

JustREACH

D2.1- STATUS QUO REPORT ON EU KNOWLEDGE ON CLIMATE ADAPTATION & SMART SPECIALIZATION

WP2–Foundations of Just Resilience

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EC Summary Requirements

1. Changes with respect to the DoA

No changes with respect to the work described in the DoA.

2. Dissemination and uptake

This deliverable can be utilized within the JustREACH project as a foundational empirical and conceptual resource for subsequent tasks related to climate justice, resilience, maladaptation, indicator development, validation, scenario-building, and implementation support. Specifically, it offers a structured evidence base for developing the Integrated Just Resilience Framework and associated indicators in Work Package 2. Additionally, it will inform later work on adaptation pathways, impact assessment, tool development, and communication activities throughout the project. Beyond the consortium, this report may also serve as a valuable resource for regional and local authorities, policymakers, researchers, practitioners, and innovation actors operating at the intersection of climate adaptation and smart specialization. Its primary value lies in consolidating fragmented knowledge at the EU level, identifying patterns of integration between adaptation and regional transformation, and highlighting gaps related to justice, territorial differentiation, maladaptation, and monitoring.

3. Short summary of results

This deliverable reviews and consolidates EU knowledge on the relationship between climate adaptation and smart specialization. It explores how EU-funded projects, knowledge platforms, strategic documents, and practical examples connect adaptation efforts with regional innovation and development priorities. The analysis is organized along two dimensions: adaptation themes and smart specialization linkages. The adaptation themes include water management, biodiversity and ecosystem-based approaches, infrastructure and the built environment, health and well-being, agriculture and food systems, and risk, vulnerability, and governance. The smart specialization linkages focus on digital transformation, energy transition, and sustainable agriculture. The findings indicate that the relationship between climate adaptation and smart specialization is real but fragmented, often implicit rather than explicit. The strongest connections emerge through combinations of governance design, enabling infrastructures, territorial implementation, and ecosystem-based and resilience-oriented approaches. Digital transformation is identified as the most important horizontal enabling dimension, while energy transition and sustainable agriculture represent smaller but recognizable pathways. The report also highlights significant gaps: maladaptation is rarely addressed explicitly, climate justice and social cohesion are insufficiently operationalized, and adaptation monitoring remains underdeveloped.

4. Evidence of accomplishment

This report serves as evidence of accomplishment.





List of abbreviations

- **CINEA** — European Climate, Infrastructure and Environment Executive Agency
- **Climate-ADAPT** — European Climate Adaptation Platform
- **CO₂e** — carbon dioxide equivalent
- **CORDIS** — Community Research and Development Information Service
- **DG** — Directorate-General
- **EAFRD** — European Agricultural Fund for Rural Development
- **EC** — European Commission
- **EEA** — European Environment Agency
- **EPO** — European Patent Office
- **ERDF** — European Regional Development Fund
- **ESIF** — European Structural and Investment Funds
- **EOSC** — European Open Science Cloud
- **ESPON** — European Observation Network for Territorial Development and Cohesion
- **EuroSciVoc** — European Science Vocabulary
- **GDP** — gross domestic product
- **GERD** — Gross Expenditure on R&D
- **GHG** — greenhouse gas
- **H2020** — Horizon 2020
- **INTERREG** — interregional cooperation funding programme
- **IPCC** — Intergovernmental Panel on Climate Change
- **IPRs** — Intellectual Property Rights
- **KPI / KPIs** — Key Performance Indicator(s)
- **LEPs** — Local Enterprise Partnerships
- **MIP4Adapt** — Mission Implementation Platform
- **MWh/a** — megawatt-hours per year
- **MW** — megawatt
- **OECD** — Organisation for Economic Co-operation and Development
- **PACA** — Provence-Alpes-Côte d'Azur
- **PRISMA-P** — Preferred Reporting Items for Systematic review and Meta-Analysis Protocols
- **REGIO** — DG Regional and Urban Policy
- **RIS3** — Regional Research and Innovation Strategies for Smart Specialisation
- **S3** — Smart Specialisation Strategy / Smart Specialisation Platform
- **SBU**s — strategic business units
- **SME / SMEs** — small and medium-sized enterprise(s)
- **STEM** — Science, Technology, Engineering and Mathematics
- **SWOT** — Strengths, Weaknesses, Opportunities, Threats
- **TSSPs** — Thematic Smart Specialisation Partnerships





Preface

Across Europe, local and regional authorities are under growing pressure to respond to the accelerating impacts of climate change while maintaining economic growth and social cohesion. Many face limited resources, complex policy requirements and the challenge of ensuring that adaptation measures are both effective and fair. The aim of JustREACH is to advance just climate resilience by enhancing the capacity of authorities, businesses and citizens to design and implement adaptation actions that align with regional innovation and development strategies. Through co-creation, knowledge integration, and practical application, the project supports a more equitable and resilient transition for all regions.

TUD – DELFT UNIVERSITY OF TECHNOLOGY	NL	
BME – BUDAPEST UNIVERSITY OF TECHNOLOGY AND ECONOMICS	HU	
THNK – THINK-E	BE	
JR – JOANNEUM RESEARCH	AT	
DAEM – DIMOS ATHINAION EPICHEIRISI MICHANOGRAFISIS	GR	
QUB – QUEENS UNIVERSITY BELFAST	UK	
WIP – WIRTSCHAFT AND INFRASTUKTUR GMBH & CO. PLANUNGS KG	DE	
REGEA – NORTH-WEST CROATIA REGIONAL ENERGY AND CLIMATE AGENCY	HR	
LCF – BODENSEE-STIFTUNG	DE	
I-ENER – I-ENER	FR	
PBL – MINISTERIE VAN INFRASTRUCTUUR EN WATERSTAAT	NL	
HOL – HOLISTIC IKE	GR	
LUH – LEIBNIZ UNIVERSITEIT HANNOVER (L3S FORHUNGSZENTRUM)	DE	
UB – UNIVERSITY OF BERN	CH	



Executive Summary

This deliverable reviews and consolidates EU knowledge on the relationship between climate adaptation and smart specialization. Its purpose is to map how EU projects, knowledge platforms, and strategic documents connect climate adaptation with regional innovation and development priorities. Additionally, it aims to provide an empirical basis for the future development of a more structured approach to just resilience. The report applies a policy-oriented systematic review and mapping approach, integrating project databases, EU knowledge platforms, strategic documents, datasets, indicators, and practice-oriented material. Key sources include CORDIS, Climate-ADAPT, the Mission Implementation Platform, ESPON, and the Smart Specialisation Platform. The analysis is organized along two dimensions. The first dimension focuses on adaptation themes, including water management, biodiversity and ecosystem-based approaches, infrastructure and the built environment, health and well-being, agriculture and food systems, and risk, vulnerability, and governance. The second dimension examines the main smart specialization topics, particularly digital transformation, energy transition, and sustainable agriculture. This dual framework enables the identification of not only which themes are present but also how they connect to innovation-driven and territorially embedded transformation pathways.

According to the key findings, the relationship between climate adaptation and smart specialization cannot be described through simple one-to-one thematic correspondences. The project-based analysis reveals that the strongest connections arise from recurring combinations of problem framing, governance design, enabling infrastructures, and territorial implementation. In the CORDIS-based project portfolio (including 173 recent EU-funded projects), the most prominent adaptation themes include risk, vulnerability and governance, biodiversity and ecosystem-based approaches, and infrastructure and the built environment. Meanwhile, digital transformation emerges as the most important horizontal enabling dimension, while energy transition and sustainable agriculture are identified as smaller but clearly discernible specialization pathways. The report's keyword and objective analyses indicate that adaptation in EU projects is not primarily framed as a collection of isolated technical measures. Instead, it is operationalized through assessment frameworks, decision-support systems, modeling, monitoring, stakeholder engagement, and regional capacity-building. A key insight is that this pattern is evident across several levels of analysis within the same project portfolio.

The Climate-ADAPT best practice collection offers an implementation-focused perspective on adaptation. While the CORDIS portfolio effectively showcases research, innovation, and knowledge infrastructure related to adaptation, the best practice collection highlights the most effective practical applications of adaptation. The reviewed best practices consistently emphasize the importance of participation and partnerships, effective water and flood management, capacity building, evidence-based planning, nature-based solutions, measures to address heat risks, and local cooling interventions. It demonstrates that adaptation often becomes evident at local and regional levels through initiatives such as water management, heat-risk reduction, ecological restoration, and community-based planning, rather than just in project descriptions.

The review of regional and national smart specialisation strategies highlights a crucial layer of evidence. The analyzed Smart Specialisation Strategy (S3) documents indicate that the relationship between climate adaptation and smart specialisation is often partial and implicit. The strongest areas of integration include digitalisation, energy transition, mobility, industrial modernisation, and urban infrastructure. However, a systematic review of shortcomings reveals that climate





adaptation is frequently not framed as an explicit strategic category. Instead, it tends to be embedded within broader technological, economic, or innovation priorities. In many cases, ecological adaptation is underdeveloped, social vulnerability and territorial justice are not adequately addressed, and adaptation-specific indicators or monitoring systems are lacking. This suggests that while there is a connection between S3 and climate adaptation, it is often more focused on technology and competitiveness rather than on social justice or ecological resilience.

The report provides significant added value through its gap analysis, highlighting three major weaknesses. First, maladaptation is rarely addressed explicitly. While maladaptive risks are present in the material, they typically emerge indirectly through concepts such as vulnerability, justice, governance, or territorial targeting, rather than being defined as a clear analytical category. Second, the concepts of climate justice and social cohesion are not sufficiently operationalized. While projects and strategies often reference skills, jobs, human capital, or inclusion, they do so less frequently in connection with climate exposure, unequal burdens, or issues of territorial justice. Third, the monitoring of adaptation and the indicators used are underdeveloped. Although adaptation is often mentioned in strategic discussions, it is rarely associated with clear metrics, evaluation frameworks, or systematic monitoring. These gaps are not merely analytical issues; they also hinder the practical integration of adaptation into regional development.

The main message of D2.1 is that the relationship between climate adaptation and smart specialization within the EU knowledge landscape is real, but fragmented, promising, yet uneven, and tends to be more implicit than explicit. The strongest connections emerge when adaptation is integrated into broader regional transformation processes, particularly in areas such as digital transformation, energy transition, infrastructure resilience, nature-based solutions, and territorial governance. However, the report indicates that the next step should not just focus on gathering more examples; rather, it is crucial to systematically incorporate aspects like justice, maladaptation, monitoring, and territorial differentiation into the understanding and assessment of equitable resilience.



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1 Introduction

1.1 Purpose and scope of the deliverable

The purpose of Deliverable 2.1 is to provide a report on the current knowledge in the EU regarding climate adaptation and smart specialization. This report serves as the first structured synthesis within the JustREACH project, illustrating how these two areas are connected across various projects, knowledge platforms, strategic documents, and practical sources. Rather than focusing on a single policy area or database, this deliverable brings together different types of evidence to clarify how climate adaptation is framed, supported, and implemented in relation to regional transformation and innovation-led development within the European Union. As such, the deliverable is both descriptive and analytical: it documents the existing knowledge base while also examining its organization, identifying the strongest linkages, and highlighting significant gaps. The scope of the deliverable is defined by Task 2.1 of the JustREACH project, which calls for a systematic review and mapping of existing EU climate adaptation projects, tools, and data, along with the support provided to regions for developing smart specialization plans. Consequently, it encompasses project databases, EU knowledge platforms, strategic and policy documents, datasets, indicators, and practical materials. This broad scope is essential since the relationship between climate adaptation and smart specialization is not always evident in individual documents or isolated databases. In practice, relevant knowledge is distributed across multiple sources that operate at different levels and for various purposes. A central task of Deliverable 2.1 is, therefore, to make these sources comparable within a unified analytical framework.

The deliverable focuses on the context of the European Union, specifically examining EU-funded projects, EU-level knowledge infrastructures, and relevant strategic materials at regional and national levels concerning adaptation and smart specialization. The analysis primarily covers the past decade to reflect current policy cycles, recent project portfolios, and contemporary implementation strategies. Within this framework, the review explores both conceptual and practical connections. It investigates how existing climate adaptation initiatives align with regional transformation goals, resource allocation mechanisms, social cohesion considerations, and infrastructure resilience. Additionally, it examines the relationship between climate adaptation and smart specialization across various territorial levels, including EU, national, regional, and local contexts. To structure this extensive field, the deliverable employs two main analytical dimensions. The first includes a set of adaptation themes, such as water management, biodiversity and ecosystem-based approaches, infrastructure and the built environment, health and well-being, agriculture and food systems, and risk, vulnerability, and governance. The second dimension focuses on the linkages of smart specialization, particularly in digital transformation, energy transition, and sustainable agriculture. This dual structure enables the report to do more than simply list topics; it allows for the identification of not only the presence of specific themes but also how they are interrelated, the most common combinations, and how adaptation efforts connect to broader regional development and innovation agendas.

The deliverable does not aim to provide a comprehensive inventory of all available EU materials. Instead, its focus is more selective and analytical, seeking to build a broad and robust evidence base to identify key patterns. This includes examining the strongest areas of integration between climate adaptation and smart specialization, the most evident implementation pathways, and the main shortcomings in the current knowledge landscape. Special attention is given to social cohesion, climate justice, risks of maladaptation, territorial differences, and how well existing strategies and tools are operationalized through indicators, monitoring systems, or guidance that is relevant to practice. In this regard, the deliverable also conducts a gap analysis, identifying what is present in the current EU knowledge base as well as areas that are weakly articulated, insufficiently monitored, or underdeveloped.





