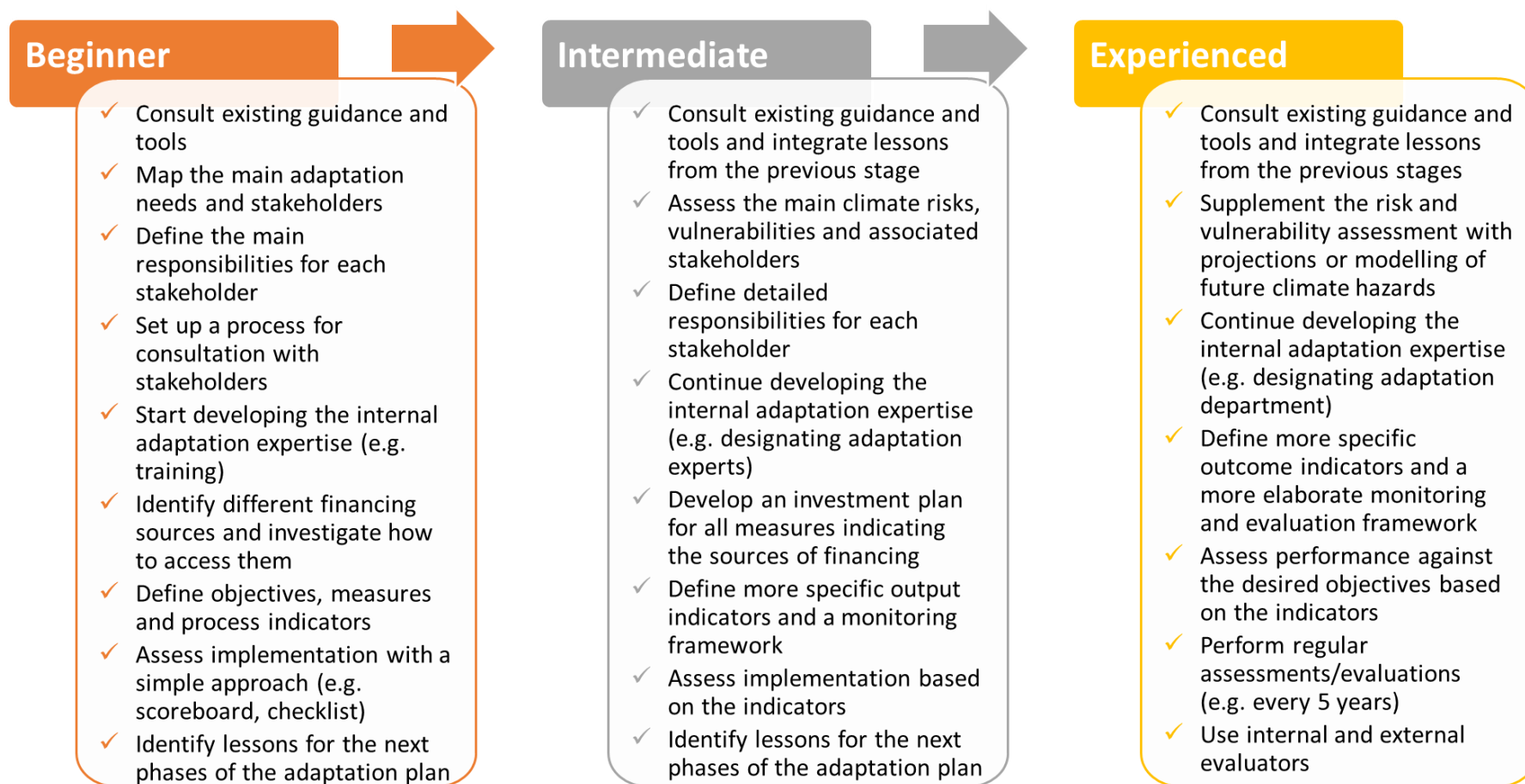
Figure 5 summarises the main recommendations for LRAs, which are designing adaptation plans, along the main phases of the policy cycle. As highlighted, LRAs can consider different recommendations based on their pre-existing experience with adaptation strategies/plans. Figure 6 summarises the main recommendations for LRAs according to their level of experience with adaptation plans – LRAs that are just getting started with their adaptation plans (i.e. ‘beginners’), those that have some experience and might be updating their original adaptation plans (‘intermediate’) and those that are experienced and have long-standing adaptation plans (‘experienced’).

Figure 5: Recommendations for LRAs designing adaptation plans based on the steps of the policy cycle



Source: authors' own elaboration.

Figure 6: Recommendations for LRAs' adaptation plans based on their experience



Source: authors' own elaboration.

5.2 National and EU policy-makers

Local and regional adaptation efforts do not exist in a vacuum but in a complex mix of international, EU and Member State level adaptation policies. Therefore, LRAs can be supported by the actions of national and EU policy-makers. Considering the findings of this study, the following recommendations can be made:

EU policy-makers:

- EU resources in the forms of funding, technical support and knowledge are important for LRAs. EU policy-makers should continue providing such resources and make sure sufficient guidance and support is available to help LRAs access these resources.
- Although platforms, networks and multiple projects exist, LRAs are not always aware and do not sufficiently use the knowledge available. EU policy-makers should aim to improve the visibility of Climate-ADAPT, Covenant of Mayors and the results of EU-funded projects (from Horizon 2020, Horizon Europe or Interreg) to facilitate learning, communication and exchange of ideas.

National policy-makers:

- The adaptation responsibilities for the LRAs should be clearly defined. As seen in the examples studied, this can be done via the legal framework or the NAS.
- Funding and support for capacity building should be provided also at the national level. LRAs can be provided with guidelines on which sectors and risks to cover, how to share the responsibilities for adaptation, how to perform risk assessments, monitor and evaluate adaptation strategies as national level policy-makers are often more experienced in the adaptation process than some LRAs. This can be strengthened with the development of standards and/or guidelines as seen in the UK¹⁰⁶.
- Knowledge and databases at the Member State level can be provided through one-stop-shops or platforms similar to Climate-ADAPT and the visibility of such platforms should be enhanced.

¹⁰⁶ ADEPT; Defra and the Local Adaptation Advisory Panel. (2019). *Preparing for a changing climate: Good practice guidance for local government*
<https://www.adeptnet.org.uk/system/files/documents/Good%20Practice%20Guide%20ADEPT%202019f.pdf>.

- Last but not least, a clear commitment to adaptation at the national level (e.g. in the form of an NAS, climate law) showcases that there is political will to take action and fosters adaptation at all other levels of governance and among all types of stakeholders. This acts as an enabling factor for LRAs and can mitigate fluctuations caused by changing political cycles.

EU and national policy-makers:

- Adapting to the inevitable impacts of climate change requires significant investments. While public resources are critical for kick-starting actions, they are unlikely to be sufficient and private financing will be necessary to complement public funding, especially over the long-term and for more significant investment efforts. To improve the visibility and ‘bankability’ of adaptation measures and projects, public authorities and policy-makers should send clear signals that such investments are prioritised. This can be done through the setting of objectives, adoption of adaptation policies but also by promoting the EU sustainable investment taxonomy¹⁰⁷. This sends a clear message that adaptation investments are beneficial and ideally, would incentivise and attract private investors, making additional financing available for the implementation of adaptation plans everywhere.

¹⁰⁷ [EU taxonomy for sustainable activities](#)

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Annex 1: Case studies: examples of local and regional adaptation plans

The information for the following examples was collected from the strategic documents listed in the reference lists (all weblinks were accessible as of 4 November 2022) and consultation with stakeholders as indicated.

Athens (Greece)

Local adaptation plan (LAP)

Example 1	Athens
General information	
City, Country	Athens, Greece
Name of the LAP	Athens Resilience Strategy for 2030 (Στρατηγική Ανθεκτικότητας της Αθήνα για το 2030) and Climate Action Plan [2021-2030] (Σχεδίου Δράσης για το Κλίμα)
Date of the LAP	The Athens Resilience Strategy for 2030 was adopted in 2017, the latest Climate Action Plan was published in 2022
Institution(s) responsible	The Municipality of Athens is responsible for the Athens Resilience Strategy for 2030 including the Climate Action Plan (2022)
If applicable, previous versions	A first version of the Climate Action Plan was published in 2017 together with the Athens Resilience Strategy for 2030
Additional information	<p>In 2008, the Municipality of Athens started to participate in the global climate network of cities C40 in which cities act together to tackle climate change, through partnerships, exchange of scientific knowledge, experiences, know-how and best practices. Athens has so far been actively involved in the following C40 thematic networks:</p> <ul style="list-style-type: none"> a) Cool Cities, as a leading city since 2018, which deals with - among others - the reduction of temperatures in the urban fabric, the urban heat island phenomenon, the adaptation of cities to high temperatures, and green infrastructure b) Municipal Buildings Efficiency, which deals with issues related to improving the energy efficiency of municipal buildings c) Waste to Resources Network, which deals with issues related to the circular economy and waste management. <p>In 2016, the Office of Urban Resilience and Sustainability was established under the mayor's office. In the same year, the Municipality of Athens participated in the 100 Resilient Cities (Global Resilient Cities Network) through a procurement process and initiated the development of the Athens Resilience Strategy 2030. The Office of Urban Resilience and Sustainability started to prepare strategies and support all horizontal actions of the Municipality of Athens and especially issues related to Climate Change.</p>

In **2017**, the Municipality of Athens managed to prepare the first integrated Climate Action Plan (for the reduction of greenhouse gas emissions and adaptation to climate change). The Climate Action Plan was an integral part of the Resilience Strategy, in the context of which actions for reduction and adaptation to climate change were complemented by climate resilience actions. Both strategic plans were approved by the City Council in 2017. The 2017 Climate Action Plan has a 2030 horizon and consists of two parts: the first part, the Greenhouse Gas (GHG) Emissions Reduction Plan, is aimed at reducing GHG emissions by 40% compared to base year (2014) emissions, while the second part, the Climate Change Adaptation Plan, is aimed at protecting the population and adapting the City to extreme weather events. Since 2017, Athens has been implementing its first Climate Action Plan.

In **2018**, in the new organisational structure of the Municipality of Athens, the Office of Resilience and Sustainability, was upgraded to a Department within the Directorate of Strategic Planning, Resilience, Innovation & Documentation, which has the authority and responsibility to deal with, among other things, the updating and monitoring of the Climate Action Plan and the coordination of the city's climate actions. At the same time and for the same purpose, from 2017 to date, two interdepartmental working groups have been operating in close cooperation with the department: one on the Reduction of Greenhouse Gas Emissions and the other on Climate Change Adaptation by Mayor's Decree.

In **2022**, the updated version of the Climate Action Plan was published, including both climate change mitigation and adaptation measures. Compared to the 2017 version, the new Plan includes additional objectives related to ecosystem and biodiversity management and restoration, prevention and response to climate risks, water and waste management, as well as digital transition.

Preparation and policy development: Adaptation measures and indicators¹⁰⁸

Objectives

The Athens Resilience Strategy for 2030 introduces four general axes that include measures/initiatives related to:

1. Administration (*Open City*);
2. Environmental aspects, e.g. green areas, transport, energy, etc. (*Green City*);
3. Planning in the face of serious challenges (*Proactive city*); and
4. Social aspects, e.g. employment, economy, social housing, etc. (*Vibrant city*).

Based on the above, the 2022 Climate Action Plan introduces seven axes that include:

1. Renewable energy production and energy upgrading of the built environment;
2. Accelerating the transition to sustainable and smart mobility;
- 3. Urban regeneration by integrating green and blue infrastructure (related to adaptation and focus in this example);**
4. Ecosystem and biodiversity management and restoration;
- 5. Prevention and response to climate risks (related to adaptation and focus in this example);**
6. Sustainable water and waste management;
7. Transition to a green and digital city.

¹⁰⁸ This part is based on the documents of the adaptation strategy/plan, unless otherwise indicated.

Measures	<p>The objectives of the Athens Resilience Strategy for 2030 are implemented through measures in the Climate Action Plan. A list of measures is provided in the 2022 Climate Action Plan for each one of the six axes, including the following measures relevant for adaptation:</p> <p><i>3. Urban regeneration by integrating green and blue infrastructure</i></p> <ul style="list-style-type: none"> 3.1. Green and Blue Cultural Routes 3.2. Maintenance and Upgrading of Built Public Space 3.3. New Green Spaces. <p><i>5. Prevention and response to climate risks</i></p> <ul style="list-style-type: none"> 5.1. Protection from Flooding 5.2. Fire Protection 5.3. Protection, Awareness and Empowerment Public Health 5.4. Draft Action Plan to address Urban Overheating.
Rationale for selection of the measures	<p>The measures suggested under the 2022 Climate Action Plan are considered to contribute to the achievement of the objectives. However, as indicated in the 2022 Climate Action Plan (p. 139), a number of issues and challenges have been identified during the implementation of the Plan. These include inter alia, legal and constitutional challenges, economic and social, as well as practical and technological challenges.</p> <p>The measures/initiatives are adopted based on the needs of the city of Athens. It is to be noted that the 2017 edition of the Climate Action Plan relied heavily on stakeholder engagement and working groups. There was also collaboration between the public and private sectors, as well as civil society involvement. In both the 2017 and 2022 Climate Adaptation Plans, participatory planning offered the opportunity to involve stakeholders, issue a first draft, have it assessed by stakeholders and adjust it based on relevant comments¹⁰⁹.</p>
Time horizon	2021-2030
Targets	Timebound targets are set in the 2022 Climate Action Plan. The timeline is divided into short-term (2021-2025), mid-term (2025-2030) and long-term (2030-2050).
Indicators	<p>A set of indicators is provided under each one of the actions listed further above. For example, under <i>5. Prevention and response to climate risks</i>, the following indicators have been introduced for each of the relevant measures:</p> <p><i>5.1. Protection from Flooding</i></p> <ul style="list-style-type: none"> 1. Annual expenditure on emergency management planning as a percentage of the total city budget 2. Stabilised slope area (m²/km²) 3. Annual expenditures for stormwater infrastructure upgrades and maintenance as a percentage of the total city budget 4. Volume of increased storage capacity (m³)/flow capacity. <p><i>5.2. Fire Protection</i></p> <ul style="list-style-type: none"> 1. Removal of dead plant mass area

¹⁰⁹ Interview with a representative of the Municipality of Athens, 17 October 2022.

2. Monitoring network area
 3. Number of monitoring stations per square kilometre (km²).
- 5.3. Protection, Awareness and Empowerment Public Health*
1. Percentage of population aware of the action
 2. Number of people who participated in the seminars
 3. Annual expenditure on social services as a percentage of the city's total budget
 4. Vulnerable population as a percentage of the city's population
 5. Percentage of population enrolled in social welfare programs
 6. Number of people in the population registered in friendship clubs
 7. Percentage of the population accommodated in municipal facilities
 8. Number of beneficiaries of the programme
 9. Percentage of the city area covered by publicly available risk maps
 10. Number of people using the application
 11. Number of people participating in the children's holiday programmes
 12. Percentage of population near a primary health care centre
 13. Percentage of population visiting facilities
 14. Percentage of water infrastructure modified to increase resilience
 15. Percentage of population near a cool spot or climate shelter
 16. Percentage of population visiting cool spots
 17. Number of people involved in the implementation of actions.
- 5.4. Draft Action Plan to address Urban Overheating*
1. Citizen Information and Awareness Actions
 - Information campaigns
 - Heatwave categorisation.
 2. Heatwave preparedness actions
 - "Heatwave line": information and support for vulnerable populations and stray animals
 - Friendship Clubs open until the evening
 - "Help at Home" and mobilisation of a network of volunteers and "Heat-Health" groups
 - EXTREMA Global application for phones
 - Work stoppage during warm hours
 - Energy diversion from industry to residential areas
 - Ban on domestic power cuts, and support for energy-poor households.
 3. Redesign actions for a Cooler City
 - Green Streets, Corridors and Routes
 - Green Neighbourhoods, Superblocks, Pocket Parks

	<ul style="list-style-type: none"> ○ The Hills of the City ○ Water Resources on the city surfaces ○ The Adrianion and the Peisistratio Aqueduct ○ Sustainable Water Utilisation and Management ○ Supporting existing Urban Nature ○ Doing an inventory of and increasing biodiversity. <p>Under 3. Urban regeneration by integrating green and blue infrastructure, the following indicators are relevant for adaptation (some indicators are repeated for multiple measures):</p> <ul style="list-style-type: none"> ● Percentage of city area covered by tree canopy (for measure 3.1) ● Green area per 100,000 inhabitants (for measures 3.1, 3.2, 3.3) ● Intensity of the urban heat island effect (for measures 3.1, 3.2) ● Permeable areas of land, public spaces and pavements built with porous, drainage materials as a percentage of the city area (for measures 3.1, 3.2) ● Annual spending on green and blue infrastructure as a percentage of the total budget ● Number and length of green and blue routes (measure 3.1) ● Kilometres of pavements per 100,000 inhabitants (measure 3.2) ● Areas of land, public spaces and sidewalks constructed with cold materials as a percentage of the city area (measure 3.2) ● Number of trees & canopy cover (measures 3.2, 3.3) ● Expropriated areas for public green space (common green areas) per 100,000 inhabitants (measure 3.3) ● Annual expenditures for upgrades and maintenance of city service assets as a percentage of its total budget (measure 3.3).
Monitoring and evaluation planned	<p>As indicated in the 2022 Climate Action Plan (p. 139), to ensure that the Plan is being implemented, regular re-evaluations must be conducted to monitor and assess the effectiveness of actions on the goals set. For this purpose, monitoring teams have been established in the city consisting of representatives of the departments and directorates of the Municipality of Athens involved in the design and implementation of the actions and coordinated by the Department of Resilience & Sustainability of the Directorate of Strategic Planning, Resilience, Innovation and Documentation.</p> <p>To facilitate monitoring, easily measurable, applicable and comparable indicators (Key Performance Indicators - KPIs) have been developed for each of the actions, in line with international standards and specifications, to ensure their correct calculation and transparency. The indicators will be calculated annually to assess the city's progress on climate change issues. The actions of the Plan should be periodically re-evaluated in the light of progress and new scientific evidence.</p>
Governance and Institution(s) implementing the LAP	The Municipality of Athens is the institution responsible for the implementation of the adaptation measures.

Sources of financing	In terms of funding sources, these are mainly European resources, such as the European Regional and Development Fund (ERDF) (through the Partnership Agreement for the Development Framework, Attica Regional Operational Programme), a low interest rate loan of EUR 55 million from the European Investment Bank, the Recovery and Resilience Facility (through the National Recovery and Resilience Plan). Other sources come from the Ministry of Interior, development programmes of ministries, the Green Fund, financial instruments, sponsorships and Public-Private Partnerships (PPPs) ¹¹⁰ .
Synergies with other policies and strategies	In the framework of the Athens Resilience Strategy for 2030 and the 2022 Climate Action Plan, the municipality of Athens takes into consideration: <ul style="list-style-type: none"> • at European level: European Green Deal, EU Sustainable Finance Taxonomy, Recovery and Resilience Facility; • at national level: National Energy and Climate Action Plan (Εθνικό Σχέδιο για την Ενέργεια και το Κλίμα), National Strategy for Adaptation to Climate Change (Εθνική Στρατηγική για την Προσαρμογή στην Κλιματική Αλλαγή); • at regional level: Regional Plans for Adaptation to Climate Change (Περιφερειακό Σχέδιο για την Προσαρμογή στην Κλιματική Αλλαγή)¹¹¹.
Implementation, monitoring and evaluation ¹¹²	
Status of implementation	The measures foreseen in the 2022 Climate Adaptation Plan are already being implemented or are in the process of being implemented.
Progress on the implementation	Elements that have worked well regarding the 2017 Climate Adaptation Plan include: <ul style="list-style-type: none"> • The introduction of a digital citizen service with over 100 different digital services of the Municipality of Athens based on both digital evolution and simplification of the Municipality's internal processes. • The creation of the digital arboretum in the National Garden. For the first time, a digital tree mapping with geographic information system (GIS) of all the trees and shrubs with their characteristics, along with the updating of the topographical map of the Garden has been introduced. • The recent creation of the geospatial mapping of the city's tree rows by the Geospatial Data Department in collaboration with the Municipality of Athens' Computerisation and Operational Units of the Municipality of Athens. It concerns approximately 94,000 trees which were mapped in their entirety. • The management and maintenance of existing green infrastructure through the adoption of relevant management plans. • The participation in research projects aimed at developing innovative tools for assessing the impact of climate change on Europe's urban centres.
Lessons learned from the implementation	The challenges in implementing the measures include: <ol style="list-style-type: none"> i. Lack of political will. Unfortunately, issues relating to the environment and thus climate change are often not a priority among policy- and decision makers in Greece.

¹¹⁰ Interview with a representative of the Municipality of Athens, 17 October 2022.

¹¹¹ More information is available on the website of the Ministry of Environment and Energy: <https://ypen.gov.gr/perivallon/klimatiki-allagi/prosarmogi-stin-klimatiki-allagi/>

¹¹² This part is primarily based on the interview with a representative of the Municipality of Athens, 17 October 2022, unless otherwise indicated.

	<ul style="list-style-type: none"> ii. The need for capacity building. For example, in Greece there is no provision for designing new or renovating old buildings with climate change in mind - often following the patterns of previous decades. iii. Number of cars. The number of cars should be drastically reduced. Cars as well as public transport should be replaced with electric vehicles and there should be respect for public spaces.
Lessons learned from the measurement of performance	According to the representative of the Municipality of Athens, an external evaluation, e.g. every five years, would be useful to monitor and measure the progress of the measures. Evaluation also takes place internally within the Municipality of Athens, but there are difficulties, such as the fact that each measure sets separate objectives and thus separate records and measurements have to be made accordingly.
Additional information	<p>According to the 2022 Climate Adaptation Plan (p. 43), the general quantitative objectives of the Updated Plan relate to:</p> <ul style="list-style-type: none"> • Accessibility and connectivity: 70% of the city's population to have, within a 15-minute walk, access to a green space with ecosystem functions by 2030. • In green spaces and on permeable surfaces: 30% of the city surface to be covered with a) green spaces (tree rows, urban forests, parks, hills, private greenery, green walls and roofs) and/or b) permeable surfaces (earth surfaces, water permeable materials, surfaces with sustainable water management systems) by 2030. <p>The main progress concerns the reduction of GHG emissions and implementation of mitigation measures (such as: support of small businesses in Athens for energy upgrading and energy saving actions; the (partial) replacement of the city's public lighting with LEDs, aiming to provide huge energy and resource savings; energy upgrading of many school buildings; the mapping of all the rooftops of the city and their potential for renewable energy production)¹¹³.</p>

National adaptation strategy (NAS)

Example 1 ¹¹⁴	Greece
Name and date of the NAS	National Strategy for Adaptation to Climate Change (Εθνική Στρατηγική για την Προσαρμογή στην Κλιματική Αλλαγή) from 2016.
Objectives of the NAS	<p>The objectives defined in the NAS (pp. 6-7) include the following:</p> <ol style="list-style-type: none"> 1. The organisation and improvement of the decision-making process (short- and long-term) related to adaptation. 2. Linking adaptation to the promotion of a sustainable development pattern through regional/local action plans. 3. The promotion of adaptation actions and policies in all sectors of the Greek economy with a focus on the most vulnerable. 4. The creation of a mechanism to monitor, evaluate and update adaptation actions and policies. 5. Strengthening the adaptive capacity of Greek society through information and awareness-raising campaigns.
Adaptation measures in	According to the NAS, the sectoral adjustment policies include (pp. 22-73): Agriculture and livestock; Forestry; Biodiversity

¹¹³ Interview with a representative of the Municipality of Athens, 17 October 2022.

¹¹⁴ This part is based on the documents of the adaptation strategy/plan, unless otherwise indicated.

the NAS	and ecosystems; Fisheries; Aquaculture; Water resources; Coastal zones; Tourism; Energy; Infrastructure and Transport; Health; Built environment; Extractive industries; Cultural heritage; and the Insurance sector.
Targets in the NAS	There are no specific quantitative targets defined in the NAS.
Indicators in the NAS	As indicated in the NAS (p. 9), the monitoring of the implementation of the strategy for adaptation to climate change is done through the establishment of a specific monitoring mechanism and the use of appropriate indicators and tools. In this regard, specific indicators are mentioned under each sectoral action (rather than objective), similar output indicators are mentioned under the different sectors. For instance, under Agriculture and livestock, the promotion and dissemination of innovative knowledge is included as one of the actions and the number of programmes and seminars, as well as the number of educational materials produced are considered relevant indicators. For Biodiversity and ecosystems the indicators concern the number of relevant research projects.
Monitoring of the NAS	As explained above, the implementation of the measures is monitored through the application of the different indicators set under each one of the sectoral actions introduced.
Sources of financing in the NAS	As indicated in the NAS (p. 13), the financing of adaptive investments and policies is mainly based on the public investment. In particular, the implementation of adaptive investments depends to a large extent on the ability of the institutions to raise funds from international financial sources (e.g. the European Investment Bank) and European funds.
Assessing progress and performance	As indicated in the NAS (p. 13, p. 93), it is necessary to establish a mechanism to monitor and support the implementation of both the National Strategy and the Regional Plans for Adaptation to Climate Change. However, no specific information regarding the above-mentioned mechanism has been identified.
Synergies with other policies and strategies	As indicated in the NAS (p. 93), for the implementation of the national strategy, the following elements, inter alia, should be taken into account: <ul style="list-style-type: none"> • expanding the knowledge and information base on climate change impacts, • the link of the NAS with the existing framework for natural disaster management, • the integration of the different elements into specific regional action plans and road maps in specific sectors of interest, • exploring specific measures to strengthen the adaptive capacity of institutions and citizens.

Links between LAP and national or European objectives

Example 1¹¹⁵	Athens (Greece)
Role of LRAs as defined in the NAS	As indicated in the NAS (pp. 6, 22), this is a strategic guidance document with the aim of setting guidelines. As such, it does not provide an in-depth analysis of the necessary sectoral policies, nor does it decide on the feasibility of individual adaptation measures and actions at local/regional level, nor does it attempt to prioritise the indicative measures and actions proposed. Moreover, as a strategic document, the NAS does not decide on the feasibility of individual actions and adaptation measures at

¹¹⁵ This part is based on the documents of the adaptation strategy/plan, unless otherwise indicated.

	<p>regional/local level and does not attempt to prioritise the indicative measures and actions proposed both at sectoral and regional/local level. The final selection, prioritisation and timing of appropriate actions and measures constitute the content and substance of the 13 Regional Plans for Adaptation to Climate Change that should be drawn up based on the specificities of each Region.</p> <p>Nevertheless, the link between adaptation and the promotion of a sustainable development strategy through regional/local action plans is one of the main objectives of the NAS. The need for public consultation and discussion among the different stakeholders at both local/regional and national level is also highlighted.</p>
References to the NAS in the LAP	<p>The 2022 Climate Action Plan includes general information regarding the NAS including reference to the main objectives of the NAS, as well as the national targets set in the NAS.</p> <p>There are no specific links made between the local adaptation measures or targets and the national adaptation objectives or measures.</p>
References to EU objectives in the LAP	<p>There is no reference to the EU Adaptation Strategy or Climate-ADAPT in the 2022 Climate Action Plan.</p> <p>Regarding other EU climate objectives or relevant initiatives, the 2022 Climate Action Plan refers to: the European Green Deal, EU Sustainable Finance Taxonomy, and the Recovery and Resilience Facility.</p> <p>As mentioned above, some EU funding will be used to finance the LAP.</p>

Reference list (Athens)

- Athens Resilience Strategy for 2030:
 - English version: https://resilientathens.files.wordpress.com/2017/07/athens_resilience_strategy_-_reduced_pdf-compressed.pdf
 - Greek version: <https://resilientathens.files.wordpress.com/2019/02/100rc-cea3cf84cf81ceb1cf84ceb7ceb3ceb9cebaceae-ce91cebdceb8ceb5cebacf84ceb9cebacf8ccf84ceb7cf84ceb1cf82-.pdf>
- Athens Climate Action Plan (2022 version): <https://www.cityofathens.gr/wp-content/uploads/2022/08/schedio-gia-tin-klimatiki-allagi-9-6-2022.pdf>
- Greek National Adaptation Strategy: https://www.depa.gr/wp-content/uploads/2020/02/06.04.2016-espka-teliko_.pdf
- **Interview** with a representative of the Municipality of Athens, carried out on 17 October 2022.

Flanders (Belgium)

Regional adaptation plan (RAP)

Example 2	Flanders
General information	
Region, Country	Flanders, Belgium
Name of the RAP	Flemish Adaptation Plan 2021-2030 (Vlaams klimaatadaptatieplan 2021-2030)
Date of the RAP	The RAP was approved in October 2022 by the Flemish government
Institution(s) responsible for the RAP	The Flemish Task Force on Adaptation (VTFA) has prepared and coordinated the RAP, while coordinated by the Department Environment of the Flemish government.
If applicable, previous versions	Flemish Adaptation Plan 2013-2020
Additional information	The Flemish Adaptation Plan 2013-2020 was accompanied by a Progress report 2013-2015 and a Progress report 2016-2017 .
Preparation and policy development: Adaptation measures and indicators¹¹⁶	
Objectives	<p>The RAP has defined 6 objectives and 14 action points for climate adaptation. The 6 objectives are:</p> <ol style="list-style-type: none"> 1. The building and connection of green-blue infrastructure: includes a wide range of blue and green natural elements in public space, including urban space (Action point A1 to A3). 2. Water availability and use: these measures are being installed after the more severe droughts of the recent years. Action Point A4 is focused on minimising water usage. 3. Space for water in the function of water safety and drought prevention: water management has to be adaptable to droughts as well as to severe rainfall (A5 to A7). 4. Restoration and climate-resilient management of nature, forest and open spaces: resilience to changes has decreased as the forests have become more fragmented over time. The aim is to have sufficiently large areas and natural corridors that connect them. Also, a more proactive role should be played by private owners and they could be made more aware of the role they could play in protecting nature and its valuable ecosystem services (A8 and A9). 5. Health policy: the direct and indirect impact on public health is addressed. These can be due to prolonged heat, calamities or new emerging diseases (A10). 6. Collaboration and coordination: knowledge exchange between the different Flemish, Federal and European administrations as well as good cooperation between the different levels of government and organisations active in the field (A11 to A14).
Measures	Action points A1 to A3 (S1) are focused on designing green-blue infrastructure in the urban area (A1). For this goal also the

¹¹⁶ This part is based on the documents of the adaptation strategy/plan, unless otherwise indicated.

	<p>policy plan space in Flanders (Beleidsplan Ruimte Vlaanderen) is used. A Climate Portal will also be used to assemble local adaptation measures and tools. A2 includes measures aimed at making the existing and new infrastructure in Flanders climate-robust. Flanders also wants to make it easier, and where possible to take away the barrier of applying for building permits, through faster and better procedures (A3).</p> <p>A4 is about reducing water consumption. This is done with drought risk management plans, a Strategic plan for water supply and circular water use that includes the Vlaanderen Waterproof project.</p> <p>Flanders wants to reduce land take and preserve open space by using hard space functions in the existing designated space, and in this way reduce the pressure on the current open space (A5), and Clearance of high-risk areas and open space (A6). Flanders is one of the most paved areas in the world, and after Malta the most paved of Europe. Flanders wants to avoid paving more, and has trajectories in place to have a reduction of paved area in flood risk areas of 20% by 2050. Several policy plans are in place to ensure water safety (A7).</p> <p>Several nature areas, such as forest, wetlands, peatlands, dunes, swamps and open water are targeted in A8. A9 protects the agricultural sectors, inter alia with an Action Program on Climate Adaptation in Agriculture 2030.</p> <p>A10 focusses on public health measures that have to do with climate-resilient health care, and anticipation of climate-related vectors and diseases that are dependent on certain higher temperatures, or new animal species entering Flanders.</p> <p>In terms of collaboration and coordination, in A11 Flanders works on ways for local governments to have knowledge dispersal and information sharing. There is coordination in the case of calamities (A12), support for the EU-strategy climate adaptation (A13) and monitoring of climate resilience (A14).</p> <p>Driven by recent more visible effects of climate change on Flanders, the following reasons for these specific measures are mentioned in the RAP: higher temperatures and more periods of extreme heat; flooding; droughts and water shortages; rise in sea level at the coast.</p>
Time horizon	The measures are designed for 2021-2030, although some are also embedded in a long-term vision for 2050.
Targets	<p>The measures are generally described in such a way that they are to be completed by 2030. Some measures that are dependent on other plans and projects, such as the river basin management plans 2022-2027, are mentioned as such, but this RAP is designed for 2030.</p> <p>Other clear set goals, such as for example softening of the landscape, are mentioned in other legislation (such as the Local Energy and Climate Pact) and are as follows:</p> <ul style="list-style-type: none"> • 1 m² of softening per inhabitant from 2021 through 2030 (= 6.6 million m² of softening) • Per capita, 1 m³ additional rainwater harvesting for reuse, buffering and infiltration of rainwater from 2021 through 2030 (=6.6 million m³ additional rainwater collected for reuse or infiltration)
Indicators	Indicators have not been drawn up yet. In the End Report ¹¹⁷ on “Elaborating an efficient monitoring system with indicators to measure the progress of the adaptation measures as described in the 2021 - 2030 Climate Adaptation Plan”, the following

¹¹⁷ Flemish Government – Department Environment, 2019, End Report, Elaborating an efficient monitoring system with indicators to measure the progress of the adaptation measures as described in the 2021 - 2030 Climate Adaptation Plan.