Finally, the scope of D2.1 is defined by its role within the wider JustREACH project. The deliverable is intended to provide a common empirical and conceptual starting point for the subsequent work on climate justice, climate resilience, maladaptation, and just resilience. In this report, maladaptation refers to adaptations that result in socially unequal, poorly targeted, or inadequately monitored outcomes. This leads to increased vulnerability, the exclusion of vulnerable groups, and the transfer of climate risks and burdens across different territories, sectors, or generations. Its immediate value lies in organising a fragmented evidence base into a coherent structure that can support later tasks concerned with framework development, indicators, validation, scenario-building, and implementation support. D2.1 therefore functions as both a review deliverable and a foundational input for later stages of the project.

1.2 Position of T2.1 within JustREACH and relation to other tasks

Task 2.1 is foundational to JustREACH, as it establishes the empirical and analytical framework that later tasks can build upon. Its purpose goes beyond simply reviewing existing materials; it also organizes the project's initial knowledge base around key themes of adaptation, smart specialization linkages, and critical gaps related to justice, maladaptation, territorial differences, and operationalization. In this way, T2.1 serves as a common reference point for subsequent work in WP2 and lays the narrative groundwork for future connections across work packages. It identifies what is already known, highlights the strongest connections between adaptation and regional transformation, and points out areas where further conceptual refinement or practical development is needed. This role is particularly important because JustREACH aims not only to review existing knowledge but also to translate it into a more operational framework for just climate resilience, which can be utilized in later tasks related to modeling, validation, implementation, and tool development. Below, the connection between T2.1 and the individual work packages of JustREACH is outlined.

WP1

This work package is on project management and coordination, thus T2.1 and D2.1 have no impact on it.

WP2

Task 2.1 aimed to gain a comprehensive overview of existing data and projects on EU climate adaptation and regional transformation strategies. Several subsequent and parallel tasks are linked to this.

Most immediately, Task 2.2 will rely on the consolidated data and knowledge base in T2.1 to conduct a thorough and systematic scientific literature review on the assessment approaches to climate justice, climate resilience and inappropriate adaptation practices. In particular, key words, terms and other strings are to be used to scan Web of Science and Scopus databases for their occurrence in scientific literature. Likewise, EU knowledge is to be scanned similarly on EU Climate-ADAPT, on the Smart Specialisation Platform, and the European Structural and Investment Funds (ESIF) database, and the CORDIS database. Priority is given to significant studies which have been produced during the past ten years, with a focus on EU-specific research, but encompassing global perspectives alike, to identify good practices.

The main objective is to (a) develop a framework (the IJR Framework) and (b) corresponding indicators for just climate resilience (Task 2.3) which could then be used to assess how just climate adaptation attempts are. The framework and indicators developed will serve as a foundational tool for WPs 3 and 4. Having established the main factors for just resilience, the proposed set of climate justice indicators will measure the distribution of climate risks and adaptation benefits across the social spectrum and geographic extent, highlighting the most vulnerable societal groups. The IJR





Framework is validated in Task 2.4. This will encompass testing the applicability, effectiveness and scalability of the framework in a diverse array of socio-economic and climatic contexts. The IJR tool is distributed to the Signatories to the Mission Adaptation Charter for feedback on feasibility and usability as a checklist tool. Based on follow-up research, it is determined which indicators are best suited for each specific type of settlement, and the framework is further refined and updated.

WP3

Deliverable 2.1 has limited direct impact on WP3, as it is primarily the tasks and deliverables based on T2.1 and D2.1, in particular, D2.3 and D2.4 which have a more significant relationship with the tasks in WP3, especially D2.3 on T3.4.

WP4

D2.1 will serve as a basis for T4.1, the development of adaptation pathway scenarios, complemented by the insights from the surveys in T3.1. Additionally, there is use for the findings in D2.1 in further tasks in WP4, especially in T4.4 in building the impact assessment database, as a way of providing secondary experiences, in support of WP5.

WP5

D2.1 is related to WP5 primarily through its derived deliverables D2.3 and D2.4, and is mostly apparent in T5.2, T5.3 and T5.3, as well as T5.4 and T5.5, where partners make good use of the inventory in creating and evaluating the Social Learning Videos and in testing the JustREACH prism at pilot sites.

WP6

Within the scope of WP6, D2.1 is relevant to building an interactive tool for query comprehension, retrieval and document comprehension. In particular, the findings in D2.1 can be used in building a query understanding module in T6.2 by using key elements, including phrases and language use within the European projects reviewed. Similarly, the retrieval and comprehension module in T6.3 can be trained by relying in the outcomes of WP2, especially D2.1, D2.3 and D2.4. Finally, the same can be used for the compilation, testing and validating the JustREACH prism in T6.5.

WP7

D2.1 can be employed in identifying target audiences in D7.1, whereas further parts in WP2 can be used in most other tasks in WP7. The Transformation Playbook in D7.3 will be partially based on the outcomes of WP2.

1.3 Methodological overview – systematic review and mapping

The methodological approach follows the PRISMA-P guidelines, adapted for a policy-oriented review context. This means that the deliverable is not restricted to scientific publications or traditional academic databases; rather, it encompasses a wide range of sources. The analysis includes project databases, EU knowledge platforms, strategic documents, indicator and dataset repositories, as well as both qualitative and quantitative policy-relevant materials. This multi-source approach is essential because the connection between climate adaptation and smart specialization is only partially reflected in single, unified policy documents. Instead, it is often spread across various sources that operate at different levels and serve different purposes. Therefore, this review aims to make project-based evidence, strategic directions, and the broader data landscape analytically comparable within a cohesive framework.

Source identification was conducted in several stages. Initially, expert knowledge from within the consortium, as well as information from established European platforms and relevant databases, served as starting points. This was supplemented by a snowball sampling process, which helped identify additional sources, platforms, and projects through references and cross-links found in the





initially selected materials. Simultaneously, systematic searches of databases and platforms were carried out using predefined keywords. The primary entry points for the review included Climate-ADAPT, the Mission Implementation Platform, ESPON, the S3 Smart Specialisation Platform, and CORDIS. Each of these platforms offers different types of knowledge: some focus on projects, others provide indicators or case studies, while some contain strategic or policy-related information. Therefore, the methodological framework assumed from the beginning that the outcome of the review would not consist of a uniform database but rather a structured map of partially comparable knowledge sources.

The process for including and excluding sources was based on their relevance and comparability. The main criterion for inclusion was that a source needed to address climate adaptation and/or smart specialization within the EU context, while also providing meaningful information on the relationship between these two areas. The geographical focus was on EU Member States, with relevant supplementary information from EEA countries and selected candidate countries. The temporal scope covered the past ten years to ensure that the review reflected current policy cycles and contemporary evidence. The review primarily considered English-language sources, though multilingual materials and translated documents were included as appropriate. The screening process was conducted in multiple stages and applied checks by multiple reviewers to minimize individual bias and ensure that the final selection aligned with the overall objectives of the review. A key methodological step was the development of a classification and extraction framework. Each selected source was processed through a standardised template that recorded basic identifying information, temporal characteristics, source type, thematic focus, methodological features, and a short content summary. The thematic classification was organised along two main dimensions. The first dimension consisted of adaptation themes, including water management, biodiversity and ecosystem-based approaches, infrastructure and the built environment, health and wellbeing, agriculture and food systems, and risk, vulnerability and governance. The second dimension captured linkages to smart specialisation, with particular attention to digital transformation, energy transition, and sustainable agriculture. This dual classification made it possible not only to identify which themes appeared in the selected material, but also to assess how climate adaptation challenges were linked to innovation-oriented and regionally embedded transformation pathways.

The report combined qualitative analysis with structured mapping tools. In the case of the project portfolio, CORDIS and the related mission-oriented project details formed the main basis for comparative analysis. The review utilized both formal project metadata and additional resources, such as objective statements, reporting summaries, and available descriptions of results. This approach allowed for keyword-based and co-occurrence analyses, as well as more in-depth thematic examinations of how adaptation themes and smart specialization topics are implemented in practice. As a result, the review extended beyond mere data collection and included thematic analysis aligned with key research questions. These questions encompassed climate adaptation objectives, connections to regional transformation, social cohesion, justice and just transitions, infrastructure robustness, and the identification of shortcomings and risks of maladaptation.

An important implication of this methodological logic is that the review does not aim to provide a simple inventory of sources. Its purpose is not the exhaustive cataloguing of all available material, but the construction of an analytical corpus through which it becomes possible to assess the extent to which EU policies, projects, and knowledge infrastructures support connections between adaptation themes, between smart specialisation topics, and across these domains. A major added value of the review is therefore its gap-analysis function: identifying which themes are overrepresented, which are less visible, and where important blind spots remain, for example in relation to health, the explicit treatment of maladaptation, social justice, or territorial operationalisation. In this sense, the review serves not only a knowledge-consolidation purpose, but also a comparative and forward-looking one.

Quality assurance and validation were essential components of the methodological design. As outlined in the report, the findings underwent an initial internal cross-checking process among the





researchers involved in the review, followed by feedback at the consortium level. This step was particularly important due to the use of diverse source types, various kinds of evidence, and a partially interpretive thematic classification. The purpose of this iterative validation process was to enhance consistency, minimize discrepancies in categorization, and ensure that the final synthesis met the needs of the JustREACH project. Consequently, the methodological overview documents not only the key steps of data collection and analysis but also the review and feedback procedures that refined the results and made them usable for subsequent tasks.

1.4 Structure of the report

The report is structured to ensure that its findings are methodologically clear and practically useful for policy-making and implementation-focused audiences. It begins with a concise executive summary that highlights the main findings and conclusions. Following this is the introduction, which outlines the purpose of the report, situates Task 2.1 within the JustREACH project, provides a brief overview of the methodology, and describes the overall structure of the document. The methodology chapter goes into detail about the review framework, including the search strategy, eligibility criteria, classification logic, and the main stages of the analysis. The report then proceeds to the main results chapters, starting with an introduction to the relevant data sources and platforms. This is followed by a project-based analysis primarily derived from CORDIS and related materials. This section includes mapping based on keywords and objectives, thematic interpretations of project goals and outcomes, and classifications of projects according to adaptation themes and dimensions of smart specialization. Next, the report reviews documents related to S3 (Smart Specialisation Strategy) and regional transformations, paying particular attention to national and regional smart specialization priorities. Subsequent sections focus on cross-domain linkages, integration opportunities, gaps in the current understanding, and risks of maladaptation. The report concludes with broader analytical implications and findings that will support the next stages of the project. This structure allows readers to progress from identifying sources and understanding the methodological foundations to engaging in comparative interpretations and drawing strategically relevant conclusions.





2 Methodology

2.1 Description of the review framework

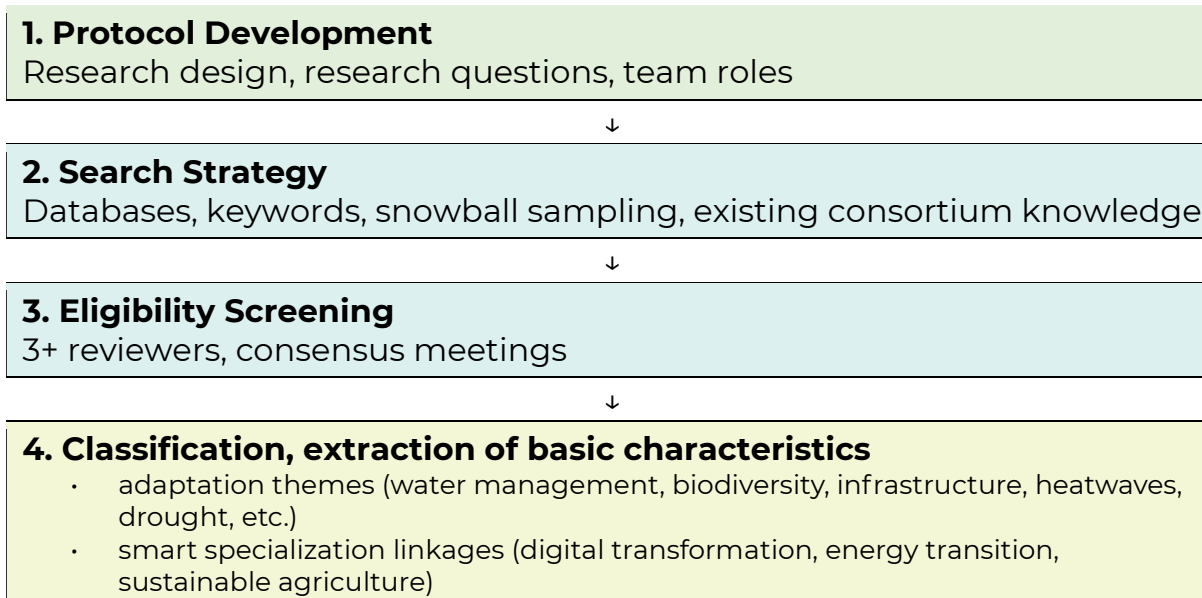
This section describes the methodological framework for Task 2.1: Review and Consolidate EU Knowledge and Data on Climate Adaptation and Smart Specialization. The review follows a structured approach integrating PRISMA-P (Preferred Reporting Items for Systematic review and Meta-Analysis Protocols) guidelines¹ adapted for policy-focused reviews. The data collection process encompasses both quantitative data (datasets, indicators, project metadata, funding schemes) and qualitative data (policy documents, strategic plans).