	<p>indicator levels are described as desired when monitoring whether the agreements made are fulfilled. These indicators should be objective and self-evaluation should be avoided. Different levels of indicators to be used are:</p> <ul style="list-style-type: none"> • Input indicators, such as budgets and personnel • Process indicators, such as rate of progress • Output indicators, such as number of published reports. <p>A long-list of indicators has been put together in the aforementioned end report. Of these, a list of indicators has been drawn up that are manageable. Eventually, 10 indicators will be extracted from this list and used¹¹⁸.</p>
Monitoring and evaluation planned	<p>With the previous climate adaptation plan, only the progress was measured. In the current plan, the impact will also be measured. This will be done more objectively, based on data and a baseline measurement to start from¹¹⁹.</p> <p>The monitoring of the RAP is described in the above-mentioned end report on “Elaborating an efficient monitoring system with indicators to measure the progress of the adaptation measures as described in the 2021 - 2030 Climate Adaptation Plan”. The intention is to adjust this action plan biennially based on the results of the monitoring. This allows sufficient flexibility in the definition of the action plan in order to deal with any changed context and new insights. This report specifies that there are different levels of learning from the monitoring:</p> <ul style="list-style-type: none"> • Learning Level 1: Indicators for the progress of the implementation of the Flemish Adaptation Plan. For example: budgets earmarked for the action, assigned personnel; • Learning level 2: Indicators for the extent to which the adaptation plan is also effective, i.e. has the objective of increasing Flanders' resilience to the impacts of climate change been achieved? For example: an indication of whether a certain action has been started and possibly completed, or an estimate of the degree of progress of the action (in %); • Learning Level 3: Indicators of the extent to which the adaptation plan continues to provide the right focus and does so in the most appropriate way. For example: the number of reports published, number of consultations on a particular topic, number of stakeholders contacted. <p>Levels 2 and 3 are additional to what was carried out in the previous RAP. In the development phase, most of the focus was put on level 2, where the indicators had to be defined to measure resilience, which at the same time had to correspond with the measures of the adaptation plan. This was done with the help of a pool of stakeholders who were consulted, after which appropriate changes were made to the lists of indicators. The indicators on level 3 depend on independent factors, such as climate change, but also societal changes.</p>
Governance and Institution(s) implementing the RAP	<p>The Flemish government, department Environment. Other authorities and actors (e.g. city/local governments, or certain actors and partners in the private sector) may be responsible for specific measures.</p>

¹¹⁸ Interview with a representative of the Flemish Government – Department Environment, 21 October 2022.

¹¹⁹ Interview with a representative of the Flemish Government – Department Environment, 21 October 2022.

Sources of financing	<p>The financing sources are not mentioned in the RAP itself. In the previous RAP, the policy areas involved were responding to climate change by structurally integrating it with their own policy domain. Therefore, the responsible organisations, such as city/local governments, or certain actors and partners in the private sector (such as the horticulture sector when greening city gardens) would carry out the necessary studies, new initiatives or intensification of existing actions, and fund them according to the necessary efforts.</p> <p>For the current RAP, the budget is released by the Flemish government, and an investment plan will be established with budget allocations. Certain tasks (such as personnel costs) will continue to be borne by other authorities responsible, where appropriate. Nationally, there is no structural funding for climate adaptation, but there are links with other funding, for example the river basin management plans, which do receive budget from the Flemish government¹²⁰.</p> <p>Through the Covenant of Mayors for Belgium (the Belgian version of the EU Covenant of Mayors), local authorities are guided on climate change adaptation in their municipality or city. In terms of financing, three kinds of financing are proposed:</p> <ol style="list-style-type: none"> (1) Linkage through the existing budget; (2) Project grant applications in Europe (the vast majority of the 86 grants is financed by a sub-regional government (namely the Province of East-Flanders), a number of existing EU grants and a relatively small number is financed by the Flanders region); (3) the acquiring of private funding.
Synergies with other policies and strategies	There is not a lot of synergy between the Flemish RAP and national strategies; more synergy is taking place directly between the Flemish RAP and the European level.
Additional information	There are other policies in Flanders on climate: The Flemish Energy and Climate Plan 2021-2030 and the Flemish Climate Strategy 2050.
Implementation, monitoring and evaluation¹²¹	
Status of implementation	<p>Implementation has not started for the 2021-2030 RAP. The exact date of the implementation of the current climate adaptation plan is yet to be decided upon, because of delays in the procedure of getting the Plan approved by the Flemish government.</p> <p>A number of measures are already being implemented: some measures are carried over from the previous Climate Adaptation Plan 2013-2020, such as the realisation of green-blue corridors (measure A1). Other measures come from other plans separate from the Climate Adaptation Plan 2021-2030, such as the Blue Deal and the Sigma Plan.</p>
Experience with the previous RAP	<p>The implementation of the previous climate adaptation plan was evaluated by two progress reports. These reported that most actors take climate adaptation seriously and are incorporating it in their regular work, and this can be seen in the annex of the report, which shows that a vast majority of the measures is ‘on schedule’. This includes measures for nature, such as connecting and enlarging natural areas, and making them more robust, and also for infrastructure, such as research on the impact of the Flemish spatial structure on climate policy.</p> <p>Monitoring took place as to whether the measures were being implemented (which was the case for almost all). The authorities</p>

¹²⁰ Interview with a representative of the Flemish Government – Department Environment, 21 October 2022.

¹²¹ This part is primarily based on the interview with a representative of the Flemish Government – Department Environment, 21 October 2022, unless indicated otherwise.

responsible were assessed on each measure as well as the progress of each measure. It should be noted that the progress was mostly evaluated by the responsible bodies themselves, and that no baseline measurement was being used. This is being improved for the current RAP, which aims to measure impact in addition to progress, and to have a more objective manner of monitoring, relying on data, a baseline, and two more levels of monitoring (as explained above).
The previous plan did not have its own budget from the Flemish government. However, it did determine which entity was responsible for the implementation and therefore the budget. At European level, there is funding for specific projects from funds such as LIFE and Horizon 2020.

National adaptation strategy (NAS)

Example 2¹²²	Belgium
Name and date of the NAS	The Belgian National Climate Change Adaptation Strategy was adopted in 2010. A Belgian National Adaptation Plan 2017-2020 was adopted in 2016.
Objectives of the NAS	In Belgium, the NAS works in an overarching manner. The indicators and measures are aimed at coordinating the process of the RAP that is taking place in the three <i>Gewesten</i> (provinces) of Belgium: Flanders, Wallonia and Brussels ¹²³ .
Adaptation measures in the NAS	The Belgian National Adaptation Plan (NAP) 2017-2020 describes 11 national measures that are being taken (including, where applicable, the budget, the responsible actor and timing of the measure). Most adaptation initiatives will be taken by local, state or federal authorities in the context of their own climate policies. The overarching 11 measures are as follows: <ol style="list-style-type: none"> 1. Elaboration of high-resolution climate scenarios for Belgium, based on the latest available information 2. Development of a roadmap for a Belgian knowledge centre for climate 3. Setting up a national online platform for climate adaptation 4. Strengthening sectoral coordination at national level 5. Taking climate change into account in the risk analysis for invasive alien species 6. Evaluating the impact of climate change on energy security and on transmission and distribution infrastructures for energy 7. Evaluation of the socioeconomic impact of climate change in Belgium 8. Taking into account the impact of climate change and adaptation needs under the future National Environmental Health Action Plan 9. Raising awareness among healthcare professionals about the impacts of climate change on health systems and healthcare, both in the short and long term 10. Promoting transnational cooperation in the area of adaptation

¹²² This part is based on the documents of the adaptation strategy/plan, unless otherwise indicated.

¹²³ Interview with a representative of the Flemish Government – Department Environment, 21 October 2022.

	11. Coordination of preventive, planning and management measures in case of emergencies related to climate change.
Targets in the NAS	In the National Adaptation Plan 2017-2020, targets are described per measure, and in a qualitative manner.
Indicators in the NAS	Indicators are given per measure and include finalising tangible parts such as: <ul style="list-style-type: none"> • the use of scientific evidence and the contribution from CORDEX (an international initiative that coordinates global climate downscaling initiatives on a regional level) for measures 1; • finalising of the measure 2 roadmap; • the creation of the platform for measure 3; • the amount of organised workshops for measure 4; • the amount of evaluations for measure 5; • the creation of a working group and the launch of a study for measure 6; • the results of the analysis of the socio-economic impact for measure 7; • the percentage of projects relevant to the climate-projects that are identified in the National Environmental Health Action Plan for measure 8; • the number of persons enrolled for the training modules; the degree of integration into basic training for measure 9; • the amount of projects on transnational cooperation for measure 10; and • the number of files in which links between prevention and crisis management were made for measure 11.
Monitoring	The "responsible agency" identified for each measure will take the necessary steps for its implementation and monitoring (consultations, studies, budgetary arrangements, planning, monitoring, etc.).
Sources of financing in NAS	The measures that have an allocated budget per measure and a responsible institution. For measure 2, 5, 8, 10 and 11, no budget is allocated, because the measure was not developed far enough at the time of writing, or because the expenses can be included in the regular expenses of the responsible body.
Assessing progress and performance	An interim evaluation took place in 2018 and a final evaluation took place in 2020. The evaluation was reasonably positive: although two measures were cancelled (one of which may still be launched later), the remaining measures were either implemented or slightly behind schedule. One of the measures that had already made good progress in the mid-term evaluation was not continued because of the COVID crisis, among other things. Measure 2 was not implemented, measure 4 was affected by the COVID crisis (events were cancelled), and measure 6 was cancelled due to inaction in the energy sector of Belgium. The degree of implementation covered whether the deadline was respected, whether the budget was respected, and the goal reached.
Synergies with other policies and strategies	On a supranational level, the NAS contributes to the juridical context of the Paris Agreement and previous international agreements, and it fits into the EU strategy on adaptation to climate change.
Additional information	An inter-federal working group will work on a new version of a national adaptation plan in 2022-2023. The federal government also has designed "Federal adaptation measures 2023-2026" which work within the framework of the 2010 Belgian national climate-change adaptation strategy.

Links between the RAP and national or European objectives

Example 2 ¹²⁴	Flanders (Belgium)
Role of the LRAs in the NAS/ NAP	<p>Different actors are responsible for different measures in the NAP. The Federal state and the “gewesten” (one of which is Flanders), are on the same level in the juridical structure, but they are responsible for different domains. Whereas the federal state is responsible for major energy infrastructures and nuclear power, economic regulation, the judicial system, and public finance, the gewesten are authorised in domains pertaining to “space”: e.g. economy, employment, agriculture, water policy, housing, public works, energy, transportation, environment, spatial planning and urban planning, rural renovation, nature conservation.</p> <p>According to the NAP, an important premise of the Flemish adaptation policy is to increase resilience. For certain challenges in the field of adaptation, Flanders will make use of ecosystem services. These and other adaptation measures are robust no-regret measures. They are one of the drivers for technological innovation, while respecting the sustainability principle.</p> <p>Since the Belgian NAP is acting as an umbrella plan, there are no direct links (financial or otherwise) between measures, indicators or objectives between the NAP and the RAP.</p> <p>The progress report of 2016-2020 (for the previous climate adaptation plan) states that Belgium has committed itself to the Paris Agreement, and for the period until 2020 this consisted of EUR 14.5 million per year for Flanders, for adaptation, mitigation, or a combination of goals. The financing was intended to continue after 2020.</p> <p>The NAP also planned to (and has finished) setting up a national online platform for climate adaptation (measure 3).</p>
Reference to the NAS/NAP in the RAP	<p>In the Flemish Climate Adaptation Plan there is no explicit mention of the NAS.</p> <p>The 6th objective in the RAP (collaboration and coordination) is aimed at good communication between Flemish, federal, and European administrations. A Flemish-wide platform for climate resilience and a Flemish knowledge and innovation program for water safety are mentioned in A11 (S6) in the RAP, but they are specifically for Flanders and include no mention of the Belgian ones.</p> <p>Protection against invasive species (measure 5 in the NAP) is mentioned in the RAP in S4 on Restoration and climate-resilient management of nature, forest and open space and also in S5 on Health care policy - but not as a separate measure, as is the case in the NAP.</p>
Reference to EU objectives in the RAP	<p>The RAP mentions the EU Adaptation Strategy, as well as Climate-ADAPT, the European Green Deal, the European Climate and Health Observatory (as part of Climate-ADAPT).</p> <p>The RAP mentions that as a knowledge economy, Flanders supports European and other transnational knowledge-sharing initiatives (S6, A13). A lot of exchange takes place at European level between Flanders and the EU. For example, reporting within the framework of Climate-ADAPT. The exchange of information between member states is also very valuable in</p>

¹²⁴ This part is based on the documents of the adaptation strategy/plan, unless otherwise indicated.

European working groups and through input from the European Environment Agency (EEA). The main source of support at EU-level comes in the form of technical support given by the European Commission and EEA, thus not directly as funding. Facilitating exchange in the delivery of studies, the content of which is very relevant, is considered valuable. The opportunity to exchange information between member states is also appreciated¹²⁵.

Reference list (Flanders)

- Flemish Adaptation Plan 2021-2030: https://omgeving.vlaanderen.be/sites/default/files/2022-10/Vlaams%20Klimaatadaptatieplan%202030_0.pdf
- Progress report 2013-2015: <https://omgeving.vlaanderen.be/sites/default/files/2021-12/Voortgangsrapport%202013-2015%20Vlaams%20Adaptatieplan.pdf>
- Progress report 2016-2017: <https://omgeving.vlaanderen.be/sites/default/files/2021-12/Voortgangsrapport%202016-2017%20Vlaams%20Adaptatieplan.pdf>
- Flemish government – Department Environment, 2019, End Report, Elaborating an efficient monitoring system with indicators to measure the progress of the adaptation measures as described in the 2021 - 2030 Climate Adaptation Plan. (*the publication was available for download on the website of the [Flemish Energy and Climate Agency](#) in October 2022*).
- Belgian National Climate Change Adaptation Strategy: <https://publicaties.vlaanderen.be/view-file/7231>
- Belgian National Adaptation Plan 2017-2020: https://klimaat.be/doc/NAP_NL.pdf
- Interim evaluation of the National Adaptation Plan: https://klimaat.be/doc/Nationale-Adaptatie-Plan_Mid-term-evaluatie_2017-2018.pdf
- Final evaluation of the National Adaptation Plan: <https://klimaat.be/doc/klimaatadaptatieplan-2017-2020-eindevaluatie.pdf>
- **Interview** with a representative of the Flemish Government – Department Environment, held on 21 October 2022.

¹²⁵ Interview with a representative of the Flemish Government – Department Environment, 21 October 2022.

Kielce (Poland)

Local adaptation plan (LAP)

Example 3	Kielce
General information	
City, Country	Kielce, Poland
Name of the LAP	Climate Adaptation Plan for the city of Kielce until 2030 (Plan Adaptacji do zmian climates Miasta Kielce do roku 2030)
Date of the LAP	17 October 2019 (annex to the resolution adopted by the Kielce City Council)
Institution(s) responsible for the LAP	The Mayor of the City of Kielce, through the Department of Municipal Economy and Environment, supervises the implementation, execution and monitoring of the activities included in the Plan. An interdisciplinary Steering Group was appointed to coordinate the implementation of the Plan. Various departments in the City Office define and select for implementation tasks that are part of the activities resulting from the Plan. A unit responsible for its implementation has been assigned to each activity ¹²⁶ .
Additional information	The "Climate Adaptation Plan for the City of Kielce until 2030" was created as part of the project "Development of adaptation plans to climate change in cities with more than 100,000 inhabitants" implemented by the Ministry of the Environment in cooperation with 44 cities. The project was supported by EU funding within the framework of the Operational Programme Infrastructure and Environment ¹²⁷ .
Preparation and policy development: Adaptation measures and indicators¹²⁸	
Objectives	Overarching objective: Increasing the quality of life for citizens, and efficient functioning of the city of Kielce in the conditions of climate change. The Strategic Objectives (p. 57) are as follows: <ul style="list-style-type: none"> • Integration of climate adaptation in the development policy of the city; • Strengthening the use of green urban areas in alleviating the impact of climate change; • Increasing resilience of the city to extreme meteorological and hydrological phenomena; • Ensuring the safety of citizens in situations of extreme phenomena related to climate change; • Improvement of the functioning of public service infrastructure in the face of climate change.
Measures	The Adaptation Plan identifies three categories of measures (p. 59): <ul style="list-style-type: none"> • Organisational activities - changes in local law in the field of, for example, spatial planning, organisation of public space, creating guidelines for dealing with situations of climatic threat, improvement of the functioning of municipal services

¹²⁶ Written feedback obtained on 21 October 2022 from the Municipality of Kielce - Department of Municipal Economy and Environment.

¹²⁷ Written feedback obtained on 21 October 2022 from the Municipality of Kielce – Department of Municipal Economy and Environment.

¹²⁸ This part is based on the documents of the adaptation strategy/plan, unless otherwise indicated.

or systems for danger warnings.

- Information and education activities - activities supporting and increasing social climate awareness and promoting good adaptation practices. These help to increase the resilience of the city and its inhabitants through appropriate education programmes and intensified information activities.
- Technical activities – investment activities, including the construction or modernisation of the existing infrastructure that helps to protect the city from the negative effects of climate change.

The measures are organised according to the strategic objective, with ten measures attributed to objective 1, six measures attributed to objective 2, five measures attributed to objective 3, four measures attributed to objective 4, and one measure attributed to objective 5. The complete list of measures is as follows:

- Strategic Objective 1. Including adaptation to climate change in the city development policy
 - Measure 1.1. Giving an Adaptation Plan the rank of a strategic document
 - Measure 1.2. Inclusion of updated climate change forecasts in the city's strategic and planning documents
 - Measure 1.3. Assessment of the effectiveness of the implementation of adaptation measures
 - Measure 1.4. Development and implementation planning/urban guidelines on shaping public space
 - Measure 1.5. Development and implementation of needs-based guidance on adaptation to climate change in public procurement
 - Measure 1.6. Including adaptation to climate change in a strategy to solve social problems
 - Measure 1.7. Develop a tourism development strategy including adaptation to climate change
 - Measure 1.8. Building a cooperation network for the implementation of the Adaptation Plan
 - Measure 1.9. Appointment of a unit coordinating the implementation of the Adaptation Plan in Kielce
 - Measure 1.10. Protection of urban ventilation corridors.
- Strategic Objective 2. Strengthening the use of greenery functions in mitigating the effects of climate change
 - Measure 2.1. Inventory of urban greenery and development of a program for the construction of blue and green infrastructure in the city
 - Measure 2.2. Construction of a blue-green infrastructure system in green areas in the city and in public spaces
 - Measure 2.3. Development of a universal Catalogue of Good Practices in the field of blue-green infrastructures
 - Measure 2.4. Promotion of the Catalogue of Good Practices and ecological models of behaviour
 - Measure 2.5. Revitalisation of the city's public spaces, taking into account the blue and green infrastructure in the revitalised areas
 - Measure 2.6. Development of the ritual, recreational and educational infrastructure of the Geopark in Kielce
- Strategic Objective 3. Increasing the city's resilience to extreme meteorological and hydrological phenomena (floods, droughts, heatwaves)
 - Measure 3.1. Building a system for optimising water consumption and protecting underground water resources in the city

	<ul style="list-style-type: none"> ○ Measure 3.2. Reconstruction of the existing underground water resources and construction of new drainage systems for rainwater allowing for the management of rainwater in the place after standing up or its retention ○ Measure 3.3. Construction of a blue and green infrastructure in the field of rainfall water management ○ Measure 3.4. Expansion of flood protection of the city of Kielce ○ Measure 3.5. Restoration of biologically active surfaces by limiting impermeable surfaces in the city or unsealing them ● Strategic Objective 4. To ensure the safety of residents in the event of extreme phenomena related to climate change <ul style="list-style-type: none"> ○ Measure 4.1. Conducting an information campaign on the effects of extreme weather events and protection against them, including those relating to the city of warning systems ○ Measure 4.2. Collecting data on threats related to climate changes and their effects, and building a meteorological monitoring system ○ Measure 4.3. Expanding the system of informing residents about the threats of weather conditions, and building an information system for residents relating to the air quality in the city ○ Measure 4.4. Infrastructure modernisation - emergency services ● Strategic Objective 5. Improving the functioning of public service infrastructure in the face of climate change <ul style="list-style-type: none"> ○ Measure 5.1. Network expansion and replacement of public transport rolling stock.
Rationale for selection of the measures	<p>Adaptation measures will help the city to adapt to climate change by reducing the vulnerability of the areas recognised as the most vulnerable: public health (including particularly sensitive social groups), water management, spatial management and biodiversity. In order to achieve the synergy effect, action is needed in various areas of the functioning of the city - its organisation, education, provision of information and warnings, as well as regarding technical solutions in the city space (p. 59). Adaptation measures were developed during working meetings of a team consisting of representatives of individual departments of the City Office of Kielce and organisational units subordinate to the Mayor, as well as representatives of the Institute of Environmental Protection, which drafted the Plan.</p> <p>The team members developed proposals for activities in the departments/units which they represented. These actions were then analysed and the team selected those that were included in the Plan of Adaptation.</p>
Time horizon	2019-2030
Targets	<p>Most of the indicators as described below are quantitative but there are no specific timebound quantitative targets set for each of them – the Plan indicates that it is expected that some of them will increase (e.g. in terms of the number of retention reservoirs built or educational activities implemented) or decrease (e.g. consumption of water per inhabitant). Only one indicator specifies a quantitative target – this refers to the number of documents to be created, i.e. the catalogue of good practices regarding blue and green infrastructure.</p> <p>The planned measures pertaining to each specific objective have time horizons specified (e.g. to be achieved by 2023 or by 2030), which can be seen as a timebound target for implementation of the measures.</p>
Indicators	Information on progress in implementation of the Plan is gathered according to categories of activities (education and information, organisational activities, and technical activities) and type of information (p. 81). The information to be reported

includes the number of activities which have been: initiated; planned; implemented, or are under implementation. Furthermore, the total cost of the activities, own expenditures and expenditures covered from external sources should be reported.

Indicators for the evaluation of progress (p. 81) are formulated specifically for each strategic objective, as follows:

For Objective 1. Integration of climate adaptation in the development policy of the city:

- share of decisions on land management and construction permits with minimum percentage of biologically-active surface in all decisions on land management (>10% in municipal and industrial areas, >30% in living district areas, >50% in one-family house areas, >80% in areas of potential green and blue infrastructure);
- share of decisions on land management and construction permits in built-up areas which ensure possibility to implement green or blue infrastructure in the total number of decisions on land management;
- share of green public procurement in the total number of procurement actions;
- areas covered by local land management plans;
- green municipal areas covered by local land management plans;
- areas covered by local land management plans which have the main goal of safeguarding nature for creation of green and blue infrastructure;
- Number of strategic and planning documents which have been updated to take climate adaptation into account.

For Objective 2. Strengthening the use of green urban areas in alleviating the impact of climate change:

- Area covered with green infrastructure following City initiatives;
- Number of squares and places transformed into so-called “climate places” following City initiatives;
- Catalogue of good practices in the area of green and blue infrastructure;
- Share of citizens living within the range of over 300 metres distance from municipal recreational green areas in total number of citizens.

For Objective 3. Increasing resilience of the city to extreme meteorological and hydrological phenomena:

- Number of constructed or modernised water retention reservoirs;
- Number of investments implemented by the City concerning modernisation of sewerage network in order to use or store rainwater;
- Water consumption per inhabitant;
- Number of buildings owned by the City and its organisational units which have rain gutters disconnected from the sewerage network.

For Objective 4. Ensuring the safety of citizens in situations of extreme phenomena related to climate change:

- Number of interventions of fire brigade due to climate conditions (heavy rain, heavy wind, flood, lightning);
- Number of households and citizens who incurred damage due to extreme phenomena related to climate change;
- Financial outlays for removal of the consequences and prevention of damage related to extreme weather phenomena per 1,000 inhabitants;

	<ul style="list-style-type: none"> • Number of educational activities carried out by the City and its organisational units concerning adaptation to climate change/number of participants in such educational activities. <p>For Objective 5. Improvement of the functioning of public service infrastructure in the face of climate change:</p> <ul style="list-style-type: none"> • Share of buses using alternative fuel in the total number of public uses of public transport. <p>Furthermore, for the overarching goal, the City government will administer public opinion polling to check the opinions of the citizens regarding:</p> <ul style="list-style-type: none"> • Quality of life and comfort of living in the City; • Level of climate awareness including climate change and climate adaptation. <p>Furthermore, because of the potential impact of some of the adaptation activities on environment, a set of monitoring indicators has been proposed to capture these aspects:</p> <ul style="list-style-type: none"> • In the area of biodiversity: the number of trees and area of bushes removed for the needs of adaptation activities; area of green and blue infrastructure. • In the area of citizens' health and living conditions: perception of comfort of living in the City (public opinion polling). • In the area of land and soil: area of organic soil lost; areas where biological functions of soil have been restored. • In the area of water: quality of water in water courses receiving water from the City's rainwater network; • In the area of air pollution: exceedances of the standards regarding ozone and particles. • In the area of cultural heritage and landscape: evaluation of the quality of urban areas by citizens and tourists (public opinion polling).
Monitoring and evaluation planned	<p>Monitoring is carried out by an administrative unit appointed by the President of the City. Monitoring of the progress in implementation is carried out biannually based on the above-mentioned categories.</p> <p>Evaluation of the progress in implementation of the Plan is carried out according to the information required for monitoring – as indicated in the categories and indicators presented in the Plan. Both on-going and ex-post evaluation is carried out.</p> <p>In February 2022, a report on implementation of the Plan was published, which presents the results of activities undertaken in 2020 and 2021.</p>
Governance and Institution(s) implementing the LAP	<p>The City Council of Kielce is the main implementing authority for the Plan. Other institutions involved include:</p> <ul style="list-style-type: none"> • Geopark Kielce (Centre for Geo-education) • Kielce Fire Brigade Unit • Heating Energy Enterprise in Kielce • Municipal Centre for Family Assistance in Kielce • Municipal Centre for Sport and Recreation • Municipal Road Administration • Municipal Transport Company • Kielce Water Enterprise

	<ul style="list-style-type: none"> • Voivodeship Inspectorate for Environmental Protection • Polish Waters, Regional Directorate for Water Management in Kraków, water basin administration in Kielce. <p>Other stakeholders involved encompass civil society organisations active in the field of environmental protection and protection of vulnerable social groups, as well as scientists and entrepreneurs (p. 77).</p>
Sources of financing	<p>The total cost of the implementation of the Plan amounts to around EUR 103 million. This is a maximum amount which can be allocated to all of the City’s planned activities, including own budget and external sources.</p> <p>Sources of financing listed include EU funds, international funding, national and regional financing sources. Among the EU funds, the Plan lists the ERDF and the Cohesion Fund, LIFE, and Horizon Europe. The Norwegian Financial Mechanism and European Economic Area Mechanism are potential international financing sources mentioned, and the National Fund for Environmental Protection and Water Management as well as the Voivodeship fund for Environmental Protection and Water Management are listed among the national and regional sources of funding.</p> <p>According to the Plan, continuous financing is expected thanks to the policies at EU- and national level which clearly support activities devoted to climate protection and adaptation. The activities are supported mainly from the City budget. Such funds are secured during the preparation of the annual budget. Funds from the Regional Fund for Environmental Protection and Water Management in Kielce were obtained for some of the activities, in particular for the preparation of the Catalogue of Good Practices. Furthermore, expansion of the Geopark Kielce was financed with the support of EU funding. Several other investments will be supported by the Regional Operational Programme for Świętokrzyskie Voivodeship, including construction of retention reservoirs and blue and green infrastructure elements¹²⁹.</p>
Synergies with other policies and strategies	<p>The Plan for Kielce refers also to other Polish strategic documents, in particular to the strategy of spatial management of the country, which encompasses two political objectives relating to climate adaptation: 1) shaping special structures supporting maintenance of high-quality natural environment and landscape and 2) increasing the resilience of spatial structures to natural risks.</p> <p>Conducting a series of trainings, workshops and meetings related to the subject of climate change expands the knowledge, especially of the elderly, of threats and dangers related to these changes, including in the context of health, and influences the shaping of appropriate attitudes and behaviour in the event of both heatwaves and very low temperatures, torrential rain, winds, and storms. Implementation of activities related to the retention of rainwater and its retention in the related catchment area is aimed at preventing droughts in the area, protecting biodiversity, and will also improve the microclimate¹³⁰.</p>
Implementation, monitoring and evaluation¹³¹	
Status of implementation	Implementation of the Plan’s activities started at the end of 2019, soon after the adoption of the Plan (in October 2019).
Progress on the	Assessment of the progress in implementing the Plan will be made every two years on the basis of information collected from

¹²⁹ Written feedback obtained on 21 October 2022 from the Municipality of Kielce – Department of Municipal Economy and Environment.

¹³⁰ Written feedback obtained on 21 October 2022 from the Municipality of Kielce – Department of Municipal Economy and Environment.

¹³¹ This part is primarily based on the written feedback obtained on 21 October 2022 from the Municipality of Kielce - Department of Municipal Economy and Environment, unless otherwise indicated.

<p>implementation and monitoring</p>	<p>individual units. At the beginning of 2022, the implementation review for the years 2020-2021 was carried out for the first time. The results of the review create a benchmark for assessing progress in the coming years. Progress towards the targets is monitored according to the indicators set out in the Plan. The implementation report provides the following information regarding each indicator, structured according to the strategic objectives and measures:</p> <ul style="list-style-type: none"> • Value of the indicator • Value achieved (for most indicators in terms of increase/decrease; for the indicators regarding the share of decisions on land management and construction permits fulfilling certain criteria, the report for 2020/2021 sets the base value) • Total cost of activities per measure • Costs incurred from own budget • Costs covered by other financing sources • Status of implementation (implemented/in the course of implementation/planned but not implemented) • Implementation deadline • Organisational unit responsible. <p>The results achieved so far are described in the implementation report. Some measures have been evaluated as ‘achieved’. These are, for example, measures aimed at including updated forecasts of climate change in planning documents (Strategic Objective 1) and planting trees and other plants (Strategic Objective 2) as well as several measures pertaining to Strategic Objective 3, such as modernisation of the water provision network, construction of sewers and provision of rainwater reservoirs to public institutions.</p>
<p>Lessons learned from the implementation</p>	<p>It was a significant challenge for all units indicated in the Plan to accept the fact that they are all responsible for the implementation of the activities set out in the document. The biggest challenge, however, is to obtain funds for the implementation of these activities.</p> <p>In terms of what worked well, various adaptation measures have been implemented with the support of inhabitants. Concerning rainwater management, the following tasks have proven successful:</p> <ul style="list-style-type: none"> • The project "Catch the rain". One part of this project was equipping public facilities with rainwater tanks (27 units subordinate to the Mayor of Kielce were equipped with tanks for collecting rainwater; 36 tanks with a capacity of 200 to 400 litres were installed). Another aim of the project was to familiarise children, adolescents and the elderly with rational management of water resources, consisting of retaining and collecting as much rainwater as possible where it falls, and enabling its later use inside and outside the building (e.g. for watering green areas). • Providing subsidies to inhabitants in order to: <ol style="list-style-type: none"> 1) purchase and install tanks to collect rainwater; 2) purchase and install underground tanks to collect rainwater and snowmelt; 3) construct retention and drainage reservoirs and drainage systems;

	<ul style="list-style-type: none"> 4) construct rain gardens; 5) construct an open reservoir (e.g. a pond) together with a system collecting rainwater and snowmelt from the property area, supplying this reservoir; 6) purchase and install a water supply system to the reservoir, cut off the water supply to the reservoir when it is overfilled and install devices enabling water intake from the reservoir. <ul style="list-style-type: none"> • Projects of greening the city, creating new green areas, and prevention of soil sealing has been met with very positive feedback from the city inhabitants.
Lessons learned from the measurement of performance	<p>The monitoring follows the initial methodology and uses the prescribed indicators, but at the same time it evolves over time, with new indicators being created.</p> <p>The work on the first implementation report has shown that the implementation of the activities included in the Plan requires extensive involvement of the different departments of the City administration, various units subordinate to the President, plus other units and services engaged. During the preparation of the Report, there were proposals to introduce new indicators. The number of the completed tasks was linked to the financial possibilities and constraints.</p>
Lessons learned in relation to financing	<p>The progress in implementation of the adaptation measures is strongly related to the available budget. The city's financial capacity for financing tasks related to adaptation to climate change was a challenge.</p> <p>The tasks carried out so far and the planned tasks will not be profit-generating tasks. Only the expansion of the water supply networks will bring income to the Kielce water management company - most likely a part of this income will be used for its maintenance.</p> <p>The main source of financing of the measures is the City budget. Some measures are co-financed from other sources of financing, such as national and EU funding. Further financing depends on the strategy of each implementation unit which will be adopted if certain sources become unavailable. The infrastructure built with the support of external funds will be maintained by the managers of the infrastructure, e.g. by the water management company.</p>

National adaptation strategy (NAS)

Example 3 ¹³²	Poland
Name and date of the NAS	The Strategic plan of climate adaptation for sectors and areas vulnerable to climate change up to 2020, with a perspective until 2030 (<i>Strategiczny plan adaptacji dla sektorów i obszarów wrażliwych na zmiany klimatu do roku 2020, z perspektywą do roku 2030</i>) was adopted by the Polish Ministry of Environment in October 2013. Since then, no new climate adaptation strategy has been adopted. The adaptation strategy for Kielce refers to this document.
Objectives of the NAS	The Plan's principal objective is to ensure sustainable development and efficient functioning of the economy and society in climate change conditions. The Plan formulates the following specific objectives:

¹³² This part is based on the documents of the adaptation strategy/plan, unless otherwise indicated.