As a first step, the methodological framework has been defined, which outlines the key research objectives of Task 2.1, the data collection process, criteria for eligibility, task management and responsibilities, ensures quality and feedback throughout the review process, defines key outputs, and establishes reporting guidelines aligned with PRISMA requirements.

Defined research objectives are to identify:

- To what extent do EU policies and projects support and make links between adaptation topics, between smart specialization topics, and across these domains;
- To what extent do EU climate adaptation, smart specialization policies and projects address social cohesion and just climate resilience;
- What are the shortcomings, possible maladaptations, and key gaps regarding climate adaptation and smart specialization tools?

The following diagram illustrates the systematic review process, showing the sequential steps, key decision points, and expected outputs.



¹ Shamseer L, Moher D, Clarke M, Ghera D, Liberati A, Petticrew M, Shekelle P, Stewart L, PRISMA-P Group. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. *BMJ*. 2015 Jan 2;349(jan02 1):g7647



- name, source type, website owner, publication year, last update date, qualitative/quantitative/mixed approach
- content description: short summary, methodology overview, key indicators used



5. Thematic Analysis

RQs address:

- connection between and across adaptation and smart specialization topics
- climate adaptation objectives supported
- regional transformation goals supported
- resource allocation mechanisms
- social equity, just transition
- infrastructure robustness
- used methodology, indicators
- shortcomings



6. Quality Assurance

Internal + consortium review



7. Synthesis

Integration, gap analysis



8. Reporting

D2.1, PRISMA checklist

Search strategy and source identification

Source identification employs a multi-pronged approach combining:

- Expert knowledge: Consortium partners contribute known sources from their respective expertise areas in climate adaptation and smart specialization
- Snowball sampling: Identification of additional sources referenced within initially identified materials, following citation trails
- Systematic database searches: Keyword-based searches in EU policy databases and project repositories using predefined search terms covering climate adaptation and smart specialization

Primary databases and platforms include Climate-ADAPT, Mission Implementation Platform (MIP4Adapt), ESPON, S3 Smart Specialisation Platform, and CORDIS. Expected outputs include a long list of identified sources, a comprehensive list of all searched databases with their respective coverage dates, specifying keywords, and Boolean operators.

Eligibility screening and selection

Eligibility assessment follows an adapted PRISMA-P approach, using explicit inclusion and exclusion criteria and a staged screening process tailored to a policy-oriented review. A PRISMA-style flow diagram of the review process is available at the official PRISMA website. The screening process ensures methodological rigor through multi-reviewer assessment by applying the following set of



inclusion criteria:

- Thematic relevance: Sources must address climate adaptation and/or smart specialization within the EU context
- Geographical scope: Focus on EU Member States, with consideration of EEA countries and candidate countries where relevant
- Temporal scope: Sources published or updated within the last 10 years (2015-2025)
- Language: English language sources, with consideration of key documents in other EU languages where translations are available

Each source undergoes independent review by at least three team members to confirm relevance. Sources flagged with uncertainty proceed to a team discussion meeting for consensus-based inclusion decisions. This multi-reviewer approach ensures robustness and reduces individual bias in source selection. The main outcome of this step is a final pool of eligible sources approved for detailed analysis.

Source classification and extraction of basic characteristics

Eligible sources are classified along the addressed topics of climate adaptation and smart specialization, such as water management, biodiversity, infrastructure, heatwaves, drought, digital transformation, energy transition, sustainable agriculture, etc). Within each dimension, sources are further categorized by data type: quantitative (datasets, indicators, metrics, project metadata), qualitative (policy documents, strategic plans, case studies, guidelines) or mixed. This dual classification framework enables systematic identification of synergies and gaps between adaptation planning and smart specialization strategies. Data extraction is performed independently by assigned researchers with cross-verification to ensure accuracy and consistency. Standardized data extraction addresses:

- Identification: Name, source type, institutional owner, URL
- Temporal information: Year published, year last updated, coverage period
- Thematic coverage: Adaptation and smart specialization themes
- Methodological information: Approach, data sources, limitations (where applicable)
- Content summary: Short description, objectives, methodology overview, key indicators used

Thematic Analysis

Each source undergoes structured thematic analysis addressing the key research questions:

1. Does the source make a connection between adaptation topics, between smart specialization topics, and across? How?
2. How does the source support climate adaptation objectives at the regional, national, and EU levels?
3. How does the source contribute to regional transformation goals and smart specialization strategies?
4. How does the source support resource allocation mechanisms?
5. How does the source incorporate social equity, just transition, and cohesion considerations?
6. How does the source support infrastructure robustness?
7. Short description of methodology, list of used indicators if relevant
8. To what extent do the strategies address thematic gaps, monitoring frameworks, social justice, and potential risks of maladaptation?

Thematic responsibility is distributed across the research team: each adaptation, smart specialization theme has one responsible researcher, while a lead researcher coordinates across themes to ensure analytical consistency. The thematic analysis generates completed analytical assessments for each source, thematic synthesis tables systematically addressing each research question, and a





preliminary gap analysis identifying areas of limited coverage or emerging concerns.

Quality assurance and validation

Initial findings undergo two rounds of collaborative review. The first round involves cross-checking among researchers directly involved in the review, ensuring consistency in interpretation and classification. The second round presents findings at the consortium level, collecting broader feedback from all project partners. This iterative process enhances validity and captures diverse expertise perspectives.

Synthesis and gap analysis

Based on feedback received during the validation rounds, findings are systematically refined and synthesized. This phase addresses the integration of consortium feedback into analytical conclusions

- Resolution of identified inconsistencies or conflicting interpretations
- Comprehensive mapping of connections between adaptation and smart specialization
- Systematic identification of knowledge gaps and underrepresented themes
- Prioritization of findings for subsequent project tasks

Reporting and dissemination

The report prioritizes narrative elements and accessible style, ensuring usability by diverse stakeholders, including policymakers, regional authorities, researchers, and practitioners. The report structure ensures PRISMA compliance while maintaining readability:

- Executive summary with key findings and recommendations
- Methodology section documenting the review process
- Detailed mapping of existing projects organized by adaptation themes (water management, biodiversity, infrastructure) and smart specialization areas (digital transformation, energy transition, sustainable agriculture)
- Analysis of cross-domain connections and integration opportunities
- Gap analysis with identification of shortcomings and maladaptation risks
- Policy recommendations for enhancing integration between adaptation planning and regional development

The final step includes a systematic PRISMA compliance check against all 17 checklist items to verify complete documentation of administrative information, introduction elements, and methods.

2.2 Description of data sources

Climate-ADAPT²

Climate-ADAPT is a partnership between the European Commission and the European Environment Agency (EEA) and gives information on adaptation in Europe. This platform provides support to a wide range of users with diverse professional profiles. The data shared cover different „areas“, such as (1) expected climate change in Europe, (2) current and future vulnerability of regions and sectors, (3) EU, national and transnational adaptation strategies and actions, (4) adaptation case studies and potential adaptation options, (5) tools that support adaptation planning. The platform organizes its information under different entry points: (1) EU Policy (EU Adaptation Policy, Adaptation in EU Policy Sectors, EU Regional Policy), (2) Countries, Transnational regions, Cities, (3) knowledge: Topics, Data and indicators, Research and innovation projects, Tools, Practice, (4) European Climate and Health

² <https://climate-adapt.eea.europa.eu/>





Observatory (accessible through "Knowledge"), (5) Networks. These entry points are already accessible from the website's homepage.

Climate-ADAPT highlights several topic-related news and events on its webpage, such as "Researchers reveal how climate change is shaping decisions to move – or stay put", "EU Agricultural Outlook 2025-2035: navigate challenges while embracing opportunities", "European Ocean Days", "The European Climate Pact annual event 2026: Together in action".

Mission Implementation Platform³

Mission Implementation Platform (MIP4Adapt) supports European regions, cities and local authorities to build climate resilience. The goal of the Mission is to accompany at least 150 European regions and communities towards climate resilience by 2030. Mission Portal is part of the European Climate Adaptation Platform (Climate-ADAPT), and developed by the European Commission, the European Environment Agency (EEA) and the Mission Implementation Platform (MIP4Adapt) team. On the website of the platform, visitors can read about Projects, Solutions, Knowledge and Data, Funding, News, *and Community of Practise*.

- **Projects:** EU-funded projects can be listed and collected in this section. Projects can be searched with the help of different filters, such as Funding Programme (Horizon Europe, HORIZON 2000, INTERREG), Climate Impacts (e.g. flooding, droughts), Adaptation Sectors (e.g. financial, agriculture), Adaptation Approaches (e.g. Adaptation Measures and Actions, Climate services, Just Resilience), Countries. Several different data points are displayed upon opening the project (e.g., lead, partners, date of creation, keywords, climate impact, duration). With this helpful function, synergies and transferable approaches can be explored.
- **Solutions:** this section supports regions and local authorities in their adaptation journey. *Adaptation Stories, Case Studies, Success Stories* can be found here. *Mission Case Studies* and the *Adaptation Stories* share experiences, *Adaptation Stories* are shorter, and more accessible.
- **Knowledge and Data:** knowledge, data, and tools relevant to the regional scale are offered by the Mission portal to assist regional authorities in developing, implementing, and monitoring climate change adaptation plans.
- **Funding:** Funding projects, adaptation measures is key to succeed in adaptation planning (for regions and local authorities). This section helps to find information on funding opportunities (funding sources from EU institutions, agencies and Member States governments), funding calls (Horizon Europe, the EU research and innovation framework programme), and a funding & financing guide (gives guidance on diverse funding options, such as grants, PPPs, crowdfunding, and philanthropic funds).

ESPON⁴

ESPON is an EU funded programme, which brings together research and policies, by providing territorial analyses, data and maps. It supports EU development policies (particularly Cohesion Policy) with facts and evidence and supports public authorities in positioning their region or city for successful future development policies. ESPON develops territorial-focused studies based on the needs of European public authorities (at local, regional, and national levels). There are diverse research outputs: study reports, publications, interactive maps and dashboards (for illustration), open data sets (for download and use), story maps (longer), blog posts (shorter), videos, magazines articles.

³ <https://climate-adapt.eea.europa.eu/en/mission/the-mission/about-mip4adapt>

⁴ <https://www.espon.eu/>





Policymakers, citizens, journalists and researchers can also benefit from ESPON research.

On the website we can search for ESPON projects; by using filters (see below) this process can be easy:

- **Thematic Action Plans:** e.g. adapting to the impacts of climate change, place resilient to crisis, smart connectivity.
- **Topics:** e.g. economy, finances, trades, population and living conditions, regional economy.
- **Project type:** applied research, European research, on demand territorial study, targeted analysis, territorial impact assessment.
- **Support:** crosscutting activities, EU presidencies, territorial impact assessment.
- **Coverage:** European, Global, Transnational.
- **Countries.**
- **EU Macro-regions:** Adriatic-Ionian, Alpine, Baltic Sea, Danube.
- **Specific focus:** Regional – NUTS 2.

After accessing one of the projects, you can see the title of the project, the “Thematic Action Plans” it belongs to, its lifetime, budget (in EUR), shorter description, its key outputs, the stakeholders, service providers and contacts, too. At the bottom of the page, some topics are listed (which you could have filtered earlier), e.g., governance or regional economy.

S3 Smart Specialisation Platform⁵

In 2015, the European Commission launched four dedicated S3 Thematic Platforms related to Agri-Food, Energy, Industrial Modernisation, and Sustainable Blue Economy (it is the newest one since 2022). These platforms are joint initiatives between several Directorates-General of the European Commission under the lead of DG Regional and Urban Policy (REGIO), including Agriculture and Rural Development (AGRI), Energy (ENER), Internal Market, Industry, Entrepreneurship and SMEs (GROW), Maritime Affairs and Fisheries (MARE), and Research and Innovation (RTD)). Since 2020, the management has been transferred to the DG Regional and Urban Policy. The objective of these platforms is to provide the structural support for an interregional collaborative network of strategic Thematic Smart Specialisation Partnerships (TSSPs); thus, these partnerships can work together in shared smart specialisation areas. TSSPs gather regions based on their shared interest in their smart specialisation strategies to explore new value chains in specific priority areas; thus, it can be described as a kind of value-creating process. Their target areas have high potential for technological, societal, and ecological return at the regional and European level and reflect shared smart specialisation strategy priorities across relevant stakeholders. On its website, you can see the four Thematic Platforms (Agri-food, Energy, Industrial Modernisation, Sustainable Blue Economy), of which you can read more. Clicking on one of these themes, there is some important information: a shorter summary of the area and the Partnerships. These Partnerships give some more knowledge; you can read about their context, establishment year, Leading and Participating Regions (which are illustrated on a map as well), Mission, Objectives (networking, sharing knowledge, policy, identifying gaps in technological infrastructure and modelling tools), and Main activities. Organizations involved (listed by countries) are also presented here. This section also gives information about the Shared smart specialisation areas, Related Projects, Contacts and the Latest news and upcoming events.