	<ol style="list-style-type: none"> 1. Ensuring energy safety and good state of environment 2. Effective climate adaptation in rural areas 3. Development of transport in climate change conditions 4. Ensuring sustainable regional and local development in the conditions of climate change 5. Stimulation of innovation supporting climate adaptation 6. Shaping social awareness and attitudes supporting climate adaptation. 																										
Adaptation measures in the NAS	<p>Each specific objective is divided into more detailed goals which imply a range of activities/measures that are listed in the Plan. For every detailed goal there is a priority activity identified, accompanied by several other activities. Priority measures are listed in the table below.</p> <table border="1"> <thead> <tr> <th>Detailed goal</th> <th>Priority activity</th> </tr> </thead> <tbody> <tr> <td>Adjustment of water management to climate change</td> <td>Reforming water management structure, taking climate adaptation needs into account</td> </tr> <tr> <td>Coastal zone adaptation</td> <td>Taking into account actual and potential increase of the sea level and flood risk, in investment plans in coastal areas</td> </tr> <tr> <td>Adjustment of energy sector to climate adaptation</td> <td>Preparation of the energy system in relation to changed conditions, taking into account increased use of energy in winter and summer</td> </tr> <tr> <td>Biodiversity protection and forestry management in the context of climate adaptation</td> <td>Preparation of strategies and protection plans taking climate change into account.</td> </tr> <tr> <td>Climate adaptation in spatial management and the construction sector</td> <td>Preparation of management rules for construction, including construction of public buildings, in areas that are vulnerable to the risk of flooding and for green areas in cities and in the coastal zone.</td> </tr> <tr> <td>Ensuring an effective health protection system in the context of climate adaptation</td> <td>Limiting health impacts on vulnerable groups of the population in relation to thermal stress and extraordinary climate events</td> </tr> <tr> <td>Creation of a local system of monitoring and warning about climate-related risks</td> <td>Development of monitoring and early warning systems regarding impacts of climate change on agricultural production</td> </tr> <tr> <td>Organisational and technical adjustment of agricultural and fishing activities to climate change</td> <td>Investment support to farms, training and advisory services, taking into account the need to adjust agricultural production to increased climate risk</td> </tr> <tr> <td>Preparation of construction standards taking climate change into account</td> <td>Taking into account changed climate conditions in the process of design and construction of transport infrastructure</td> </tr> <tr> <td>Transport network management in climate change conditions</td> <td>Revision or creation of plans aimed at maintaining functionality of transport networks or changing the existing networks and providing alternative transport modes</td> </tr> <tr> <td>Monitoring of environment and early warning systems in the context of climate change (cities and rural areas)</td> <td>Preparation of risk management strategies on national, regional and local level, taking into account climate adaptation needs</td> </tr> <tr> <td>Urban spatial policy addressing climate change</td> <td>Taking into account the necessity of increasing green areas, water reservoirs, ventilation corridors, and preferred method of heating buildings.</td> </tr> </tbody> </table>	Detailed goal	Priority activity	Adjustment of water management to climate change	Reforming water management structure, taking climate adaptation needs into account	Coastal zone adaptation	Taking into account actual and potential increase of the sea level and flood risk, in investment plans in coastal areas	Adjustment of energy sector to climate adaptation	Preparation of the energy system in relation to changed conditions, taking into account increased use of energy in winter and summer	Biodiversity protection and forestry management in the context of climate adaptation	Preparation of strategies and protection plans taking climate change into account.	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	Promotion of innovation in organisation and management activities aligned with climate adaptation	Preparation of procedures regarding cooperation of services and institutions in order to address the needs related to reacting to multidimensional climate change risks
	Strengthening the system of support for Polish innovative technologies aligned with climate adaptation	Analysis of the Polish potential to develop and implement innovative climate adaptation technologies
	Increasing awareness regarding risks of extreme phenomena and methods to limit their consequences	Education and awareness-raising regarding climate change and methods to minimise their consequences, impact of invasive species and the necessity of saving resources, in particular water
	Protection of social groups which are particularly vulnerable to the consequences of damaging climate-change related phenomena	Preparation of comprehensive solutions in the area of state aid granted to compensate damages following natural disasters, and development of insurance systems covering climate change-related risks
Targets in the NAS	Specific targets are provided in the chapter related to monitoring (p. 50). Monitoring indicators are provided together with baseline values and with the values expected in 2020.	
Indicators in the NAS	<p>The following indicators are included:</p> <p>Specific Objective 1: Ensuring energy safety and good state of environment</p> <ul style="list-style-type: none"> • Afforestation level of the country • Share of area covered by spatial management plans • Existence of flood risk management plans • Existence of maps of landslide risks <p>Specific Objective 2: Effective climate adaptation in rural areas</p> <ul style="list-style-type: none"> • Existence of a monitoring system for tracking the impact of climate conditions on agricultural production, including early warning on consequences of climate change <p>Specific Objective 3: Development of transport in climate change conditions</p> <ul style="list-style-type: none"> • Existence of monitoring systems taking into account the vulnerability of transport infrastructure to changes in climate conditions, including a warning system for technical services <p>Specific Objective 4: Ensuring sustainable regional and local development in climate change conditions</p> <ul style="list-style-type: none"> • Existence of plans for climate adaptation for cities with over 100,000 inhabitants <p>Specific Objective 5: Stimulation of innovation supporting climate adaptation</p> <ul style="list-style-type: none"> • The number of Polish environmental technologies supporting climate adaptation and verified within the Environmental Technology Verification system <p>Specific Objective 6: Shaping social awareness and attitudes supporting climate adaptation</p> <ul style="list-style-type: none"> • Household water consumption per capita in cities [m³/year]. 	
Monitoring	The Plan states that the monitoring of the Plan's implementation will be carried out by the Ministry of Environment based on the indicators as presented above. However, no implementation reports of the Plan have been identified through desk research.	

Sources of financing in the NAS	Financing sources are listed as follows (p. 53):	
	Type	Sources
	Public-national	National Fund for Environmental Protection and Water Management; voivodeship funds for environmental protection and water management; self-government own resources; incomes from selling AAU (Assigned Amount Unit – carbon trading), state budget
	EU funding 2014-2020	National and regional operational programmes; LIFE; instruments for sustainable urban development
	International	World Bank; International Monetary Fund; other
	Private – national and foreign	Entrepreneurs, including SMEs; associations
	Other	Commercial banks; Foundations; investment funds, including venture capital and private equity
	Long-term financing is not described in the document. The Plan provides only a general framework for financing, without providing estimates of the total costs or indication of the amounts to be provided by various types of financing sources. Losses related to not undertaking climate adaptation actions are estimated at PLN 86 billion in the years 2011-2020 (equivalent to 0.49% of the Polish GDP) and PLN 120 billion (0.52% of the Polish GDP) in the years 2021-2030.	
Assessing progress and performance	The Plan states that the monitoring will be performed by the Ministry of Environment according to the monitoring indicators as listed. Adaptation actions have also been indicated in other Polish strategic policy documents and therefore, their monitoring will be carried out on the basis of these strategies.	
Synergies with other policies and strategies	The Plan stresses links between the Plan and other strategic documents at various levels of administration. Many activities will be implemented on regional and local levels and will require engagement of various stakeholders on all levels, including national authorities, regional and local authorities as well as entrepreneurs.	
Additional information	The document was prepared by the Ministry of Environment on the basis of analyses performed by the Institute for Environmental Protection within the framework of the project KLIMADA implemented in the years 2011-2013 and financed from the National fund for Environmental Protection and Water Management.	

Links between LAP and national or European objectives

Example 3 ¹³³	Kielce (Poland)
Role of the LRAs in the NAS	<p>Regional self-governments will have to incorporate the guidelines from the Plan in their strategic documents and operational activities, adjusting them to the environmental, social and economic regional conditions.</p> <p>The NAS lists preparation and implementation of climate adaptation plans as well as monitoring of their progress are among key horizontal activities (p. 49).</p> <p>Among the actions in the area “urban spatial policy taking into account climate change” the NAS recommends including aspects</p>

¹³³ This part is based on the documents of the adaptation strategy/plan, unless otherwise indicated.

	<p>such as: creation of local adaptation plans, modernisation and proper functioning of sewage infrastructure, implementation of innovative solutions in construction and infrastructure, and development of green urban space.</p> <p>The NAS does not specify how progress from local/regional adaptation measures will be taken into account.</p> <p>In principle, the same financing sources as the ones listed in the NAS can be used for the LAS, local authorities and their subordinate institutions must find the best ways to combine the available financing sources and use them to support their priorities.</p>
Reference to the NAS in the LAP	<p>Preparation of the adaptation plan for Kielce reflects the need for climate adaptation in cities, which is underlined in the NAS – this is explicitly stated in the section of the Plan for Kielce devoted to links with other strategies and plans.</p> <p>The NAS was prepared at high policy-level, with specific chapters devoted to various sectors of the economy (water management, transport, agriculture etc.). Some links between the measures recommended to the LAS in the NAS can be made (for example, management of flood risk measures recommended in the NAS are reflected in the strategic goal of the LAS with regard to ensuring safety in situations of extreme weather phenomena) but there is no direct reference and there are no identical measures.</p> <p>The Plan for Kielce was developed within the framework of the project which implements Strategic Objective 4.2 of the NAS: spatial policy in cities taking into account climate adaptation, activity 4.2.1: Preparation of municipal adaptation plans taking management of rainwater into account (or including the climate adaptation component in other strategic documents).</p> <p>The report on the implementation of the measures set out in the Kielce Adaptation Plan was sent to the Ministry of Climate and Environment. How local progress will be taken into account in the progress of the implementation of the national strategy is up to the institution supervising the implementation of the national strategy¹³⁴.</p> <p>Each institution involved in the implementation of the activities covered by the Plan uses various sources of financing. In the Implementation Report, the institutions did not divide the funding into domestic and foreign funds, so it is impossible to say to what extent national-level funding sources were used¹³⁵.</p>
Reference to EU objectives in the LAP	<p>No links are made to the EU Adaptation Strategy or Climate-ADAPT. Links are only made to national and regional strategic documents. However, it is mentioned that the national strategy implements EU priorities, which follow the recommendations on climate adaptation formulated by the UNFCCC.</p> <p>EU funds are some of the possible sources for financing the LAP.</p>

Reference list (Kielce)

- Climate Adaptation Plan for the city of Kielce until 2030: http://www.um.kielce.pl/gfx/kielce2/userfiles/files/srodowisko/plan_zmian_klimatu/2019_0351_zal.pdf

¹³⁴ Written feedback obtained on 21 October 2022 from the Municipality of Kielce - Department of Municipal Economy and Environment.

¹³⁵ Written feedback obtained on 21 October 2022 from the Municipality of Kielce - Department of Municipal Economy and Environment.

- Report on the implementation of activities resulting from the Climate Adaptation Plan for the City of Kielce until 2030, (February 2022): <https://bipum.kielce.eu/urząd-miasta-kielce/dokumenty-strategiczne-i-programy/srodowisko/plan-adaptacji-do-zmian-klimatu-miasta-kielce-do-roku-20230.html>
- Polish National Adaptation Strategy: https://bip.mos.gov.pl/fileadmin/user_upload/bip/strategie_plany_programy/Strategiczny_plan_adaptacji_2020.pdf
- **Written feedback** obtained on 21 October 2022 from the Municipality of Kielce - Department of Municipal Economy and Environment.

North Rhine-Westphalia (Germany)

Regional adaptation plan (RAP)

Example 4	North Rhine-Westphalia (Germany)
General information	
Region, Country	North Rhine-Westphalia (NRW), Germany
Name of the RAP	“North Rhine-Westphalia climate protection plan - climate protection and climate change adaptation” (Klimaschutzplan Nordrhein-Westfalen - Klimaschutz und Klimafolgenanpassung)
Date of the RAP	2015. The NRW state parliament adopted the strategy in early 2016 ¹³⁶
Institution(s) responsible for the RAP	Ministry of North Rhine-Westphalia (NRW) for climate protection, environment, agriculture, nature conservation and consumer protection (<i>Original: Ministerium für Klimaschutz, Umwelt, Landwirtschaft, Natur- und Verbraucherschutz des Landes Nordrhein-Westfalen</i>)
If applicable, previous versions	Based on a synthesis of evidence “Adaptation to climate change - a strategy for North Rhine-Westphalia” (Anpassung and den Klimawandel – eine Strategie fuer Nordrhein-Westfalen) from 2009
Additional information	December 2020: NRW adopted the first climate adaptation law in Germany ¹³⁷
Preparation and policy development: Adaptation measures and indicators¹³⁸	
Objectives	With the measures, the NRW government aims to achieve several objectives. Their importance varies from field of action to field

¹³⁶Press release ‘Umsetzung Klimaschutzplan NRW gestartet‘ 22/01/2016, available at: <https://www.land.nrw/pressemitteilung/umsetzung-klimaschutzplan-nrw-gestartet#:~:text=Klimaschutzplan%20ist%20Fahrplan%20f%C3%BCr%20Klimaschutz%20made%20in%20NRW&text=So%20sollen%20die%20Treibhausgasemissionen%20in,im%20Vergleich%20zum%20Basisjahr%201990>

¹³⁷ Press release ‘Kabinett beschließt verschärftes Klimaschutzgesetz und bundesweit erstes Klimaanpassungsgesetz‘ available at: <https://www.land.nrw/pressemitteilung/kabinett-beschliesst-verschaerftes-klimaschutzgesetz-und-bundesweit-erstes>

¹³⁸ This part is based on the documents of the adaptation strategy/plan, unless otherwise indicated.

	<p>of action depending on the exposure to climate change. The broader objectives are:</p> <ul style="list-style-type: none"> • Fill knowledge gaps • Inform and raise awareness • Complement planning and regulatory frameworks • Initiate action, provide assistance and reduce existing vulnerabilities of institutions and enterprises • Create structures and networks • Foster stability and resilience of nature and ecosystem services • Make built infrastructure (Housing etc.) more resilient.
Measures	<p>Overall, there are 66 measures within 13 sectorial and 3 horizontal fields of intervention. The structure of the fields of intervention is based on the national German adaptation strategy. The horizontal/cross-sectorial fields are: Information, education, and networks; Urban planning and development; Regional planning.</p> <p>The sectorial fields of intervention include a range of economic sectors (energy, agriculture, tourism, industry), infrastructure, transport, and housing, segments of the natural environment (soil, water, human health) and disaster relief. The number of measures varies from one field to another. Each measure is described with a title, a short problem statement, objective, instrument, actors. Moreover, the measures are prioritised (cat. 1, 2 & 3).</p> <p>All measures are directed to the regional government (self-commitment) and cover a broad range of actions, among others counselling/advice to local-level actors or preparation of guidelines to facilitate action at local level, the development of risk-management plans e.g. against urban flooding, or early warning systems, information sessions, data collection systems, the establishment of protected areas or restoration of areas. The concrete adaptation measures are to be implemented at local level. Thus, the obligation at regional level consists of the provision of funding to enable local level action.</p>
Rationale for the selection of measures	<p>By providing support and finance opportunities at local level, i.e. for the development of risk-management strategies, the financing of adaptation of manager roles at local level, or provision of counselling to municipalities. The financing is in the form of project-bound funding programmes. There are no general contributions to the budget, but they are based on the implementation of specific measures.</p> <p>Fields of intervention were taken over from the federal level (NAS), with slight adjustments. For the measures of the existing strategy, they organised a stakeholder consultation process, comprising enterprises, citizens, municipalities, and experts. For the future strategy, they will develop the measures from existing measures and based on needs identified by the monitoring system (see below)¹³⁹.</p>
Time horizon	<p>The climate protection strategy is scheduled to be revised every five years (2015-2020). The revision of the climate adaptation strategy every five years is codified in the adaptation law of 2020. The ministry is currently working on the next version of the climate strategy (including adaptation).</p>
Targets	<p>No specific quantitative and timebound targets are defined in the RAP.</p>

¹³⁹ Interview with a representative of the Ministry for the environment, nature protection, and transport of North Rhine Westphalia, 5 October 2022.

Indicators	No, there are no implementation indicators, nor measurable targets defined in the RAP. However, the next strategy will include those.
Monitoring and evaluation planned	No, so far the implementation has not been measured. Now, in 2022, the ministry has initiated the development of an implementation monitoring system to monitor the consequences of climate change (see ‘additional information’ below).
Governance and Institution(s) implementing the RAP	Local level/ municipalities & regional ministries.
Sources of financing	The Plan includes information on the financing of the measure. It differentiates between those without financing needs, those that are financed through existing budget allocations, and finally those without a set budget allocation (to be determined in the future). Irrespective of whether budget allocations exist or not, the Plan does not make binding financing commitments. In cases where budget allocations are already identified, they are mentioned. They mostly refer to either state funding (<i>Original: Landesmittel</i>) or EU funding (from the ERDF). One major problem for implementation was the lack of clear financial commitments. Other regional ministries did not provide a budget for adaptation measures due to a lack of ownership ¹⁴⁰ .
Synergies with other policies and strategies	<ul style="list-style-type: none"> • Sustainability strategies, biodiversity strategy, urban planning (criteria for new projects need to reflect adaptation), health strategies. • Moreover, there is a more concrete overlap with sector-specific strategies (e.g. forest strategy).
Additional information	Since 2011, NRW has developed “climate change and adaptation monitoring” (Klimafolgen- und Anpassungsmonitoring), the results of which are published in the NRW climate report every five years. This monitoring system does not cover the targets or implementation, but monitors the consequences of climate change along five dimensions: <ul style="list-style-type: none"> • Climate development (air temperature, precipitation, sun) • Environment (water, soil, biodiversity, forests, agriculture) • Human (health, civil protection, information/education/networks) • Planning and construction (regional planning, urban development, housing, traffic, infrastructure) • Economy (energy, industry and manufacturing, finance, tourism).
Implementation, monitoring and evaluation¹⁴¹	
Status of implementation	Implementation started after adoption in 2015. However, implementation was delayed due to change in the state government. Currently, 20-30 measures out of the 66 have been implemented.
Progress on the implementation and	In two areas, the following measures were a great success: <ul style="list-style-type: none"> • Fostering the data reporting/database for indicators.

¹⁴⁰ Interview with a representative of the Ministry for the environment, nature protection, and transport of North Rhine Westphalia, 5 October 2022.