⁵ https://ec.europa.eu/regional_policy/policy/communities-and-networks/s3-community-of-practice/thematic_platforms_en





CORDIS⁶

On this website, you can browse comprehensive information about EU Research & Development projects. Researchers, innovators, and curious visitors can find information on projects, topics, and publications funded by the EU's research programs - in multiple languages (Spanish, German, English, French, Italian, and Polish). Different types of content can be accessed: Thematic Packs (up-to-date articles, bringing information about EU-funded projects and results), Projects and Results (entire framework programmes' data as open data, articles highlighting key projects, interactive maps showing project connections and advanced dashboards), Videos and Podcasts, News, Datalab.

Within "Projects and Results", Horizon 2020 and Horizon Europe projects are also available:

- **Horizon 2020 projects (2014-2020):** <https://data.europa.eu/data/datasets/cordish2020projects?locale=en>
 - Six distinct sub-sets (in various formats) make up the dataset: (1) H2020 projects – which includes participating organisations, legal basis information, topic information, project URLs and classification with the European Science Vocabulary (EuroSciVoc), (2) H2020 project IPRs (Intellectual Property Rights) [N.B.: This dataset only includes patent data for awarded patents available in the database of the European Patent Office (EPO)], (3) H2020 project deliverables (meta-data and links to deliverables included since May 2019), (4) H2020 project publications (meta-data and links to publications included since May 2019), (5) H2020 report summaries (periodic or final publishable summaries included since September 2018), (6) Principal Investigators in Horizon 2020 ERC projects.
 - Reference data (programmes, topics, topic keywords funding schemes (types of action), organisation types and countries): <https://data.europa.eu/euodp/en/data/dataset/cordisref-data>
- **Horizon Europe projects (2021-2027):** <https://data.europa.eu/data/datasets/cordis-eu-research-projects-under-horizon-europe-2021-2027?locale=en>
 - The dataset is composed of different sub-set (in different formats): HORIZON projects – which includes participating organisations, legal basis information, topic information, project URLs and classification with the European Science Vocabulary (EuroSciVoc), HORIZON project deliverables (meta-data and links to deliverables), HORIZON project publications (meta-data and links to publications), HORIZON report summaries (periodic or final publishable summaries).

⁶ <https://cordis.europa.eu/>





3 Results

3.1 Project database construction and analytical framework

This chapter focuses on a project database created for comparative analysis. The primary source for this database was CORDIS, the European Commission's main resource for information on projects funded under the EU research and innovation framework programs. CORDIS offers a structured project environment that includes project records, results, publications, and related outputs, making it the most suitable source for building a comparable database of adaptation-relevant projects. The initial identification of projects in CORDIS involved a broad keyword search using terms "climate resilience," "climate justice," and "maladaptation." This search was designed to be inclusive. However, the complete set of search results was not considered the final analytical pool. The raw results included projects with varying levels of relevance, different interpretations of the search terms, and differing levels of descriptive detail. Therefore, the final project database was constructed through a second stage of relevance-based selection, including 173 EU-funded projects. Projects were included only if climate adaptation was a significant aspect, and if the dimensions of resilience, justice, or maladaptation could be identified as meaningful analytical components. This approach ensured internal consistency and facilitated cross-project comparisons.

During the preparation of the chapter, we reviewed two additional European sources: Climate-ADAPT and ESPON. However, these sources were not utilized for direct extraction of project information due to their structure being incompatible with the CORDIS-based project database. Climate-ADAPT primarily serves as a knowledge platform and resource catalogue. Its content is organized around adaptation options, case studies, and other knowledge objects, which can be explored by climate impact, adaptation sector, and IPCC category. In contrast, ESPON is a portal for territorial data and indicators. It provides datasets, indicators, and tools important for analyzing territorial development and cohesion policy across various geographical levels. Neither source offers a project structure that is directly comparable to the project records available in CORDIS. While their review was beneficial for contextual understanding, it did not allow for direct integration into the project database. However, Climate-ADAPT best practices and case-based materials remain relevant as complementary practice-based evidence. This limitation may later be considered as an analytical gap, particularly regarding the connection between project-based evidence and broader adaptation knowledge or territorial indicator systems.

The project database was enhanced by the Mission Projects Catalogue 2025 from the EU Mission on Adaptation to Climate Change. According to its official description, the catalogue consolidates information on 46 Horizon Europe projects, detailing their objectives, achievements, targeted climate risks, and the regional or local authorities involved. Unlike Climate-ADAPT and ESPON, this source presents initiatives in a project-based format, aligning well with the structure of the database. Relevant projects were selected from the catalogue using the same criteria for relevance that were applied to the CORDIS results. The analytical framework in this chapter is organized around two dimensions. First, projects are categorized by adaptation themes, which include water management, biodiversity and ecosystem-based approaches, infrastructure and the built environment, health and wellbeing, agriculture and food systems, and risk, vulnerability, and governance. Second, projects are classified based on their relationship to smart specialization topics, with a focus on digital transformation, energy transition, and sustainable agriculture. This framework allows for the interpretation of the project database from both a climate adaptation perspective and an





innovation-oriented regional development perspective. Figure 1 shows the overview of the applied PRISMA Protocol to analyse selected projects and best practices.

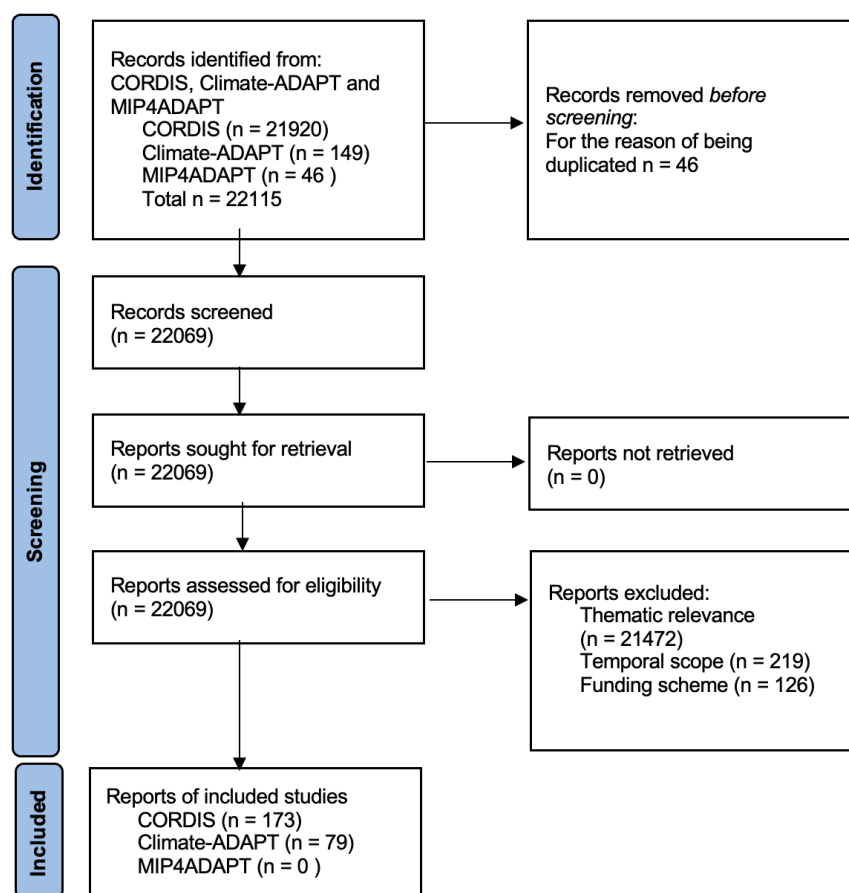


Figure 1. Adapted PRISMA-style flow diagram for the source identification, screening, classification and synthesis workflow

To enhance the thematic interpretation of the selected portfolio, two exploratory co-occurrence maps were created using VOSviewer. The analysis was based on the textual material from 173 selected CORDIS project records. For Figure 2, we utilized the keywords found in these project records, while Figure 3 was based on the project objectives and result-summary texts. Co-occurrence was defined at the level of individual project records, meaning that two terms were linked when they appeared in the same record. Before mapping, we harmonized duplicate forms and obvious lexical variants, while also excluding generic terms that had limited analytical value. The resulting maps are network visualizations in which the size of each node represents the relative frequency of a term, the strength of the links indicates the intensity of co-occurrence, and the spatial proximity of nodes suggests stronger relatedness within the VOS mapping layout. These maps serve as exploratory analytical tools to identify dominant thematic clusters and recurring associations, rather than as standalone statistical tests.



3.2 Keyword analysis

The keyword co-occurrence analysis carried out using VOSviewer on the selected CORDIS-based project portfolio reveals that climate adaptation is a multidimensional field rather than a narrowly defined sector or technological issue. The network is centered around key terms such as climate resilience, climate justice, climate change, adaptation, and nature-based solutions. However, these terms are connected to a broader range of concepts related to participation, governance, vulnerability, digital mediation, and sustainability. This suggests that the selected projects frame adaptation not just as a response to specific climate impacts, but as a wider process involving social organization, institutional capacity, and territorial transformation. It is important to note that the prominence of climate resilience and climate justice should be understood in the context of how the database was constructed. The project corpus was initially identified through broad searches that used the terms “climate resilience,” “climate justice,” and “maladaptation.” As a result, the network reflects both the internal structure of the selected projects and the logic behind the database's assembly. Despite this limitation, the keyword structure offers a valuable overview of the dominant thematic relationships within the portfolio.

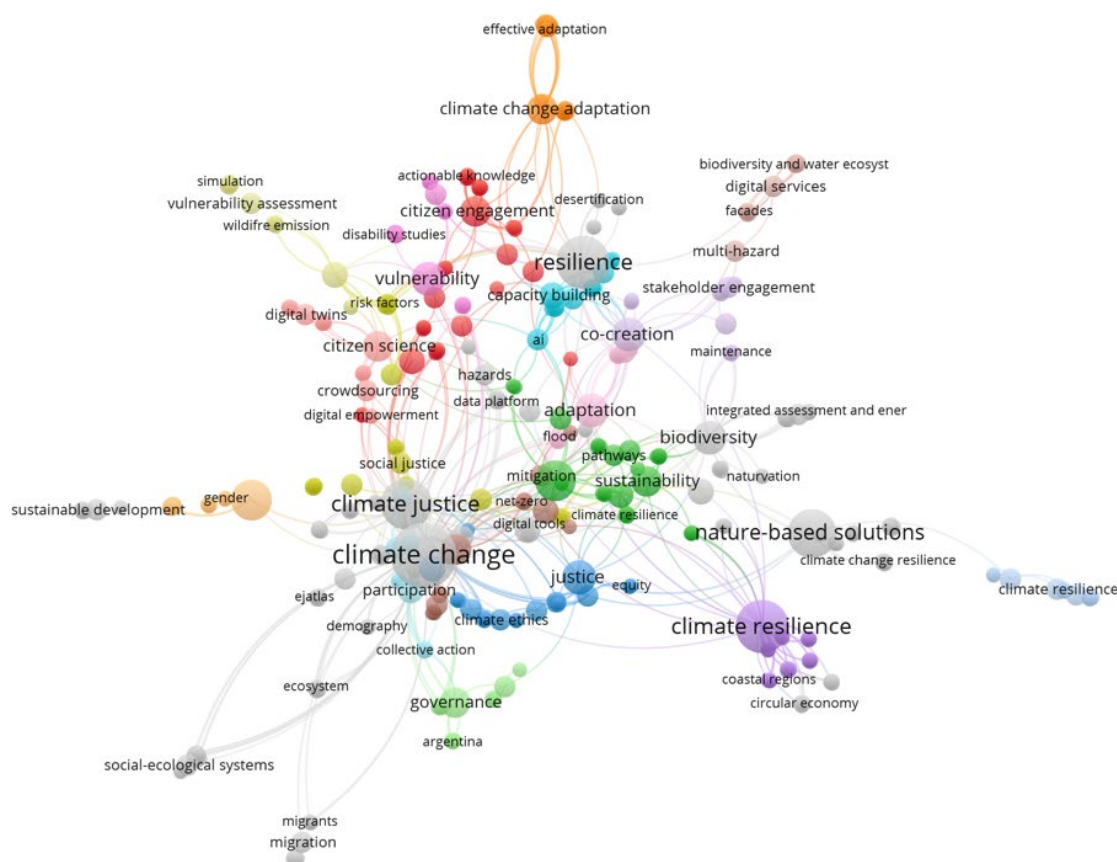


Figure 2. Keyword co-occurrence in the selected projects

A first important observation concerns the relatively weak position of maladaptation in the network.



While climate resilience and climate justice occupy central and well-connected positions, maladaptation does not emerge as a major keyword cluster. This suggests that the project portfolio is primarily framed in positive and solution-oriented terms, with emphasis on resilience building, just transitions, inclusion, and adaptive capacity. However, this does not mean that maladaptive risks are absent. Rather, they appear to be addressed indirectly through concepts such as vulnerability, risk factor, social justice, and governance. In this sense, maladaptation functions less as an explicit project label than as an implicit concern embedded in broader debates on inequality, participation, and the distribution of adaptation benefits.