¹⁴¹ This part is primarily based on the interview with a representative of the Ministry for the environment, nature protection, and transport of North Rhine Westphalia, carried out on 5 October 2022, unless otherwise indicated.

monitoring	<ul style="list-style-type: none"> • A counselling service for municipalities. <p>There is no process in place for reviewing the performance of the measures. So far, monitoring is done on an informal basis, without a formalised process/system.</p> <p>Implementation monitoring and target indicators were not foreseen in the 2015 strategy. The upcoming strategy (currently in development) will include those aspects.</p>
Lessons learned from the implementation	<p>What worked well:</p> <ul style="list-style-type: none"> • The biggest success was a counselling service for municipalities, which has been taken up at national level. • Another success was the data collection and monitoring system for monitoring climate change and impact on sectors. <p>Challenges:</p> <ul style="list-style-type: none"> • Lack of motivation/ownership in other departments/ministries to implement measures, also because of the stakeholder process (local and regional authorities don't think of measures as useful).
Lessons learned from the measurement of performance	<ul style="list-style-type: none"> • It is important to have a system in place at the adoption stage of the strategy. • It is important to have measurable indicators, even if they are indirect. • Political dimension should be considered (change in government and lack of political will to move on with implementation).
Lessons learned in relation to financing	<p>Financing was a problem, because there was no clear financing agreement/strategy at the time of implementation. This is not sustainable and it is expected that new financing provisions will be necessary when the next strategy is adopted. The problem was especially due to the fact that the other regional departments/ministries did not allocate funding for adaptation measures in their budget. They did not have a sense of ownership for the adaptation measures that were adopted (there is a need for mainstream adaptation to ensure that all contribute and allocate resources).</p> <p>No national funds were used. NRW finances costs from its own resources or EU funding. There is no follow-up financing planned for the EU projects. Using EU funding was an opportunity when no other funding was allocated but there is no specific strategy for how to continue using EU funding.</p> <p>Lessons for the next strategy:</p> <ul style="list-style-type: none"> • The goal is to increase budget for adaptation within the ministry for environment, and thus to be independent of EU funding. • It is important to settle financing at the time of adoption, to have a budget line in the budget.
Additional information	<p>It is important to highlight the relevance of the EU level as an ally in pushing for adaptation, as it provides a justification to push for the development of adaptation plans at regional level.</p>

National adaptation strategy (NAS)

Example 4 ¹⁴²	Germany
Name and Date of the NAS	The German Strategy for Adaptation to Climate Change (<i>Deutsche Anpassungsstrategie an den Klimawandel</i>) was adopted on 17 December 2008 and has been revised in two progress reports since then. The latest is the Second progress report from November 2020.
Objectives of the NAS	<ul style="list-style-type: none"> • Reduce the vulnerability to climate change of natural, social and economic systems and increase the resilience, adaptability and opportunities of those systems. • Fifteen fields of intervention covering natural, social and economic sectors, as well as two cross-cutting themes: civil protection and area planning.
Adaptation measures in the NAS	<p>Concrete measures of the adaptation strategy are defined in the adaptation action plan (<i>Original: Aktionsplan Anpassung</i>). The first national adaptation action plan was published in 2011. The third version was published in 2020, together with the second progress report. Measures are structured as cross-cutting measures (regional and urban planning, municipal planning, information technology and networks) and 6 clusters:</p> <ul style="list-style-type: none"> • Water • Infrastructure (construction, energy, traffic) • Land/ground (soil, agriculture, forest, biodiversity) • Health (human health) • Economy (industry, business, tourism, finance) • Area planning & civil protection.
Targets in the NAS	No specific quantitative targets are defined in the NAS.
Indicators in the NAS	<p>There are 105 indicators:</p> <ul style="list-style-type: none"> • 56 impact indicators measuring the consequences of climate change. • 44 response indicators measuring the activities and conditions supporting adaptation. • 5 cross-cutting overarching indicators measuring the support of activities by the federal government.
Monitoring	<p>The Monitoring/evaluation framework of the NAS is defined in the Second progress report as follows:</p> <ul style="list-style-type: none"> • Monitoring reports: 2015, 2019 & every four years. • Climate impact and vulnerability analysis: every six years. • Action plans: 2011, 2015, 2020 & every five years (measures of the action plans are revised every four years). • Evaluation report: 2019, every 4 years. • Progress report (revision of strategy), every five years (the government has published two updates on the strategy)

¹⁴² This part is based on the documents of the adaptation strategy/plan, unless otherwise indicated.

	(“progress reports”) so far, the second one is from November 2020).
Sources of financing in the NAS	Only federal-state level cooperation in the framework of European funding programmes is mentioned (Source: adaptation action plan).
Assessing progress and performance	The national adaptation action plan envisions the development of a monitoring and evaluation system. It shall be presented by the federal government in the next legislation (2013). For this endeavor, they plan to collect ideas of indicator systems for evaluation and monitoring and to plan close collaboration with the regions.
Synergies with other policies and strategies	Direct cross-references between the adaptation strategy and the following strategies are mentioned in the first edition of the first national adaptation action plan (p. 11): Biodiversity strategy; National forest strategy; High-tech strategy. Moreover, references to adaptation exist in policy fields on rural areas, agri-biodiversity, the national strategy for sustainable use and protection of maritime, and in the national strategy for integrated coast management.

Links between RAP and national or European objectives

Example 4¹⁴³	North Rhine-Westphalia (Germany)
Role of the LRAs in the NAS	<p>The NAS mentions the following roles of LRAs:</p> <ul style="list-style-type: none"> • Municipalities as central actors in adaptation. • Municipalities/local level as main responsible authority-level for action, an ambition that national government supports through knowledge sharing and general support of the municipalities, as well as services such as climate management, council activities. • Moreover, funding programmes are envisioned for developing pilot projects at local and regional level for demonstration purposes (p. 28). <p>The Federal level envisions a number of legal framework regulations for considering adaptation in areas of financial market and financial services stability, for urban planning, and in the modeling of energy efficiency (p. 31). Successful pilot projects should serve as examples for other regions.</p>
Reference to the NAS in the RAP	<p>Overall, the main area of continuous coordination is the development of funding programmes. As NRW and federal government both provide funding programmes for the local level, they have to ensure that they do not create double funding structures and ensure complementarity. Nevertheless¹⁴⁴:</p> <ul style="list-style-type: none"> • There is good collaboration between the relevant departments at federal level and regional level. • The fields of intervention are very similar, and the measures are also similar but with a higher granularity at regional level. • Since 2008, there is a coordinating working group between the federal and state levels, the “permanent committee on

¹⁴³ This part is based on the documents of the adaptation strategy/plan, unless otherwise indicated.

¹⁴⁴ Interview with a representative of the Ministry for the environment, nature protection, and transport of North Rhine Westphalia, 5 October 2022.

	<p>climate adaptation” of the Bund-Laender working group on climate & nature (<i>Original: Staendige Ausschuss Anpassung und die Folgen des Klimawandels der BLAG KliNa</i>). It serves for the sharing of practices and collaboration and coordination between national and state level. It meets twice a year and discusses shared issues between federal level and states, but also among different states.</p> <ul style="list-style-type: none"> • Current issues are, for example, the development of target indicators for adaptation, and improving the legal framework of adaptation. <p>National-level financing is used as follows:</p> <ul style="list-style-type: none"> • The federal level provides funding programmes for action at local level. • At regional level, NRW uses either its own resources or EU funds, but no national resources.
Reference to EU objectives in the RAP	<p>There is no explicit reference to the EU Adaptation Strategy or Climate-ADAPT. EU initiatives are not very relevant for the strategy, however they are important for the overall support to pushing for adaptation at regional/state level. ERDF funding is used as a potential source of financing. EU funding is very important for adaptation measures in NRW; without EU funding, adaptation would not be financed in some cases, as so far there were no alternative funding sources¹⁴⁵.</p>

Reference list (NRW)

- North Rhine-Westphalia climate protection plan: *Klimaschutzplan Nordrhein-Westfalen - Klimaschutz und Klimafolgenanpassung*, December 2015: https://www.klimaschutz.nrw.de/fileadmin/Dateien/Download-Dokumente/Broschueren/klimaschutzbericht_nrw_151201.pdf
- Synthesis of evidence: *Anpassung and den Klimawandel – eine Strategie fuer Nordrhein-Westfalen*, 2009: https://www.bbn-online.de/fileadmin/RG_Nordrhein-Westfalen/Teil1_Klimawandel_Strategie.pdf
- German Adaptation Strategy: *Deutsche Anpassungsstrategie an den Klimawandel*, 17 December 2008: https://www.bmu.bund.de/fileadmin/bmu-import/files/pdfs/allgemein/application/pdf/das_gesamt_bf.pdf
- First national adaptation action plan: *Aktionsplan Anpassung der Deutschen Anpassungsstrategie an den Klimawandel*, 31 August, 2011: https://www.bmu.de/fileadmin/bmu-import/files/pdfs/allgemein/application/pdf/aktionsplan_anpassung_klimawandel_bf.pdf
- Second progress report on the German Strategy for Adaptation to climate change: *Zweiter Fortschrittsbericht zur Deutschen Anpassungsstrategie an den Klimawandel*, 2020: <https://www.bmu.de/download/zweiter-fortschrittsbericht-zur-deutschen-anpassungsstrategie-an-den-klimawandel>
- **Interview** with a representative of Department VIII-2 Adaptation to Climate Change, protection of areas, sustainable infrastructure, at the Ministry for the environment, nature protection, and transport of North Rhine Westphalia, carried out on 5 October 2022.

¹⁴⁵ Interview with a representative of the Ministry for the environment, nature protection, and transport of North Rhine Westphalia, 5 October 2022.

Stockholm (Sweden)

Local adaptation plan (LAP)

Example 5		Stockholm
General information		
Country	Sweden	
Name of the LAP	Action Plan for Climate Adaptation 2022-2025 (Handlingsplan för klimatanpassning 2022–2025)	
Date of the LAP	Adopted by the Municipal Council on 13 December 2021	
Institution(s) responsible for the LAP	<p>The action plan specifies which institutions are responsible and which roles they have under the action plan's two overall themes, i.e., cloudburst and stormwater, and heatwaves and droughts. The institutions involved and their roles are indicated in the box on governance and institutions in this table.</p> <p>The main responsibility lies with the City Executive Board, which has the responsibility for coordination and processes as well as the overall risk- and vulnerability analyses. The administrative department under the city's executive board (City executive office) also has an overall responsibility for keeping a dialogue with relevant actors, and in coordination with, e.g., the city-wide cloudburst commission. Moreover, the department for built environment has a certain responsibility to serve as a hub for questions and answers in dialogue with other departments, mainly regarding the work on cloudburst. The city's work on meeting the objectives regarding heatwaves has a rather weaker clarity when it comes to responsibilities. However, the city's environmental department has an important role, e.g., in developing heat maps¹⁴⁶.</p>	
If applicable, previous versions	<ul style="list-style-type: none"> • Climate adaptation plan 2016: In 2015, the municipal assembly decided that the city's work on climate adaptation should be process-oriented by identifying and assessing risks, vulnerabilities, measures, and costs prior to practical implementation, followed by monitoring and evaluation. These steps take human, environmental, physical, and societal dimensions into account. • Climate adaptation in the city's environmental programme 2016-2019, sub-goal 3.1, related to urban planning, water supply and sewerage, and green infrastructure¹⁴⁷. • Climate adaptation in the city's environmental programme 2020-2023, goal 3, with a focus on flooding and management of heatwaves with measures such as for urban planning, water supply and sewerage, and green infrastructure¹⁴⁸. 	

¹⁴⁶ Interview with a representative of the City of Stockholm - City Executive Office, 06 September 2022.

¹⁴⁷ Stockholms stad, 2020, *Miljöprogram 2020-2023*, pp. 18-20, <https://miljobarometern.stockholm.se/content/docs/mp/2020-2023/miljoprogram-sthlm-2020-2023.pdf>

¹⁴⁸ Stockholms stad Miljöbarometer, 2022, *Klimatanpassad stad*, viewed on 10 October 2022 [Klimatanpassad stad - Stockholms miljöbarometer](#)

Additional information	<ul style="list-style-type: none"> • The city executive board had the formal responsibility of coordinating the city’s work on climate adaptation in 2013. The municipal assembly decided to prioritise issues related to flooding in the city’s work on climate adaptation, in its decision on the municipal budget for 2015-2018¹⁴⁹. • A model for heavy rain was initiated in 2015 and updated in 2018, to understand and identify risks and measures¹⁵⁰. • A pilot project on adaptation to heavy rain was implemented from 2017-2020, based on areas identified with a model for heavy rain¹⁵¹. • A guidance document was published in 2020 by the city’s environment department on climate adaptation in urban planning¹⁵².
Preparation and policy development: Adaptation measures and indicators¹⁵³	
Objectives	<p>Regarding cloudburst:</p> <ul style="list-style-type: none"> • Implement measures to decrease the worst effects of cloudburst in order to protect life, health, and the city’s properties. • Strengthen the city’s robustness against cloudburst by working stepwise in a long-term manner. <p>Regarding heatwaves:</p> <ul style="list-style-type: none"> • Implement measures to decrease the worst effects of heatwaves in order to protect life, health, and vegetation. • Strengthen the city’s robustness against heatwaves and droughts by working stepwise in a long-term manner. <p>The objectives on climate adaptation are specified in the city’s environmental programme¹⁵⁴. The objectives are based on prior risk- and vulnerability analyses¹⁵⁵.</p>
Measures	<p>Two general approaches (p. 18) are outlined:</p> <ol style="list-style-type: none"> 1) To make an inventory of risks such as for life and health, and damages to critical infrastructure. Thereafter, to address these risks by implementing physical operations, routines, and warning systems. 2) To consider climate change in spatial planning and construction projects by ensuring the capacity to manage downpour and by ensuring access to shade. <p>Regarding cloudburst specifically, measures include but are not limited to (pp. 46-59):</p> <p><i>For resilience to cloudburst:</i></p> <ul style="list-style-type: none"> • Describe and concretise critical activities during cloudburst events to secure life and health.

¹⁴⁹ Stockholms stad, 2018, *Klimatanpassning Maj 2018*, [Strateg \(stockholm.se\)](http://strategi.stockholm.se)

¹⁵⁰ Stockholm Vatten och Avfall, 2018, *Skyfallsmodellering Stockholm Stad – Rapport*, [Skyfallsmodellering Stockholm STAD](http://skyfallsmodellering.stockholm.se)

¹⁵¹ Stockholm stad Miljöbarometern, 2022, *CLARITY pilotprojekt skyfallshantering i City*, viewed 10 October 2022 [CLARITY pilotprojekt skyfallshantering i City - Stockholms miljöbarometer](http://miljobarometern.stockholm.se)

¹⁵² Stockholms stad Miljöförvaltningen Plan- och Miljö, 2020, *Klimatanpassning i stadsplaneringen - En vägledning*, [Miljöutredare \(tillstand.stockholm\)](http://miljoutredare.tillstand.stockholm.se)

¹⁵³ This part is based on the documents of the adaptation strategy/plan, unless otherwise indicated.

¹⁵⁴ Stockholms stad, 2020, *Miljöprogram 2020-2023*, pp. 18-20, <https://miljobarometern.stockholm.se/content/docs/mp/2020-2023/miljoprogram-sthlm-2020-2023.pdf>

¹⁵⁵ Interview with a representative of the City of Stockholm - City Executive Office, 06 September 2022.

- Risk and vulnerability analyses for cloudburst in certain high-risk areas to protect societally important infrastructure and operations.
- A pilot project for priority measures in case of cloudburst in the area of Östermalm, to concretise measures and create examples for further action in other areas.
- Development of action plans based on the result of the above measures, e.g., to identify further priority areas.
- Climate adaptation of buildings owned by the city in order to create resilience to cloudburst.
- Assessment of risk management for damage costs in case of cloudburst, as a basis for further work on risks and vulnerability, preparedness, actions, cost- and benefit analysis.
- Planning short-term resilience of prioritised built environments to cloudburst in order to minimise adverse effects on human health and life, such as with portable flood protections.

For planning and construction:

- Support for civil servants concerning resilience to cloudburst when planning for construction of new buildings and infrastructure.
- Development of routines for the use of different types of surface to create resilience to cloudburst.
- Delegation of specific responsibilities to respective actors so that all are aware of who is doing what to prepare for, and in case of, emergency.

For strengthening governance:

- Guidance to the city's committees and companies in connection with existing built environment when assessing investment measures for adaptation.
- Development of methods for multifunctional actions related to cloudburst and stormwater in order to increase the capability for treating stormwater and increased pressure on the sewage system.
- Coordination between the city's landlords to identify vulnerabilities and cost-effective actions.
- Communications to disseminate information and knowledge to relevant agents.

Regarding heatwaves specifically, measures include but are not limited to (pp. 77-83):

For general issues:

- Assess principals for the city's management of heatwaves in order to specify organisation and routines for the city's work on heatwaves.

For mapping risks:

- Complementary risk and vulnerability analysis to identify risks and vulnerabilities, and measures to deal with these.

For adapting operations/public services:

- Planning for the changing routines of the city's operations (such as kindergartens and elderly care) in case of heatwaves, to protect vulnerable groups and to secure a good working environment for the city's employees.

For improving robustness/governance:

	<ul style="list-style-type: none"> • Make it possible to include and manage the effects of heatwaves in urban planning. • Carry out an in-depth analysis of heat issues, including a heat map, e.g., to identify priority measures. • Assess proposals for measures that provide possibilities for drinking water in public spaces, including through a pilot project. <p><i>For management of water resources:</i></p> <ul style="list-style-type: none"> • Assess the possibilities for saving water when there are long-term droughts and heatwaves, in order to know which areas are more or less resilient to droughts. • Assess the possibilities for leading surface runoff from neighbourhoods to public spaces with the aim of irrigating plant beds and plantations. <p><i>For action plans for buildings:</i></p> <ul style="list-style-type: none"> • Action plans for improving buildings' resilience to heat and the surrounding environment.
Time horizon	2022-2025. Not necessarily to have all actions fulfilled by 2025, but to initiate the work. Renewed action plans will build on the existing one and revise the progress.
Targets	There are no specific quantitative or timebound targets defined in the action plan.
Indicators	There are no specific indicators for tracking progress defined in the action plan. General indicators are defined in the city's environmental programme. Risks are continuously overseen by the city's committees and undertakings, which are integrating priorities into their ordinary operations, based on the needs and degree of those risks ¹⁵⁶ . One priority risk assessment includes the city's cloudburst modelling. In 2015, Stockholm's public Water and Waste company and the city's environmental department developed a cloudburst model to assess flooding risks from intensive cloudburst, taking effects of climate change until 2100 into account ¹⁵⁷ .
Monitoring and evaluation planned	Monitoring of progress and performance is done via the goals on cloudburst and heatwaves in the city's environmental programme. Feedback and evaluations of routines and methods are done continuously by each actor according to their responsibilities ¹⁵⁸ , which are specified in the Governance and Institutions box of this table. The city's environmental programme specifies a strengthened ability to manage the effects of cloudburst and heatwaves as climate adaptation goals (which are developed in detail in the action plan on climate adaptation). However, the environmental programme does not specify any indicators. The overall responsibility of monitoring the goal on cloudburst is given to the committee on traffic. The city executive board and Stadshus AB Corporation - the parent company of city-owned companies - are responsible for monitoring the goal on heatwaves ¹⁵⁹ . There is no micromanagement from any central authority in implementing the action plan. The action plan's function is to

¹⁵⁶ Interview with a representative of the City of Stockholm - City Executive Office, 06 September 2022.

¹⁵⁷ Stocholms Stad – Miljöbarometern, 2022, *Framtagande av skyfallmodell för Stockholm*, accessed on 24 October 2022, [Framtagande av skyfallmodell för Stockholm - Stockholms miljöbarometer](#)

¹⁵⁸ Idem.

¹⁵⁹ Stockholms stad, 2020, *Miljöprogram 2020-2023*, <https://miljobarometern.stockholm.se/content/docs/mp/2020-2023/miljoprogram-sthlm-2020-2023.pdf>

	provide guidance to the city's committees and undertakings and indicate priorities. The municipal budget mentions that the action plan should be considered. The yearly follow-up of the action plan is integrated into the follow-up on the city's environmental program ¹⁶⁰ .
Governance and Institution(s) implementing the LAP	<p>Organisation and responsibilities regarding cloudburst and stormwater (pp. 33-40):</p> <ul style="list-style-type: none"> • The city executive board has the responsibility for coordination and processes as well as the overall risk- and vulnerability analyses. • The committee on environment and health supervises stormwater management and assists the committee on city planning in developing detailed planning instruments. In addition, the committee develops data and tools on climate- and weather statistics, key figures, ecosystem services and green surface factors as well as coordinating environmental monitoring and preparing local action plans for good water status. • Stockholm Water and Waste (Stockholm Vatten och Avfall AB - SVOA) is responsible for waste water treatment, related investments, and provides expertise on the topic. • The committee on land development has the responsibility of regulating: land use, building and infrastructure projects, and some parks and natural areas on the city's land. • The committee on city planning is responsible for fulfilling the city's responsibilities under the Planning and Building Act (2010:900). The committee ensures that strategic planning fulfills the objectives on stormwater and cloudburst. • The committee on traffic maintains the city's infrastructure. The committee has a special strategic cloudburst function, to support the city's work on cloudburst under the action plan on climate adaptation. • The neighbourhood councils are responsible for managing parks and natural areas and partly stormwater management. • The committee on properties is responsible for the work related to buildings in the city together with the city's public housing and public property companies, which work on assessing the risks and vulnerabilities of their buildings related to climate change. <p>Organisation and responsibilities regarding heatwaves and droughts (pp. 72-74):</p> <ul style="list-style-type: none"> • The organisation is similar to that regarding cloudburst and stormwater, but relates to heat. For example, the city's public property companies which manage schools, health and elderly care activities, together with related committees, deal with, certain heat-related aspects that can be important for e.g., the elderly.
Sources of financing	In general, financing is integrated into the ordinary budgetary procedures of the city's committees and undertakings with the aim of not expanding costs beyond the existing budgetary frameworks. The responsible actors will have to assess priorities and cost-benefit considerations. Certain projects may be eligible for external financing (p. 20). In addition, financing for increasing the capacity of the water and sewer system to create resilience to cloudburst can be done if necessary by increasing the water service fees (p. 21).

¹⁶⁰ Idem.

	Although the city’s general system is to integrate financing into the ordinary budgetary procedures, the interviewee described how the city has internal funding instruments that can be applied for. However, for buildings and infrastructure, landlords have the legal responsibility to adapt their buildings to the consequences of climate change ¹⁶¹ .
Synergies with other policies and strategies	An explicit aim of many of the measures in the action plan is to protect life, health, and vegetation. The committee on environment and health protection is, among other things, responsible for ensuring water quality and environmental consequences are integrated into its contribution to the action plan on climate adaptation. Solutions for resilience to cloudburst should be integrated into overall urban planning. The action plan says that multifunctional solutions can contribute to strengthening urban ecosystem services and an attractive living environment, (p. 40). Routines for using certain surfaces for creating resilience to cloudburst should be suitable in relation to hydrological and ecological conditions. A good water status should also be sustained (p. 54). Development of methods for multifunctional actions within the framework of the action plan will address recreational, ecological, and esthetical values (p. 57). The intended action plans to improve buildings’ resilience to heat and the surrounding environment exemplify measures such as conservation of older and larger trees and increasing the share of green areas (p. 82), which can increase biodiversity.
Implementation, monitoring and evaluation ¹⁶²	
Status of implementation	After adoption of the action plan, the city’s different departments have worked together on developing concrete measures. Some of the measures were already ongoing at the time of the adoption of the action plan. By now, about 25 to 50% of the action plan’s listed activities have already been initiated.
Progress on implementation and monitoring	Monitoring of progress and performance is done via the goals on cloudburst and heatwaves in the city’s environmental programme. Results are reported via the general reporting system and do not specify any specific indicators. Feedback and evaluation of routines and methods are continuously done internally. The city’s environmental programme specifies a strengthened ability to manage the effects of cloudburst and heatwaves as climate adaptation goals (which are developed in detail in the action plan on climate adaptation). In the environmental programme, the overall responsibility of monitoring the goal on cloudburst is given to the committee on traffic ¹⁶³ . Implementation is based on choosing the right priorities and using the right methods in relation to existing needs and risks, and is integrated into the ordinary planning and operations of the city’s committees and undertakings.
Lessons learned from implementation	Good examples from the implementation include: <ul style="list-style-type: none"> • Stormwater management in the area “Norra Djurgårdsstaden”: The project on stormwater management in Norra Djurgårdsstaden takes into account potential extreme cloudburst events. To create resilience to these events, the project includes adapting green infrastructure (such as green passages with plant- and rain beds of specific soil mixture of biochar and gravel). Up until 2021, 14 hectares of green infrastructure were built, including 26,400 m² of green roofs,

¹⁶¹ Interview with a representative of the City of Stockholm - City Executive Office, 06 September 2022.

¹⁶² This part is primarily based on the interview with a representative of the City of Stockholm - City Executive Office, 06 September 2022, unless otherwise specified.

¹⁶³ Stockholms stad, 2020, *Miljöprogram 2020-2023*, <https://miljobarometern.stockholm.se/content/docs/mp/2020-2023/miljoprogram-sthlm-2020-2023.pdf>

	<p>47,300 m² farms, and planting 550 new trees¹⁶⁴.</p> <ul style="list-style-type: none"> • Adaptation measures for surfaces related to downpour in the park “Rålambshovsparken”: The project is the first of its kind to manage large volumes of rain- and stormwater in a central park in Stockholm, and was implemented between 2017 and 2021. The project consists of three parts: the cloudburst dam, rain park, and outflow. Together, these manage stormwater from the park’s hard surfaces to keep them dry and lead water away. The project received funding from the city’s climate investments and the Swedish National Board of Housing, Building and Planning. The result of the project is documented in a final report from 2021¹⁶⁵. • Cloudburst modelling: In 2015, Stockholm’s public Water and Waste company and the city’s environmental department developed a cloudburst model to assess flooding risks of intensive cloudburst, considering the effect of climate change scenarios until 2100¹⁶⁶. An updated version was issued in 2018¹⁶⁷, and an interactive risk map is available on the city’s environmental data portal¹⁶⁸. <p>The purposes of the modelling are to:</p> <ul style="list-style-type: none"> - Provide an overview of vulnerabilities in events of extreme cloudbursts. - Show where the flooding risks are. - Show where in-depth and detailed assessments are needed. - Provide a basis for the city’s work on climate adaptation. <p>The modelling shows, among other things, variables such as rain scenario, land use per surface type, infiltration per soil type, maximum depths, and water flow paths.</p> <ul style="list-style-type: none"> • Heat mapping: the city uses a heat map model to assess risks and vulnerabilities related to heatwaves. The model shows temperature differences between different building types, and vegetation. It also considers climate change scenarios of +2 °C and +4 °C¹⁶⁹.
Lessons learned in relation	As explained above, financing is usually integrated into the ordinary budgetary procedures of the city’s committees and

¹⁶⁴ Stockholms stad – Stockholm växer, 2021, *Regnvatten som resurs - så planerar Norra Djurgårdsstaden för stora mängder regn och skyfall*, accessed on 24 October 2022 <https://vaxer.stockholm/nyheter/2021/09/regnvatten-som-resurs---sa-planerar-norra-djurgardsstaden-for-stora-mangder-regn-och-skyfall/>

¹⁶⁵ Stockholms stad, 2021, *Rålambshovsparken Genomförda åtgärder för bättre dagvatten- och skyfallshantering*, accessed on 24 October 2022 <https://miljobarometern.stockholm.se/content/docs/tema/klimat/skyfall/Ralambhovsparken/Slutrapport-Genomf%C3%B6rda-%C3%A5tg%C3%A4rder-R%C3%A5lambhovsparken-2021.pdf>

¹⁶⁶ Stockholms Stad, Miljöbarometern, 2022, *Stockholms skyfallsmodell*, accessed on 09 November 2022 <https://miljobarometern.stockholm.se/klimat/klimatanpassning/skyfall/stockholms-skyfallsmodellering/>

¹⁶⁷ Thurin, Sofia (WSP), 2018, *Skyfallsmodellering Stockholm Stad – Rapport*, Stockholm Vatten och Avfall, available at: <https://miljobarometern.stockholm.se/content/docs/tema/klimat/skyfall/skyfallsmodellering/WSP-Rapport-uppdaterad-skyfallsmodellering-Stockholm-2018.pdf>

¹⁶⁸ Stockholms Stad, Miljöbarometern, 2022, *Skyfall och översvämningsrisker*, accessed on 09 November <https://miljodataportalen.stockholm.se/>

¹⁶⁹ Stockholms Stad, Miljöbarometern, 2022, *Karteringar av värme i Stockholm*, accessed on 10 October 2022 <https://miljobarometern.stockholm.se/klimat/klimatanpassning/varmeboljor-och-varmestress/karteringar-av-varme-i-stockholm/#:~:text=F%C3%B6r%20Stockholm%20finns%20en%20v%C3%A4rme-kartering,natt%20samt%20vid%20olika%20C3%A5rstider>

to financing	<p>undertakings responsible for implementing measures. Nevertheless, there is an aim to enhance the use of external financing. The city has already received financing for adaptation measures related to cloudburst, from the County Administrative Board¹⁷⁰ and Vinnova, the national agency for innovation systems. The city could also apply for funding from the Swedish Civil Contingencies Agency, as their funds have increased this year. Moreover, the city actively monitors calls from EU funds and missions. However, the EU financing sources are not crucial presently.</p> <p>Although increasing the capacity of the water and sewer system to create resilience to cloudburst can, if necessary, be done by increasing the water service fees, this has not happened. Discussions have been held in the City of Stockholm, but one challenge is that there are legal uncertainties regarding utilising the water service fees as a funding instrument.</p>
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National adaptation strategy (NAS)

Example 5 ¹⁷¹	Sweden
Name and Date of the NAS	National Climate Adaptation Strategy (Nationell strategi för klimatanpassning) from 2017
Objectives of the NAS	<p>The objectives of the NAS are to:</p> <ul style="list-style-type: none"> • Develop a long-term sustainable and resilient society that actively addresses climate change by decreasing vulnerability and using opportunities. • Achieve the goals in the Paris Agreement for climate adaptation (adaptation capability to defend against the adverse effects of climate change, and in a way that will not pose a threat to food production). • Achieve the goals for climate adaptation in the Agenda 2030 (e.g., Goal 13.1 on natural disasters, Goal 13.2 on national actions, Goal 13.3 on education, awareness, and early warning systems). <p>Guiding principles for the strategy on climate adaptation include:</p> <ul style="list-style-type: none"> • Sustainable development (positive effects on the environment and ecosystem services, positive synergies with other sectors, socioeconomic efficiency, and positive effects on social cohesion, sustainable economic growth, good living environments and health, without disadvantages for any social groups). • Synergies with climate mitigation. • Scientifically-based measures. • Being based on the precautionary principle. • Measures integrated into activities of all actors. • Flexibility, without lock-in effects. • Management of uncertainties • Risk management

¹⁷⁰ Note that a County Administrative Board is a regional part of the Swedish National Government.

¹⁷¹ This part is based on the documents of the adaptation strategy/plan, unless otherwise indicated.

	<ul style="list-style-type: none"> • Time-perspectives • Transparency.
Adaptation measures in the NAS	The National Strategy does not mention any concrete adaptation measures in addition to the general principles. A proposal to amend the planning and building act (2010:900) was integrated into the NAS (see below for details).
Targets in the NAS	There are no specific quantitative targets in the national strategy.
Indicators in the NAS	Development and progress tracking is delegated to the Swedish Meteorological and Hydrological Institute), which is developing these indicators continuously. Their latest publication (2021) on a proposal for a system for follow-up and evaluation of national climate adaptation measures includes several proposed indicators ¹⁷² . Of these, the proposal suggests five types of indicators for follow-up implementation. Three types of indicators follow up on implemented measures: physical measures implemented, strategies or plans implemented, and informative measures implemented. Moreover, two types of indicators are aimed at assessing the effects of measures, on vulnerability: degree of vulnerability of objects and subjects in a changing climate, and phenomena in the present that indicate vulnerability related to events that have occurred and are expected to become more common in a changing climate ¹⁷³ . Specific indicators are developed in cooperation with relevant authorities and agencies ¹⁷⁴ .
Monitoring and assessment of progress	The national strategy on climate adaptation comes with a five-year policy cycle for monitoring, follow-ups, and revisions in order to guarantee effectiveness and continuity. From 2019-2022, there is an updating of the climate- and vulnerability analysis and follow-ups, and assessment of implementation. In 2023, there will be a new revised climate adaptation strategy. The monitoring system is developed by the Swedish Meteorological and Hydrological Institute, which is also responsible for developing indicators. They state that the national strategy lacks goals that are possible to follow up ¹⁷⁵ .
Sources of financing in the NAS	The Government believes that the main principle is that the cost of protecting property lies with the owner of the property. Responsibility for preventing and restoring damage due to extreme weather events does not differ from the responsibility for other risk management in society. This creates incentives to avoid exploitation in hazardous areas and to take appropriate protective measures, according to the NAS. The national strategy refers mainly to existing funding sources: <ul style="list-style-type: none"> • EU funding such as through LIFE. • Through the landslide proposition [jordskredspropositionen 1986 (prop. 1985/86:150 bilaga 3)] to implement preventive measures against landslides and other natural damages. • Some funding can also be received from the Swedish Geotechnical Institute, and the Swedish Civil Contingencies Agency.

¹⁷² Swedish Meteorological and Hydrological Institute, 2021, *Förslag på system för uppföljning och utvärdering av det nationella arbetet med klimatanpassning*, <https://www.smhi.se/publikationer/publikationer/forslag-pa-system-for-uppfoljning-och-utvardering-av-det-nationella-arbetet-med-klimatanpassning-1.167668>

¹⁷³ *Idem.*, pp. 30-31.

¹⁷⁴ *Idem.*, p. 75.

¹⁷⁵ *Idem.*, p. 37.

	<ul style="list-style-type: none"> • Other funding opportunities exist, connected to greener cities (bidraget för grönare städer). • Moreover, the national strategy refers to the webpage https://www.klimatanpassning.se/ that lists national and international funding opportunities. <p>The national strategy also refers to an amendment to Utredningen om hållbara vattentjänster (M 2017:02) in order to enable increasing the municipal water service fees to finance adaptation measures.</p>
Synergies with other policies and strategies	The strategy mentions in its guiding principle that it should contribute to a sustainable development in terms of positive effects on the environment and ecosystem services. In addition, it should contribute to positive synergies with relevant sectors and positive effects on socioeconomic conditions, social cohesion, sustainable economic growth, living environments, health, and climate mitigation, without disadvantaging any social groups.