In this chapter, several adaptation themes emerge, with a strong emphasis on risk, vulnerability, governance, biodiversity, ecosystem-based approaches, and infrastructure within the built environment. Importantly, these themes are not isolated; they are interconnected through recurring relational structures. One of the most significant clusters links resilience, vulnerability, capacity building, co-creation, citizen engagement, stakeholder involvement, and actionable knowledge. This indicates that adaptation is often viewed as a governance and knowledge-production process, rather than just a series of physical interventions. The frequent use of terms like participation, citizen science, crowdsourcing, and co-creation suggests that many adaptation projects adopt participatory and socially mediated decision-making approaches. Another key pattern is the notable emphasis on biodiversity and ecosystem-based adaptation. Terms such as nature-based solutions, biodiversity, sustainability, pathways, and adaptation form one of the most recognizable structures within the network. This indicates that ecosystem-based approaches are not just peripheral to the project portfolio; they constitute a central logic of adaptation. Furthermore, the co-occurrence of biodiversity-related terms with broader concepts such as climate resilience and sustainability suggests that these approaches are framed not only in ecological terms but also as essential components of wider transformation agendas.

The theme of infrastructure and the built environment is also clearly present, although in the network it appears less as a single compact block and more as a field connected to resilience, risk, and digital support functions. Terms such as digital twins, facades, maintenance, multi-hazard, and digital services indicate that a substantial part of the portfolio approaches adaptation through the planning, operation, and resilience of urban and infrastructural systems. The association of these terms with participation-, resilience-, and governance-related concepts suggests that built-environment adaptation is framed not only as a technical matter, but also as a question of evidence-based planning, local implementation, and institutional coordination. The remaining adaptation themes are present in more differentiated ways. Water management appears through terms associated with biodiversity and water ecosystems, coastal regions, and hazard-related expressions, but it does not form a large autonomous cluster. This supports the interpretation that water functions mainly as a connecting theme linking ecological systems, territorial risks, and infrastructural concerns. Agriculture and food systems are less prominent in the visual centre of the network, but remain identifiable through associations with sustainability, biodiversity, and productive-system resilience. Health and well-being appear more weakly as an independent keyword field, which is consistent with the broader pattern in the project portfolio: health-related adaptation is present, but generally less dominant than biodiversity-, infrastructure-, or risk-oriented themes.

From the perspective of smart specialization, the concept of "network" highlights the importance of digital transformation. Terms such as digital twins, AI, data platforms, digital tools, digital services, and simulation are distributed across various clusters rather than being confined to a single field.





This observation is analytically significant; it indicates that digital transformation functions not as a standalone thematic area, but rather as a transversal enabling capacity that connects different adaptation themes. In the network, digital terms are associated with resilience, vulnerability assessment, infrastructure, participation, and knowledge generation. This supports the interpretation made throughout the chapter that digital transformation is the primary horizontal smart specialization topic within the selected project portfolio. On the other hand, the two additional smart specialization topics—energy transition and sustainable agriculture—are less prominent in the keyword map but can still be identified as secondary trajectories. Energy-related terms do not dominate the network; however, their presence within the broader contexts of resilience and infrastructure suggests that the energy transition is relevant where system robustness, climate neutrality, or distributive concerns are highlighted. Similarly, sustainable agriculture does not form a major visual cluster but is indirectly represented through the intersection of biodiversity, sustainability, and productive system adaptation.

The keyword analysis supports the following conclusion: digital transformation is the primary overarching theme, while energy transition and sustainable agriculture serve as smaller yet significant specialization pathways. The analysis does not suggest a direct correlation between specific adaptation domains and particular smart specialization topics. Instead, it indicates that adaptation themes are often implemented through governance arrangements, participatory processes, digital infrastructures, and pathways focused on transformation. This keyword analysis offers an initial structural overview of the portfolio and sets the stage for the next section, where a more in-depth examination of project objectives and reporting summaries will further explore these patterns. It should be noted that the Climate-ADAPT best practice collection was not processed through the same VOSviewer-based workflow, as these sources consist of shorter, more heterogeneous, and more implementation-oriented descriptions than the standardised CORDIS project records. They are therefore analysed separately in a later subsection as complementary practice-based evidence.

3.3 Analysis of project objectives and results

The CORDIS project portfolio shows that the link between climate adaptation and smart specialization is more complicated than just matching sector themes. The project objectives and results indicate that adaptation themes are put into action through specific innovation strategies, governance arrangements, and local implementation pathways. This confirms the value of the dual analytical framework used in the chapter. Adaptation themes identify the key problem areas that the projects address, while smart specialization topics describe the areas that help tackle these problems. Therefore, the portfolio reveals not only whether projects focus on biodiversity, water, infrastructure, health, or agriculture, but also how they approach these challenges through digital infrastructure, energy system changes, or agri-food innovation paths.

A co-occurrence analysis of the objective texts enhances our understanding by revealing that project aims are centered around a limited number of recurring operational logics. The VOSviewer map highlights a central cluster focused on terms such as solution, adaptation, resilience, risk, and measure. This suggests that projects primarily frame adaptation in intervention-oriented ways, connecting climate challenges to tangible responses, applied scenarios, and expected benefits. A second cluster, which includes region, capacity, monitoring, replication, and partner, emphasizes the strong territorial and implementation-oriented nature of the portfolio. This indicates that many projects do not perceive adaptation as a one-time pilot activity but rather as an ongoing process of





capacity building, regional learning, and the transfer or scaling up of practices across European contexts. A third cluster, featuring terms like science, justice study, policy maker, and transformation, underscores the continued importance of knowledge production, governance, and social considerations in formulating project objectives. Together, these patterns reinforce the analytical framework presented in this chapter. On one hand, the objectives reflect the main adaptation themes identified earlier, particularly risk and vulnerability, biodiversity and ecosystem-based approaches, and infrastructure-related adaptation. On the other hand, they demonstrate how these themes are operationalized through enabling capacities that are central to smart specialization, especially digital support functions, territorial implementation, and innovation-oriented pathways.

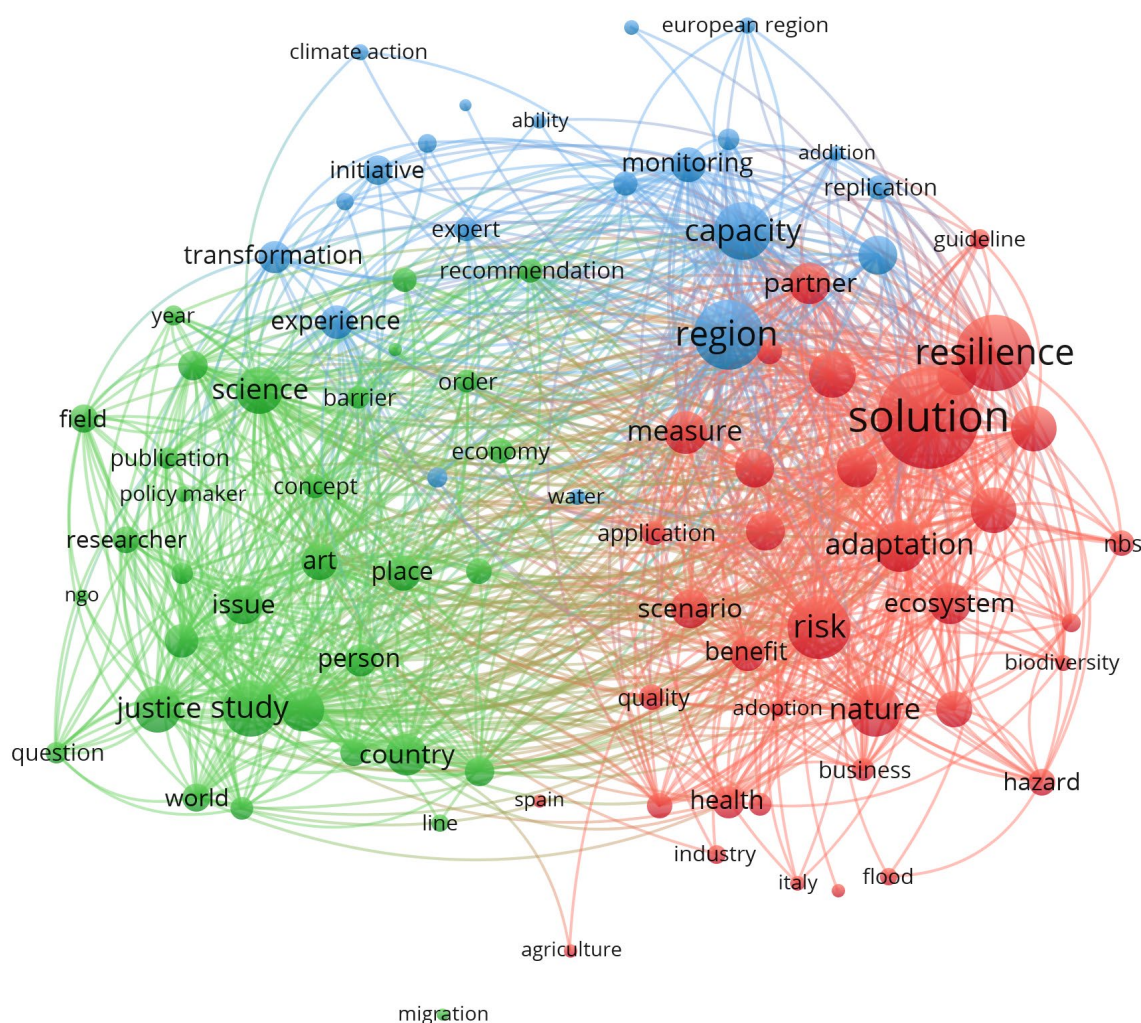


Figure 3. Co-occurrence network of terms in project objectives and results (minimum 10 links)

In terms of thematic distribution, the strongest project clusters focus on biodiversity and ecosystem-based approaches, urban and infrastructural adaptation, and interventions aimed at reducing risk and vulnerability. While water-related adaptation is included, it is generally framed within broader



ecological, territorial, and infrastructural contexts. Agriculture and food systems form a smaller yet distinct cluster, and health and wellbeing aspects can be identified, although they are less prominent compared to the biodiversity, infrastructure, and risk-oriented themes. Regarding smart specialization, digital transformation serves as the most significant horizontal enabling factor, while energy transition and sustainable agriculture emerge as smaller but clearly identifiable trajectories. This pattern aligns well with the initial keyword-based analysis presented in the chapter draft, but the objective texts and reporting summaries provide a more nuanced understanding of how these relationships are structured in practice.

Adaptation themes

The most prominent and analytically significant theme in the portfolio of adaptations is the interplay between risk, vulnerability, governance, and justice. The project objectives and results consistently demonstrate that successful adaptation is achieved through comprehensive assessment frameworks, decision-support tools, modeling environments, stakeholder engagement, and mechanisms for institutional coordination, rather than relying solely on isolated technical solutions. This theme is especially apparent in projects that focus not on a single adaptation intervention, but rather on creating a structured system for evaluating, prioritizing, and managing adaptation decisions.





CLIMAAX⁷ serves as a prime example of effective climate risk assessment. Its goal is to establish a standardized and comparable framework for evaluating climate risks across various European regions and communities. The project tackles a significant governance issue: many areas lack the methodological tools needed to integrate local evidence with broader modeling resources for context-specific climate risk assessments. CLIMAAX addresses this by standardizing methodological support, analytical tools, and access to relevant data and models. Thus, adaptation is framed not as a predetermined solution but as a flexible framework for generating region-specific risk knowledge. Similarly, CARMINE⁸ connects climate-resilient development pathways in metropolitan areas to impact-based decision support and multi-level governance. This approach positions adaptation as a planning challenge that bridges local and regional scales, incorporates co-production processes, and combines nature-based and conventional solutions.

ACCUREU⁹ further develops this approach by incorporating both adaptation and mitigation within a socio-economic assessment of future climate risks. Its project design explicitly considers biodiversity, ecosystems, health, food systems, water management, critical infrastructure, and justice within a unified analytical framework. This is significant because it illustrates that the most advanced risk-oriented projects do not view adaptation as a single-sector issue. Instead, they create integrated scenarios and modeling environments that can trace implications across households, businesses, sectors, and territories. The practical outcome is that risk governance becomes the interface through which otherwise separate adaptation themes can be compared and analyzed. Several projects reinforce this perspective by shifting from single-hazard to multi-hazard and cascading-risk approaches. DIRECTED¹⁰ addresses recent European droughts and floods by emphasizing vulnerability to severe weather and the need for interoperable data, communication, and governance systems. C2IMPRESS¹¹ explicitly aims to transition from hazard-centered approaches to a more integrated, place- and people-centered multi-hazard framework. MULTICLIMACT¹² develops digital tools for assessing resilience, extending from individual buildings to broader urban areas. In these projects, adaptation is defined as the ability to understand compound exposure, interdependencies, and indirect loss pathways. This is important because it demonstrates that risk is not just one theme among many; rather, it serves as the central integrative logic through which adaptation themes are organized into decision-making systems.

The governance aspect of this cluster is equally important. Projects like I-CISK¹³ and REACHOUT¹⁴ focus on climate services that convert scientific data into information that is relevant for local decision-makers. FAIR2Adapt¹⁵ employs FAIR data principles and infrastructures related to the European Open Science Cloud (EOSC) to transform distributed datasets into actionable knowledge. CLIMABOROUGH¹⁶ tests the Climate Sandbox, ClimHub, and various climate service concepts in multiple cities, explicitly linking urban ecological transitions with digital transformations. In each

⁷ <https://www.climaax.eu>

⁸ <https://carmine-project.eu>

⁹ <https://www.accreu.eu>

¹⁰ <https://directedproject.eu>

¹¹ <https://www.c2impress.com/home>

¹² <https://multiclimact.eu>

¹³ <https://icisk.eu>

¹⁴ <https://reachout-cities.eu>

¹⁵ <https://fair2adapt-eosc.eu>

¹⁶ <https://climaborough.eu>





instance, governance is not an external component; rather, it is integrated into the design of the service, the structure of the knowledge infrastructure, and the interface between expert and user communities.