Links between LAP and national or European objectives

Example 5 ¹⁷⁶	Stockholm (Sweden)
Role of the LRAs in the NAS	<p>The NAS puts a major responsibility on municipalities by referring to existing laws on municipality responsibilities for conducting risk- and vulnerability analyses, and responsibility for physical planning of land use, protection of cultural heritage, provisioning of water and sewer systems, waste management, and preventive actions related to natural disasters. In addition, the strategy mentions examples of the measures needed in each sector, and which sectors municipalities are responsible for. Such sectors include those related to water supply, sewerage systems, electricity supply, electronic communications, waterways, roads and buildings.</p> <p>To clarify and specify municipality responsibilities for climate adaptation measures, the NAS suggested a proposition to make two amendments to the Planning and Building Act (2010:900). The amendments clarify municipality responsibilities in relation to climate adaptation:</p> <ul style="list-style-type: none"> • The municipality's overall planning documents shall include the municipality's view of climate risks related to built environment, flooding, landslides, and erosion, and how such risks can be reduced or prevented. • The municipality may decide in a detailed plan that land permits are required for land measures that may impair the permeability of the land and which are not considered in the construction of a street, road or railway, and that are compatible with the municipality's development plan. The rationale behind this decision is related to the municipalities' management of stormwater and the importance of soil characteristics in the event of stormwater. <p>Concerning preventive adaptation measures, the responsibility for the protection of property falls first of all to the owner of the property. It provides a driving force to avoid building on hazardous areas and taking appropriate protective measures. This applies to all property owners and individuals and companies such as local and state authorities. [According to the Planning</p>

¹⁷⁶ This part is based on the documents of the adaptation strategy/plan, unless otherwise indicated.

	<p>and Building Act (2010:900)], municipalities are responsible for locating new built environment on suitable land and considering risks for accidents such as landslides, flooding and erosion. Municipalities are otherwise able to take preventive adaptation measures, provided that the measures are compatible with the public interest in the Local Government Act (2017:725).]</p> <p>The main guidance provided in the national strategy is general advice on long-term planning. In addition, are the general principles (which are listed in the table on national strategy, box “Objectives of the NAS”) and references to knowledge resources of different national authorities and agencies that can be used by, for example, municipalities. Stockholm’s action plan refers to some of these supporting authorities, including the national Board of Housing, Swedish Meteorological and Hydrological Institute, the Swedish Geotechnical Institute, and the Swedish Civil Contingencies Agency. The County Administrative Board has a special coordinating role in supporting municipalities’ planning and evaluation of climate adaptation measures.</p>
Reference to the NAS in the LAP	<p>The local strategy refers to the Planning and Building Act (2010:900) which was updated with the national strategy. Spatial planning is a main tool for implementing the adaptation measures in local strategy. The overall goal of the national strategy is to develop a long-term sustainable and resilient society that actively addresses climate change by decreasing vulnerability and using opportunities. Since the goal is so broad, the local strategy can be viewed as contributing to it. Moreover, the principles listed in the national strategy include, for example, risk management, which is a crucial part of the local strategy. Furthermore, local actions are crucial for the national strategy.</p> <p>There are no direct links between Stockholm’s action plan and the progress of the national strategy. However, as an example, the strategy itself, physical measures, and the detailed flooding map developed by the city of Stockholm will contribute to fulfilling Swedish Meteorological and Hydrological Institute’s indicators developed on behalf of the national strategy. In addition, the assessments made in the work to develop Stockholm’s action plan were partly based on Swedish Meteorological and Hydrological Institute’s material.</p> <p>The national strategy targets all sectors in a general fashion and does not specify in detail the roles and responsibilities of different actors and authorities. Therefore, Stockholm has, in its local strategy, focused on local needs. However, more national instruments and legal clarities would facilitate Stockholm’s work on climate adaptation.</p> <p>Regarding the national financing resources available, the City of Stockholm’s strategy merely mentions that external funding exists, and that the possibility exists for increasing the water service fees in order to finance adaptation measures¹⁷⁷.</p>
References to EU objectives in the LAP	<p>The EU strategy is merely mentioned in Stockholm’s action plan on climate adaptation. It also mentions the European Climate Law, which says that the Member States shall have a national strategy on climate adaptation.</p> <p>Regarding financing, the interviewee mentioned that the city actively monitors calls from EU funds and missions, although the EU financing sources are currently not crucial. Moreover, knowledge resources from Climate-ADAPT are regularly monitored by the city¹⁷⁸.</p>

¹⁷⁷ Interview with a representative of the City of Stockholm - City executive office, 06 September 2022.

¹⁷⁸ Interview with a representative of the City of Stockholm - City executive office, 06 September 2022.

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Annex 2: Examples of adaptation indicators

Indicator	Measurement Unit	Sector	Source
Historical disaster losses as a percentage of city GDP	%		ISO ¹⁷⁹
Average annual disaster losses as a percentage of city GDP	%		ISO
Number of internally displaced persons per 100 000 population	#		ISO
Total GDP at risk as a percentage of average annual GDP	%		ISO
Average annual hours of basic healthcare service interruptions	#		ISO
Average annual hours of public transport service interruptions	#		ISO
Total GDP at risk as a percentage of average annual GDP	€		ISO
Number of health and educational facilities destroyed or damaged by natural hazards per 100 000 population	#		ISO
Number of people directly affected (evacuated, relocated, injured or ill) by natural hazards per 100 000 population	#		ISO
Number of properties lost due to coastal erosion per year	#		GIZ ¹⁸⁰
Losses of GDP in percentage per year due to extreme rainfall	%		GIZ
Reduced work productivity due to heat stress	€		GIZ
Financial losses to businesses due to extreme weather events	€		GIZ
Number of cases of water-borne diseases	#		GIZ
Number of people permanently displaced from homes as a result of flood, drought or sea-level rise	#		GIZ
Number of properties flooded per year	#		GIZ
Reduction of flood damage and disaster relief costs in cities due to increased standards for flood	€		GIZ
Weather-related disruption of electricity supply	#		GIZ
Percentage of households at reduced flood risk due to construction of new or enhanced defences	%		GIZ
Saved health	DALY		CCIS ¹⁸¹

¹⁷⁹ ISO/TC268/WG2 N100 – ISO/WD 37123 Resilient Cities Standard March 2017. Working Draft 2017-03-28, through RESIN Project. (2017). *Monitoring And Evaluation*. <http://wiki.resin.itti.com.pl/article/frequently-encountered-challenges/monitoring-and-evaluation/>

¹⁸⁰ GIZ (2014). Repository of Adaptation Indicators. Trough RESIN Project. (2017). *Monitoring And Evaluation*. <http://wiki.resin.itti.com.pl/article/frequently-encountered-challenges/monitoring-and-evaluation/>

¹⁸¹ Stadelmann M., Michaelowa A., Butzengeiger-Geyer S., Kohler M. (2011), Universal metrics to compare the effectiveness of climate change adaptation projects. Centre for Comparative and International Studies. University of Zurich. Available at: <http://www.oecd.org/env/cc/48351229.pdf>. Trough RESIN Project. (2017). *Monitoring And Evaluation*. <http://wiki.resin.itti.com.pl/article/frequently-encountered-challenges/monitoring-and-evaluation/>

Indicator	Measurement Unit	Sector	Source
saved wealth	Absolute / relative		CCIS
Number of people injured/evacuated/relocated due to extreme weather event(s) (e.g. heat or cold waves)	#		Covenant of Mayors (2017) ¹⁸² , Covenant of Mayors (2022) ¹⁸³
Number or % of (public/residential/tertiary) buildings damaged by extreme weather conditions/events	(per year / over a certain period)	Buildings	Covenant of Mayors
Number or % of transport/energy/water/waste/ICT infrastructure damaged by extreme weather conditions/events	(per year / over a certain period)	Transport, Energy, Water, Waste, ICT	Covenant of Mayors
% of grey/blue/green areas affected by extreme weather conditions/events (e.g. Heat Island Effect, Flood, Rockfalls and/or Landslides, Forest/Land Fire)	%	Land Use Planning	Covenant of Mayors
Number of days with public service interruptions (e.g. energy/water supply, health/civil protection/emergency services, waste)	#	Transport, Energy, Water, Waste, Civil Protection & Emergency	Covenant of Mayors
Average length (in hours) of the public service interruptions (e.g. energy/water supply, public transport traffic, health/civil protection/emergency services)	Hours	Transport, Energy, Water, Waste, Civil Protection & Emergency	Covenant of Mayors
Number of deaths related to extreme weather event(s) (e.g. heat or cold waves)	(per year / over a certain period)	Health	Covenant of Mayors
Average response time (in min.) for police/fire-fighters/emergency services in case of extreme	Minutes	Civil Protection &	Covenant of

¹⁸² Neves A; Blondel L; Brand K; Hendel Blackford S; Rivas Calvete S; Iancu A; Melica G; Koffi Lefeivre B; Zancanella P; Kona A. The Covenant of Mayors for Climate and Energy Reporting Guidelines; EUR 28160 EN; doi:10.2790/586693. Trough RESIN Project. (2017). *Monitoring And Evaluation*. <http://wiki.resin.iti.com.pl/article/frequently-encountered-challenges/monitoring-and-evaluation/>

¹⁸³ Covenant of Mayors. (2022). *Climate Change Risks and Vulnerabilities Indicators*. Retrieved 28 October from https://www.eumayors.eu/index.php?option=com_attachments&task=download&id=843

Indicator	Measurement Unit	Sector	Source
weather events		Emergency	Mayors
Number of water quality warnings issued	#	Health	Covenant of Mayors
Number of air quality warnings issued	#	Health	Covenant of Mayors
% of areas affected by soil erosion / soil quality degradation	%	Environment & Biodiversity	Covenant of Mayors
% of habitat losses from extreme weather event(s)	%	Environment & Biodiversity	Covenant of Mayors
% change in number of native species	%	Environment & Biodiversity	Covenant of Mayors
% of native (animal/plant) species affected by diseases related to extreme weather conditions/events	%	Environment & Biodiversity	Covenant of Mayors
% of agriculture losses from extreme weather conditions/events (e.g. drought/water scarcity, soil erosion)	%	Agriculture & Forestry	Covenant of Mayors
% of livestock losses from extreme weather conditions	%	Agriculture & Forestry	Covenant of Mayors
% change in crop yield / evolution of the annual grassland productivity	%	Agriculture & Forestry	Covenant of Mayors
% of livestock losses from pests/pathogens	%	Agriculture & Forestry	Covenant of Mayors
% of timber losses from pests/pathogens	%	Agriculture & Forestry	Covenant of Mayors
% change in Forest composition	%	Agriculture & Forestry	Covenant of Mayors
% change in water abstraction	%	Agriculture & Forestry	Covenant of Mayors
% change in tourist flows / tourism activities	%	Tourism	Covenant of Mayors
€ annual direct economic losses (e.g. in commercial/agricultural/industrial/touristic sectors) due to extreme weather event(s)	€/year	Other	Covenant of Mayors
€ annual amount of compensation received (e.g. insurance)	€/year	Other	Covenant of Mayors
% of public funds available to address a climate hazard and its impacts (e.g. fire, flood, heatwave,	%	Socio-economic	Covenant of

Indicator	Measurement Unit	Sector	Source
etc)			Mayors
% share of vulnerable population groups (e.g. elderly (65+)/young (25-) people, lonely pensioner households, low-income/unemployed households, migrants and displaced people) - compared to national average in year X in country X	%	Socio-economic	Covenant of Mayors
Number of households educated in house energy/water/waste management	#	Socio-economic	Covenant of Mayors
Population density (compared to national/regional average in year X in country/region X)	People per km2	Socio-economic	Covenant of Mayors
% of population living in areas at risk (e.g. flood/drought/heat wave/ forest or land fire)	%	Socio-economic	Covenant of Mayors
% change in green & blue infrastructure/areas (e.g. through new urban planning regulation/policy)	%	Governmental & institutional	Covenant of Mayors
Length of transport network (e.g. road/rail) located in areas at risk (e.g. flood/drought/heat wave/ forest or land fire)	Km	Physical & environmental	Covenant of Mayors
Average time needed to reach a health facility	Hours	Physical & environmental	Covenant of Mayors
% of areas non-accessible for emergency responses (e.g. firefighting services)	%	Physical & environmental	Covenant of Mayors
% of (e.g. residential / commercial / agricultural / industrial / touristic) areas at risk (e.g. flood/drought/heat wave/ forest or land fire)	%	Physical & environmental	Covenant of Mayors
Hours needed to inform population of a risk via an early warning system	Hours	Physical & environmental	Covenant of Mayors
Number of heat advisories per year	#		NYCPCC ¹⁸⁴
Change in surface and air temperature during peak periods (July–August)	%		NYCPCC
Number of extreme precipitation events (95th percentile values) per year	#		NYCPCC
Number of coastal flooding advisories for major or moderate flooding	#		NYCPCC
Trend in mean sea level			NYCPCC
Trend in peak storm surge for 100-year and 500-year storms			NYCPCC
Number of days per year with sustained winds or gusts exceeding certain thresholds	#		NYCPCC
Heat-related morbidity and excess mortality from extreme heat events per year	#		NYCPCC

¹⁸⁴ Solecki, W., Rosenzweig, C., Blake, R., de Sherbinin, A., Matte, T., Moshary, F., Rosenzweig, B., Arend, M., Gaffin, S., Bou-Zeid, E., Rule, K., Sweeny, G. and Dessy, W. (2015), New York City Panel on Climate Change 2015 Report Chapter 6: Indicators and Monitoring. Ann. N.Y. Acad. Sci., 1336: 89-106. <https://doi.org/10.1111/nyas.12587>

Indicator	Measurement Unit	Sector	Source
Other health-related heat impacts (e.g., heat-induced strokes)			NYCPCC
Other climate hazard-related morbidity and mortality per year (e.g., drowning due to storms)	#		NYCPCC
Number of days per year with observed air quality index > 100	#		NYCPCC
Cooling (and heating) degree days per year	#		NYCPCC
Duration of blackouts/brownouts per year associated with weather-related events	Length of duration		NYCPCC
Number of weather-related transit and subway outages per year	#		NYCPCC
Number of weather-related telecommunications outages and customer hours without telecommunications per year	#		NYCPCC
Area of land inundated by coastal flooding per year	Area		NYCPCC
Costs of additional water treatment owing to extreme rainfall events per year	€		NYCPCC
Total economic losses from climate-related events per year	€		NYCPCC
Disparity in heat-related morbidity and mortality across neighbourhoods with respect to a variety of equity conditions (e.g., income, race/ethnicity, non-English speaking population, housing stock)			NYCPCC
Disparity in other climate-related morbidity and mortality across neighbourhoods with respect to a variety of equity conditions			NYCPCC
Disparity in households without air conditioning across neighbourhoods with respect to a variety of equity conditions			NYCPCC
Percentage population with a disability (one or more of six types: hearing, vision, cognitive, ambulatory, self-care, independent living)			NYCPCC
Social vulnerability indices, tailored as needed to specific climate hazards, for example: <ul style="list-style-type: none"> Heat Vulnerability Index in census block groups experiencing relatively higher heat stress Social Vulnerability Index scores related to access to green space Social Isolation Index in census block groups in flood evacuation zones 			NYCPCC
Change in vegetation cover			NYCPCC
Number of trees planted per year	#		NYCPCC
Square footage of white/green roofs			NYCPCC
Surface temperature change in areas that have adopted white/green roofs relative to non-white/green roof locations			NYCPCC
Estimated percent of households with residential air conditioning	%		NYCPCC
Number of citizen groups engaged in climate resiliency programs per year	#		NYCPCC
Square footage of residential, commercial, industrial space not flood-proofed or elevated in areas within the 100-year floodplain			NYCPCC
Number of residential units in 100-year floodplain implementing Core Flood Resiliency measures	#		NYCPCC

Indicator	Measurement Unit	Sector	Source
Percentage of flood-affected areas with improved storm drainage	%		NYCPCC
Acres of restored coastal wetlands	#		NYCPCC
Miles of coastal defences erected (dune replenishment/hard defences)	#		NYCPCC
Population growth/decline in the 100-year floodplain			NYCPCC
Percentage of NYC transportation assets adapted for climate change resiliency	%		NYCPCC
Financial expenditure on resiliency activities per year; as a percent of total expenditure			NYCPCC
Percent of area that is impervious surface	%		ND-GAIN ¹⁸⁵
Percent of buildings built after 1999	%		ND-GAIN
Percent of buildings built after 1979	%		ND-GAIN
Percent of population residing in mobile homes	%		ND-GAIN
Percent of population that is 65 years old or older	%		ND-GAIN
Percent of population that is 18 years old or younger	%		ND-GAIN
Percent of workers without access to a vehicle	%		ND-GAIN
Percent of population that is chronically sick (12 separate diseases)	%		ND-GAIN
Outdoor workers	#		ND-GAIN
Percent of population spending over 50% of income on rent	%		ND-GAIN
Quality of drinking water			ND-GAIN
Number of acute care hospital beds available per 1,000 residents	#		ND-GAIN
Percent of population with health insurance	%		ND-GAIN
Percent of land covered by tree canopy	%		ND-GAIN
Percent of houses with heating	%		ND-GAIN
Number of cars on roads in flood zone	#		ND-GAIN
Percent of population living in flood plains	%		ND-GAIN
Number of buildings in the flood plain	#		ND-GAIN
Number of people in city	#		ND-GAIN

¹⁸⁵ University of Notre Dame - Notre Dame Global Adaptation Initiative (ND-GAIN). (2022). Urban Adaptation Assessment Indicator List. https://gain.nd.edu/assets/256491/new_uaa_indicator_list.pdf



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