The justice dimension enhances this pattern rather than standing apart from it. The adJUST¹⁷ project focuses on the distributional impacts of the transition to climate neutrality and the conditions necessary for climate policy to be socially fair and politically supported. JUST4CARE¹⁸ aims to incorporate justice, equity, and resilience into urban and regional planning. JUSTSAFE prioritizes the needs of vulnerable and marginalized groups in the context of climate resilience and digital transitions. FairFuture¹⁹ specifically targets inclusive adaptation measures for these vulnerable communities. Together, these projects demonstrate that governance in this portfolio is not defined solely by coordination capacity or institutional efficiency. It is also characterized by whether adaptation measures are socially viable, territorially balanced, and procedurally inclusive. From an analytical perspective, this cluster is highly relevant to the chapter's focus on maladaptation. While the project objectives do not explicitly address maladaptation, they frequently highlight distributional, procedural, and territorial blind spots as potential risks for failure. In practice, this indicates that maladaptation is already evident within the portfolio as a negative outcome: adaptation is deemed inadequate when it perpetuates inequality, excludes vulnerable groups, or shifts burdens across different territories. This supports the chapter's broader argument that maladaptation in EU project discourse is often addressed indirectly through concerns related to justice, vulnerability, and governance, rather than through explicit terminology.

The second major cluster of adaptation themes focuses on biodiversity and ecosystem-based approaches. This project portfolio stands out because it treats biodiversity not just as a secondary environmental issue but as a primary pathway for adaptation. The above-listed projects consistently connect climate resilience with ecosystem restoration, ecosystem-based management, nature-based solutions, and the enhancement of ecological functions. A-AAgora²⁰ is a prime example of this approach. It is explicitly designed to restore marine and coastal ecosystems while reducing pressures in coastal areas through ecosystem-based management and nature-based solutions. Its model goes beyond ecological repair; it also incorporates demonstration activities, replication roadmaps, and scaling strategies. The significance of this project lies in framing ecosystem restoration as an interlinked environmental, territorial, and innovation process. CLIMAREST²¹ develops a modular toolbox for restoring and monitoring coastal habitats. This toolbox integrates expert knowledge, stakeholder involvement, ecosystem service improvement, and cost-benefit analysis. Similarly, DaWetRest²² adopts a comparable approach in the Danube basin, linking wetland and floodplain restoration to biodiversity, water quality, climate resilience, and socio-economic benefits.

The Mediterranean projects provide a further refinement of this theme. DesirMED²³ treats the Mediterranean as a climate hotspot and seeks transformative adaptation strategies based on nature-based solutions and multilevel coordination. CARDIMED²⁴ develops a framework for climate

¹⁷ <https://adjust-project.eu>

¹⁸ <https://just4care.eu>

¹⁹ <https://placemaking-europe.eu/project/fairfuture/>

²⁰ <https://a-aagora.eu>

²¹ <https://climarest.eu>

²² <https://dawetrest.eu>

²³ <https://www.desirmed.eu>

²⁴ <https://www.cardimed-project.eu>





resilience in the Mediterranean biogeographical region through digital infrastructure, harmonised evaluation, and citizen participation. These projects are particularly significant as they demonstrate that ecosystem-based adaptation is not limited to restoration ecology. It is increasingly integrated into regional implementation frameworks, performance evaluation methods, replication strategies, and digital support systems.

Urban biodiversity and nature-based regeneration projects apply similar principles to those in the built environment. GreenInCities²⁵ focuses on urban regeneration through nature-based strategies and aims to address the unequal distribution of green initiatives. VARCITIES²⁶ connects nature-based interventions to health and well-being in urban areas. CONNECTING Nature²⁷ positions Europe as a leader in the innovation and implementation of nature-based solutions, emphasizing city-based experimentation and peer learning. These projects show that biodiversity and ecosystem-based adaptation can thrive not only in "natural" or rural areas but also reshape urban planning, public spaces, and local governance. The ecological cluster also extends into agriculture and pollination systems. For instance, BeeGuards²⁸ aims to enhance the resilience of beekeeping in the face of climate stress, resource constraints, and management challenges. Meanwhile, BETTER-B²⁹ focuses on the resilience of honey bee colonies against abiotic stresses, including climate change, habitat loss, and harmful chemicals. In both scenarios, biodiversity is directly linked to productive systems and the resilience of food systems. This suggests that biodiversity is not merely a theme for conservation; it also serves as a fundamental condition for broader socio-economic adaptation.

The most important conclusion from this cluster is that ecosystem-based adaptation is one of the clearest sites where adaptation and regional transformation intersect. Many biodiversity-oriented projects are not purely ecological in design. They involve demonstration platforms, local stakeholder systems, valuation methods, monitoring infrastructures, and territorial roadmaps. As a result, they are highly compatible with innovation-led regional development, even when they are not explicitly labelled in S3 themes.

Infrastructure and the built environment are crucial themes in climate adaptation. Climate risks become significant when they threaten buildings, transportation systems, public services, ports, logistics chains, historic districts, and urban operational systems. This aligns with the argument that adaptation in cities and infrastructure involves more than just protection against hazards; it also includes planning, service provision, and system coordination. The ARCH³⁰ project focuses on the resilience of historic areas through a comprehensive disaster risk management framework. CLARION³¹ emphasizes climate resilience in port infrastructure and inland waterways. ICARIA³² employs asset-level modeling to assess both direct and indirect climate-related losses. MULTICLIMACT develops design methods and digital solutions to enhance resilience in the built environment. CLIMRES³³ aims to improve urban and building resilience against multiple climate threats. Together, these projects illustrate that adapting infrastructure is increasingly viewed as a

²⁵ <https://www.greenincities.eu>

²⁶ <https://varcities.eu>

²⁷ <https://connectingnature.oppla.eu>

²⁸ <https://beeguards.eu>

²⁹ <https://www.better-b.eu>

³⁰ <https://savingculturalheritage.eu>

³¹ <https://projectclarion.eu>

³² <https://www.icaria-project.eu>

³³ <https://climres.eu>





matter of systemic functionality rather than merely static protection. The emphasis is not only on whether an asset can survive a hazard but also on ensuring that critical systems continue to operate across interconnected networks.

UrbanAIR³⁴ introduces a health-sensitive and data-driven approach to urban design challenges related to heat and air quality by developing a digital twin. Similarly, CLIMABOROUGH combines data, urban planning, and ecological transition within city-level experimentation platforms. These projects highlight how the adaptation of built environments increasingly relies on high-resolution data environments and model-based planning tools. In essence, infrastructure resilience is becoming intertwined with digital mediation. Moreover, the built-environment sector encompasses more than just traditional "grey infrastructure" categories. Projects like GreenInCities and VARCITIES integrate public spaces, green infrastructure, and urban regeneration. ASCEND³⁵ focuses on creating positive clean energy districts that are healthier, more inclusive, and climate-neutral. Smart-BEEJS³⁶ emphasizes human-centric energy districts and energy justice. In these cases, adaptation in the built environment intersects with mobility, energy, public health, and social inclusion. This hybrid nature is analytically significant as it blurs the boundaries between infrastructure adaptation and other important themes such as biodiversity, health, and energy transition. Taken together, these projects indicate that infrastructure is one of the main sites where the portfolio's adaptation themes and smart specialisation topics converge. It is here that digital services, energy systems, ecological design, and distributive questions are combined most visibly.

Water management as a standalone adaptation theme is an important aspect across the portfolio, but it is generally not treated as a standalone dominant field. Instead, water serves as a relational and connecting theme that links various areas such as biodiversity, territorial risk, infrastructure, coastal systems, and agriculture. This idea is already reflected in the chapter draft, which notes that while water-related themes are identifiable, they are less prominent than those related to biodiversity, infrastructure, or risk clusters. The project database supports this assessment. CoCliCo³⁷ focuses on developing core coastal climate services that address sea-level rise and coastal flooding. Similarly, A-Agora, CLIMAREST, and DaWetRest all incorporate significant water management dimensions, but these are intertwined with ecosystem restoration and regional resilience efforts. ACCREU explicitly includes water management as one of its adaptation decision types. ALBATROSS³⁸ deals with cross-sectoral territorial management and climate-induced displacement, considering the interactions between water, food, and energy within a nexus perspective. In each of these cases, water is not treated as an isolated hydraulic issue. Instead, it is embedded within socio-ecological systems and multi-sector governance.

The portfolio indicates that water adaptation is a key connecting factor across various domains. It links wetlands to biodiversity, flooding to infrastructure, irrigation to agriculture, and coastal risks to regional planning. The absence of a distinct cluster of water-only projects should not be seen as a sign of weak relevance. Rather, it emphasizes that water serves as a crucial medium through which different adaptation areas are interconnected. From an analytical perspective, water is less of a standalone theme and more of a field of interdependence.

³⁴ <https://www.urbanair-project.eu>

³⁵ <https://www.ascend-project.eu>

³⁶ <http://www.smart-beejs.eu>

³⁷ <https://coclicoservices.eu>

³⁸ <https://albatross-project.eu>





Health and wellbeing represent a smaller yet significant cluster of adaptation themes. The project objectives and outcomes reveal that health is addressed in two main ways: first, as a direct exposure issue linked to heat, air pollution, wildfire emissions, and pollen; and second, as a broader wellbeing concern related to urban environmental quality and access to green and blue spaces. The healthRiskADAPT³⁹ project is a prime example of direct health adaptation, specifically targeting health risks associated with heatwaves, air pollution, wildfire emissions, and pollen. It positions transformative adaptation within public health assessment and intervention. Similarly, the AURORA⁴⁰ project addresses the health and wellbeing impacts of climate change, focusing particularly on marginalized populations and the systemic vulnerabilities highlighted by extreme natural events. Meanwhile, EARLY-ADAPT⁴¹ examines temperature-related mortality and investigates to what extent adaptation measures can mitigate health impacts in a warming world.

A second group of projects connects health to urban environmental quality and nature-based solutions. UrbanAIR develops tools to manage trade-offs between heat and air quality. GoGreenNext⁴² combines participatory methods, digital innovations, and future scenario development to address health risks arising from climate change and biodiversity loss. NATURELAB⁴³ explores how green and blue spaces can serve as health providers, offering preventive and rehabilitative functions through nature-based therapies. VARCITIES also fits within this group as it links nature-based interventions to quality of life and well-being. Although the health cluster is smaller than the biodiversity, infrastructure, or risk governance clusters, it is analytically significant for two reasons. First, it demonstrates that the portfolio covers the health domain outlined by the IPCC, albeit unevenly. Second, it indicates that health adaptation in EU projects tends to be most robust when it intersects with urban planning, digital monitoring, or nature-based solutions. This suggests that health is currently underrepresented as a standalone domain but is increasingly integrated through cross-domain projects.

Agriculture and food systems represent a distinct, albeit more limited, adaptation cluster. The project details indicate that agricultural adaptation in this portfolio is primarily framed through concepts such as innovation, bioeconomy, agroecology, and system resilience, rather than through traditional sectoral policy language. This aligns with the chapter draft's observation that agriculture emerges as a smaller yet identifiable theme, closely linked to food security, agroecology, crop breeding, and pollinator protection. The Agroecology-TRANSECT⁴⁴ project aims to unlock the potential of agroecology for crop, grassland, and integrated crop-livestock systems through collaborative innovation among researchers and farmers. ClimaPannonia⁴⁵ focuses on enhancing agricultural resilience in the Pannonian biogeographical area, explicitly connecting climate vulnerability to regional socio-economic significance. Crop4Clima⁴⁶ aims to support low-impact food supply chains by developing new rapeseed varieties and facilitating technology transfer to other crops. ECO-READY⁴⁷ is working to create a real-time food-system observatory through a digital platform.

³⁹ <https://healthriskadapt.eu>

⁴⁰ <https://www.auroraclima.eu>

⁴¹ <https://early-adapt.eu>

⁴² <https://gogreennext.eu>

⁴³ <https://naturelab-project.eu>

⁴⁴ <https://www.agroecology-transect.net>

⁴⁵ <https://climapannonia.eu>

⁴⁶ <https://crop4clima.eu>

⁴⁷ <https://www.eco-ready.eu>





ResAlliance⁴⁸ emphasizes knowledge flows and landscape resilience for farmers and foresters in the Mediterranean region. Lastly, TRANSFORM⁴⁹ is centered around developing regional roadmaps for adapting agriculture to climate change.

These projects demonstrate that agriculture is seldom treated as merely a productive sector. Instead, it is interconnected with landscape resilience, pollination, crop innovation, observatory infrastructures, and regional adaptation planning. In fact, agriculture is one of the few areas where the themes of adaptation and specialization often coincide directly. Thus, the portfolio indicates that sustainable agriculture has a clearer and more concrete interface between adaptation and specialization than some other Smart Specialization Strategy (S3) themes.

Smart specialization themes

In the context of smart specialization, digital transformation is a crucial horizontal enabling dimension. The project database strongly indicates that digital transformation is not just an auxiliary support layer; rather, it is a fundamental component of how adaptation is organized in practice. A crucial insight is that many projects are not merely utilizing digital tools; they are actually defining adaptation through digital infrastructures. For instance, CLIMAAAX relies on the integration of local and pan-European data to inform risk assessment workflows. FAIR2Adapt is specifically designed to convert distributed data into actionable knowledge using FAIR principles and EOSC-compatible approaches. UrbanAIR employs a digital twin to enhance urban decision-making regarding heat and air quality. CLIMABOROUGH uses sandbox and service concepts to evaluate digital planning environments. Additionally, CARDIMED implements digital infrastructure to standardize resilience-building efforts in the Mediterranean region. Projects such as MULTICLIMACT, ICARIA, REACHOUT, I-CISK, CLARITY⁵⁰, CityCLIM⁵¹, and CoCliCo all depend on digital tools for climate services, monitoring, forecasting, and platform-based decision support.

Digital transformation therefore functions as a transversal enabling capacity that cuts across risk governance, infrastructure resilience, ecosystem monitoring, and urban planning. It is not a separate technological sector in the portfolio. Rather, it is the medium through which adaptation knowledge is made actionable, scalable, and transferable. This is particularly relevant to the smart specialisation perspective because it suggests that digital transformation is the principal bridge between adaptation needs and innovation-led regional development.

The second important point is that digital transformation also reshapes participation and governance. Various projects utilize digital tools not only for modeling or prediction but also for co-production, integrating local knowledge, and providing user-oriented services. This can be seen in projects like I-CISK, CARDIMED, and CLIMABOROUGH. The implication is that digital transformation within this portfolio encompasses both technical and institutional aspects. It alters how evidence is generated and how actors connect to that evidence.

Energy transition is a smaller but strategically important smart specialisation theme in the project portfolio: it appears most clearly where climate neutrality, energy-system transformation, and vulnerability reduction intersect. Unlike digital transformation, this process is not entirely transversal. Instead, it focuses on projects that connect various aspects such as adapting to energy districts,

⁴⁸ <https://www.resalliance.eu>

⁴⁹ <https://www.transform-project.eu>

⁵⁰ <https://clarity-project.eu>

⁵¹ <https://www.cityclim.eu>





integrating renewable energy, addressing energy poverty, and enhancing infrastructure robustness. AdJUST explores the distributive implications of the transition to climate neutrality. Smart-BEEJS is focused on creating human-centric, positive energy districts and energy systems that prioritize prosumers. ASCEND aims to accelerate the development of positive clean energy districts in urban areas. ENERPOL⁵² examines how the green transition reshapes household roles, energy consumption patterns, and the distribution of risks. META-GRID⁵³ addresses the climate vulnerability of the European power grid. Finally, RECLAIM investigates whether renewable energy communities effectively reach vulnerable populations and promote inclusion rather than exclusion. The importance of this cluster lies in the fact that adaptation is not always the primary focus of these projects. In many cases, these initiatives are more oriented toward transition rather than strictly on adaptation. However, they become relevant to adaptation when they address issues such as system robustness, vulnerability to outages, energy poverty, or unequal access to the benefits of the transition. Therefore, energy transition within this project portfolio is strongly linked to both infrastructure resilience and social justice. It is not merely a general theme of adaptation but rather a specific pathway through which the social and technical aspects of resilience are being reorganized.

Sustainable agriculture represents a key intersection between adaptation themes and smart specialization topics. Projects in this field not only adapt agriculture to climate change but also redefine it as an innovation sector. This is achieved through practices rooted in agroecology, crop technology, observatories, pollinator resilience, and landscape management. Initiatives such as Agroecology-TRANSECT, ClimaPannonia, Crop4Clima, ECO-READY, ResAlliance, and TRANSFORM exemplify this approach. Their goals include promoting technological innovation, fostering co-innovation systems, developing regional roadmaps, creating digital observatories, and establishing resilience-oriented value chains. Additionally, projects like BeeGuards and BETTER-B enhance this trajectory by linking pollinator resilience to agricultural sustainability. In this context, sustainable agriculture stands out as a prime example of how a smart specialization topic can simultaneously serve as a regional innovation priority and a significant adaptation strategy. One key analytical insight is that sustainable agriculture is more focused in scope compared to digital transformation, but it provides a more direct approach. Where sustainable agriculture is implemented, it often showcases one of the strongest instances of genuine collaboration between adaptation efforts and smart specialization strategies.

Synthesis

The project portfolio includes Horizon Europe, H2020 and ERC projects that shows considerable differences between the interpretation and integration of both adaptation themes and smart specialization topics. Horizon Europe projects in the portfolio are more frequently mission-oriented, demonstrative, and territorially explicit. Projects such as A-AAgora, DaWetRest, DesirMED, CARDIMED, CLIMABOROUGH, MountResilience⁵⁴, ASCEND, and FairFuture are characterised by pilot sites, replication strategies, stakeholder co-creation, and implementation pathways tied to regions, cities, or communities. They are more likely to combine multiple adaptation themes within an operational framework and to connect these themes to practical transformation agendas. H2020 projects often serve a distinct purpose. Initiatives like REACHOUT, I-CISK, CLARITY, CityCLIM, CoCliCo,

⁵² <https://www.nhh.no/en/research-projects-and-groups/enerpol/>

⁵³ <https://metainfrastructure.org/meta-grid/>

⁵⁴ <https://mountresilience.eu>



VARCITIES, CONNECTING Nature, and ARCH are typically focused on areas such as climate services, tool development, methodological integration, or building platforms. This focus does not imply that they lack relevance to specific territories; rather, the predominant trend involves the creation of intermediate infrastructures. These include service architectures, data platforms, decision-support environments, and demonstration frameworks. Essentially, H2020 projects frequently establish the enabling systems that facilitate the scaling and standardization of subsequent adaptation practices. ERC projects typically focus on areas such as conceptual framing, norm formation, critical diagnosis, and foundational knowledge. For instance, ClimateJusticeReady addresses issues related to green climate gentrification. DIVERSE explores the relationship between digitalization, environmental justice, and biocultural diversity. DynamITE examines how territories need to be normatively restructured in response to climate disruption. LICCI investigates local indicators of climate change impacts and emphasizes grounded knowledge. IMBRACE connects climate change with health, immigration, and justice. Additionally, CCLAD and EnvJustice expand the discussion by addressing topics like loss and damage and global environmental justice. In these cases, the contribution to adaptation is often indirect but essential. ERC projects provide the conceptual, empirical, and normative insights necessary to challenge simplistic or technocratic approaches to resilience.

It can be concluded that adaptation themes and smart specialization topics are not directly related in a one-to-one manner. Instead, they intersect through recurring combinations of problem framing, governance design, enabling infrastructures, and territorial implementation. Three such combinations are particularly significant. First, there is a consistent link between risk, vulnerability, governance, and justice in the context of digital transformation. This is evident in projects like CLIMAAX, CARMINE, ACCREU, REACHOUT, I-CISK, FAIR2Adapt, and CLIMABOROUGH, where adaptation is implemented through risk assessments, models, digital platforms, and decision-support services. Second, biodiversity and ecosystem-based approaches are frequently integrated with urban or territorial implementation. This is illustrated in projects such as A-AAgora, CLIMAREST, DaWetRest, DesirMED, CARDIMED, GreenInCities, and VARCITIES. Third, the pathways of energy transition and sustainable agriculture are clear examples of how adaptation becomes part of regional transformation agendas. This is particularly true when issues such as distributive concerns, infrastructure resilience, and changes to productive systems are highlighted.

In summary, the project portfolio suggests that the strongest connection between climate adaptation and smart specialization occurs when adaptation strategies are integrated into wider regional transformation efforts. The most effective project clusters are those that do not focus solely on a single sector; instead, they combine elements such as climate risk governance, digital infrastructure, ecosystem-based solutions, resilience in the built environment, and considerations for equitable distribution within innovation strategies that are grounded in the local context.

Analysis of best practices

The best practice review examined 79 initiatives collected from Climate-ADAPT and the Mission Implementation Platform. The findings reveal a thematic profile that differs in emphasis from the CORDIS project portfolio. In the best practice sample, the most common elements include participation and partnerships, water and flood management, and capacity building. These are followed by evidence-based planning, the use of economic and financial tools, nature-based solutions, cooling interventions, ecosystem restoration, and monitoring of heat hazards. This distribution suggests that, at the implementation level, adaptation is primarily organized through local collaboration, stakeholder engagement, practical planning tools, water-related interventions,





and measures addressing heat stress and environmental restoration. These findings reinforce several patterns already identified in the project-based analysis. First, they support the earlier conclusion that risk, vulnerability, and governance are among the strongest factors for adaptation highlighted in the report. In the project portfolio, this was evident through risk assessments, climate services, modeling environments, and decision-support tools. In the best practice materials, the same logic is evident in a more implementation-oriented form, reflected through participation and partnerships, evidence-based planning, governance, preparedness, and capacity building. The key implication is that adaptation is not merely a single technical intervention; rather, it is a process requiring coordination, learning, local engagement, and institutional support.

The best practice collection emphasizes the significance of biodiversity and ecosystem-based approaches in a more practical way than the CORDIS project portfolio. While the project analysis identified biodiversity, nature-based solutions, and ecosystem restoration as key themes for adaptation, the Climate-ADAPT cases outline the main implementation methods through which these themes are realized in practice. These methods include river and land restoration, ecosystem restoration, forest management, biodiversity-sensitive land use, and nature-based cooling or green infrastructure measures. This reinforces the earlier conclusion of the report that ecosystem-based adaptation is one of the most evident connections between climate adaptation and broader territorial transformation. Third, the best practices shift focus more clearly towards water management, heat management, and local cooling measures. In the analysis based on CORDIS, water management was primarily presented as a connecting theme rather than as a dominant organizing field, while health and well-being formed a smaller yet identifiable cluster. In contrast, the Climate-ADAPT sample indicates that water and flood management are among the most frequently addressed categories, with significant attention also given to heat hazards, monitoring, and cooling interventions. This suggests that, in practice, local adaptation often becomes evident through immediate territorial challenges such as flooding, water retention, urban heat, and heat-related vulnerabilities.

From the perspective of smart specialization, the Climate-ADAPT collection provides an important contrast to the project analysis. In the CORDIS portfolio, digital transformation emerged as the strongest transversal enabling factor. However, in the best practice sample, while digital tools are present, they are not as dominant. This observation does not contradict the earlier finding; rather, it suggests that digitalization is more prominent in the design and operationalization of innovation projects than in the practical descriptions of local adaptation measures. In the best practice material, the primary implementation approaches are participation, planning, water management, capacity building, and nature-based interventions, rather than digital mediation.





3.4 Overview of Smart Specialisation and Regional Transformation Data

Starting in 2015, the European Commission has launched four dedicated S3 Thematic Platforms; this chapter introduces the main characteristics of the four S3 Thematic Platforms based on open data available at the website of the European Commission. (More info: https://ec.europa.eu/regional_policy/policy/communities-and-networks/s3-community-of-practice/thematic_platforms_en). The partnerships back-to-back with objectives and S3 priorities are available in the Appendices section.

The agri-food platform connects regions that prioritize agriculture and food within their smart specialisation strategies to foster interregional collaboration. Through thematic partnerships, these regions explore new value chains and develop joint investment projects to strengthen their collective expertise. The platform focuses on high-tech areas like big data, smart sensors, and sustainable packaging to generate significant business and ecological returns. By aligning strategies and resources, it has the goal of leveraging the strengths of businesses, innovation actors, and civil society across Europe. This integrated approach ensures that smart specialisation investments deliver both regional growth and broader societal benefits.

The energy platform brings together regions that identify clean, secure, and sustainable energy as a strategic priority within their smart specialisation strategies. Fostering structured interregional collaboration, it enables these regions to co-develop innovative solutions that address the challenges of the green and digital transition. Through thematic partnerships, regions explore emerging value chains such as renewable hydrogen, bioenergy, smart grids, and advanced energy storage, creating opportunities for joint investment and large-scale demonstration projects. The platform strengthens regional expertise by encouraging cooperation between businesses, research institutions, public authorities, and civil society. This collaboration accelerates the development and deployment of technologies that reduce emissions, enhance system flexibility, and improve energy resilience. By aligning strategic directions and pooling complementary strengths, the energy platform maximises the impact of innovation-driven investments and supports the broader European objective of climate neutrality. This integrated approach ensures that smart specialisation in the energy domain generates not only regional economic growth but also contributes to Europe's long-term sustainability, technological leadership, and societal well-being.

The Industrial Modernization Platform brings together regions in Europe that prioritize advanced manufacturing, digital transformation, and resource efficiency in industrial systems in their smart specialization strategies. Through thematic partnerships, regions will cooperate to strengthen strategic value chains, accelerate the uptake of key enabling technologies, and support the transition to a more flexible, sustainable, and competitive industrial base. The platform connects the strengths of the regions' assets with emerging industrial opportunities, accelerates joint investment projects, and encourages knowledge exchange between businesses, researchers, and innovation ecosystems. This ensures that smart investments contribute to industrial transformation and support broader social and environmental goals.

In May 2021, the Communication on Sustainable Blue Economy (SBE) was adopted as integral part of the European Green Deal. DG MARE has identified Smart Specialisation Strategies (S3) as a key tool to implement the Communication. S3 is a useful tool to support the transition towards a sustainable blue economy by creating the necessary innovation ecosystems in Member States and





Regions while promoting investments that boost the competitiveness of blue economy sectors. In that aspect, the S3 thematic platform for sustainable blue economy will provide a framework of cooperation among blue economy stakeholders of the quadruple helix, to exchange their interests, best practices, to address their common needs, to prepare joint proposals, and collaborate among themselves for implementing innovative projects. The S3 thematic platform for sustainable blue economy supports interregional partnerships and value chains, thus facilitating the cooperation among blue economy quadruple helix stakeholders. It was formally launched during the last Steering Committee meeting of the S3 thematic platforms, held on 29 March 2022. Five brokerage sessions and a follow-up event have been organised in 2022, to raise the interest of stakeholders to create partnerships on priorities of common interest. Synergies with sea basin and macroregional strategies, the Union for the Mediterranean and other networks are being developed⁵⁵.

3.5 Review of regional S3 plans and priorities

The primary source for the review of regional S3 plans and priorities was the S3 CoP Observatory available at https://ec.europa.eu/regional_policy/assets/s3-observatory/index_en.html. The platform provides various information about the plans, as well as a map-based visualisation of the documents (Figure 3).

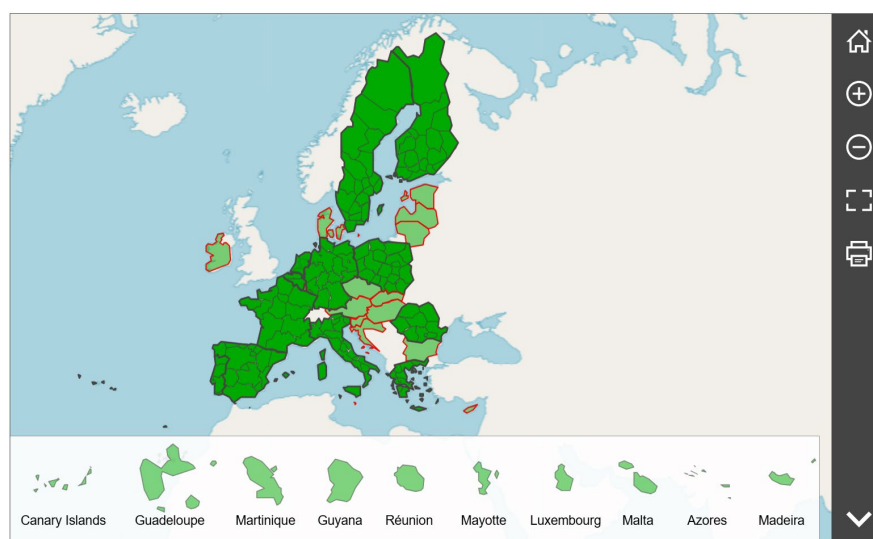


Figure 4. S3 CoP Observatory (source: https://ec.europa.eu/regional_policy/assets/s3-observatory/index_en.html)

In addition, the platform navigates to a county-profile where access to the original plans is provided. For the analysis, we reviewed these plans alongside the key research questions defined in the Methodology section. For the analysis, we prioritized pilot sites' countries, accordingly UK's S3 Plan⁵⁶ has been included although it is not part of the Observatory. Furthermore, the selection of the analysed strategies was based on language preferences of the research group (English, German,

⁵⁵ https://ec.europa.eu/regional_policy/policy/communities-and-networks/s3-community-of-practice/thematic_sustainable_blue_economy_en

⁵⁶ <https://assets.publishing.service.gov.uk/media/5a814ecae5274a2e8ab5344f/bis-15-310-smart-specialisation-in-england-submission-to-european-commission.pdf>



French), consideration of country-level and regional plans, as well as selecting strategies from different subregions from Europe with different. As a result, the following Strategies have been analysed:

- Country-level: Austria, Hungary, United Kingdom
- Regional: Germany (1: Metropole Ruhr, 2: Berlin und Brandenburg) and France (1: Île-de-France, 2: Provence-Alpes-Côte-d'Azur).

Austria: Research, Technology and Innovation Strategy 2030

In case of Austria's national strategy, the central document entitled "Research, Technology and Innovation Strategy 2030" was analysed, which provides a comprehensive framework and interprets innovation priorities, climate adaptation, and economic changes as multi-level interrelationships. The strategy identifies technological developments and research funding as tools for achieving national climate goals, with an emphasis on digitalization and resource efficiency.

Does the source make connection between adaptation topics, between smart specialization topics and across? How?

The document presents multi-level interconnections as a framework between innovation priorities, climate change adaptation, and economic restructuring. Innovation and technology goals are linked to climate goals under the heading "RTI for achievement of the climate targets." This suggests that, within the strategy, the climate crisis is framed primarily through research and development and industrial innovation. Digitalization, resource efficiency, and energy innovation are areas that reinforce each other.

How does the source support climate adaptation objectives at regional, national, and EU levels?

EU level:

The RTI 2030 Strategy fits into the common European value chain (IPCEI). Climate adaptation contributes to the achievement of common EU climate goals, mainly through active participation in EU research programs and technological developments.

National level:

At the national level, adaptation is seen as a technological innovation issue in the areas of energy, construction, transport, and resource efficiency, and is approached less from the perspective of social or territorial vulnerability.

Regional level:

Not applicable.

How does the source contribute to regional transformation goals and smart specialization strategies?

Primarily indirectly. The document extends economic restructuring to the national level; regional priorities are not mentioned.

How does the source support resource allocation mechanisms?

Resource allocation plays a key role in the document. The Research Financing Act and the RTI Pacts provide a continuous financing framework for the innovation system. The Future Austria Fund serves to provide targeted support for research.





How does the source incorporate social equity, just transition, and cohesion considerations?

To a limited extent. Although the strategy emphasizes talent development, STEM fields, and the attractiveness of research careers, which are elements of social cohesion.

How does the source support infrastructure robustness?

Rather than addressing the resilience of critical infrastructure directly, the strategy places priority on strengthening research, data, and digital infrastructures. This includes the development of research infrastructures, stronger connections to European and international large-scale facilities, and the expansion of data and digital capacities.

Short description of methodology, list of used indicators if relevant

International results, e.g., OECD Innovation Policy Review, are linked to indicator systems for performance evaluation, R&D expenditure, and international rankings (EIS, DESI, GII).

To what extent do the strategies address thematic gaps, monitoring frameworks, social justice, and potential risks of maladaptation?

The Austrian national strategy provides a high-level framework for innovation, yet it faces challenges regarding the visibility of specific environmental goals. Climate adaptation is not treated as a standalone pillar; instead, it is integrated into broader categories such as energy, resource efficiency, and digital solutions. This "embedding" approach tends to diminish the policy weight of adaptation measures. Furthermore, the strategy maintains a highly centralized perspective, lacking a dedicated regional dimension and a tailored indicator system to track localized progress.

Category	Assessment
Thematic gaps & visibility	Climate adaptation is embedded within other priorities, reducing its independent policy weight.
Monitoring & data gaps	The strategy lacks a separate, dedicated indicator system for tracking adaptation progress.
Social & justice gaps	Issues of social justice and the protection of vulnerable groups are treated marginally.
Strategic risks & maladaptations	Absence of a regionalized approach, favouring a centralized national logic.

Hungary: National Smart Specialisation Strategy (S3) of Hungary

Regarding Hungary, the processing of the National Smart Specialisation Strategy (S3) revealed that the strategy is based on the methodology of the Entrepreneurial Discovery Process (EDP), creating a logical link between energy, climate and industrial development objectives. Although it is a national document, the Hungarian strategy focuses strongly on the different levels of development and specific adaptation needs of the regions.

Does the source make connection between adaptation topics, between smart specialization topics and across? How?

The document logically links the topics on several levels. Energy, climate, and resource-efficient economy as priorities link climate adaptation and decarbonization with industrial development. The smart specialization priorities are mutually reinforcing areas. Interoperability between sectors is





further ensured by horizontal priorities and infrastructure. However, these connections are primarily a framework rather than measures.

How does the source support climate adaptation objectives at regional, national, and EU levels?

EU level:

Hungarian developments are in line with the EU's climate neutrality ambitions, especially in the field of energy innovations, but also in the pursuit of the transition to a circular economy. The document also highlights the connection to the Horizon Europe programme, in which climate adaptation (e.g. missions) is given a prominent role. Priority goal: Hungary should approach the European forefront in research related to the most modern technologies.

National level:

Energy-climate priority also appears as a separate national economic goal. The document identifies it primarily as an industrial and innovation challenge. It justifies the development of low-carbon technologies, research into renewable technologies, and an industrial transformation that is already taking place in light of climate risks.

Regional level:

The strategy identifies different types of regions, such as knowledge regions, regions with moderate knowledge intensity, and industrial zones. Climate adaptation is implemented in accordance with the specific characteristics of each region. Regional innovation platforms play a key role in helping local actors identify their development priorities, thereby increasing the resilience of the region.

How does the source contribute to regional transformation goals and smart specialization strategies?

The Strategy (S3) focuses strongly on the transformation of regions and offers several tools for strengthening the economic renewal and innovation capacity of the regions. The document takes as its starting point the differences in the levels of development of Hungarian regions, which, together with the specific characteristics of the regions, make a territorial approach essential. The definition of different types of regions allows intelligent specialization priorities to emerge as an adaptation process. Thanks to the Entrepreneurial Discovery Process (EDP) and Regional Innovation Platforms, national priorities can also be interpreted at the regional level. Climate-related demands are emerging in economic and technological transformation as a factor responsible for maintaining competitiveness.

How does the source support resource allocation mechanisms?

In line with the principle of smart specialization, it envisages the conscious concentration of resources in areas with the greatest growth potential.

The distribution of resources is supported by the EDP process, the Regional Innovation Platforms, and the coordinating role of the NKFI Office, which ensure that financing decisions are aligned with regional conditions and technological transformation. The distribution of resources related to climate adaptation does not appear independently, but only as part of other objectives.

How does the source incorporate social equity, just transition, and cohesion considerations?

Indirectly. The Hungarian National Smart Specialization Strategy does not address the concept of a "just transition." Nor does it make any promises to reduce social inequalities. On the other hand, it





touches on goals that indirectly strengthen social cohesion and reduce inequalities between regions. The strategy focuses primarily on economic and innovation cohesion, with little mention of the social context and equal opportunities for vulnerable groups. The idea of a just transition also appears in relation to Industry 4.0 and digitalization, and the strategy recognizes that the transition to decarbonization may also lead to social tensions. Equity is touched upon in relation to skilled labor and access to knowledge.

How does the source support infrastructure robustness?

The document calls for the development and modernization of research laboratories, test environments, and university research facilities, which form the basis for corporate R&D&I activities. Among international-level infrastructures, it highlights the ZalaZONE automotive test track. The document emphasizes the stability and reliability of wired and wireless (e.g., 5G) digital network infrastructure, which is available nationwide. Strengthening cyber defense is given priority. It envisages increasing energy supply security through stable base load capacity expansion and district heating modernization. In addition, hydrogen technology and energy storage are key areas of innovation.

Short description of methodology, list of used indicators if relevant

The strategy was developed based on the Entrepreneurial Discovery Process (EDP) methodology. Qualitative and quantitative methods were combined to determine the final priorities.

Health:

- R&D expenditure as a percentage of GDP in medical and health sciences
- Proportion of innovative enterprises in pharmaceutical manufacturing, medical device manufacturing, and food manufacturing.

Digitalization of the economy:

- DESI digital technology integration in enterprises
- Proportion of enterprises introducing product innovation.
- Proportion of enterprises introducing business process innovation.

Energy, climate:

- Proportion of renewable electricity production in relation to domestic production

Services:

- Corporate R&D expenditure as a percentage of GDP in relevant service sectors (transport, trade, administration).
- Enterprises introducing service innovation.

Resource-efficient economy:

- R&D expenditure as a percentage of GDP in relevant industries (vehicle manufacturing, machinery manufacturing, electrical industry, construction, etc.).
- Proportion of innovative enterprises.

Agriculture, food industry:

- R&D expenditure as a percentage of GDP in the field of agricultural and food sciences
- Proportion of innovative enterprises in the food industry and agricultural machinery manufacturing.
- Cutting-edge technologies (e.g. AI, 5G):



- Number of research jobs created in supported facilities.

Creative industries:

- R&D expenditure as a percentage of GDP in creative industries (publishing, film production, advertising, architecture).
- Training, education (horizontal objective):
- Corporate resources devoted to workforce training.

To what extent do the strategies address thematic gaps, monitoring frameworks, social justice, and potential risks of maladaptation?

In the Hungarian context, "smart specialization" is gradually being integrated into everyday policy planning, but several structural barriers remain. A major obstacle is the lack of reliable innovation statistics at the county level, making it difficult to address sub-regional disparities. The strategy struggles with a significant productivity gap between foreign-owned large enterprises and domestic SMEs, coupled with a high rate of brain drain. Furthermore, the priorities are defined so broadly that they risk a loss of focus during resource distribution.

Category	Assessment
Thematic gaps & visibility	A systemic adaptation logic regarding climate change management is missing.
Monitoring & data gaps	Reliable innovation statistics are unavailable at the county level, hindering the identification of regional disparities.
Social & justice gaps	Social justice and inequalities are not integrated into the strategic framework.
Strategic risks & maladaptations	Overly broad priorities leading to resource fragmentation; high brain drain and performance gap between foreign firms and domestic SMEs.

United Kingdom: Smart Specialization in England

For the UK, the national "Smart Specialization in England" has been analysed, developed by the Department for Business Innovation & Skills. The document has multi-purpose approach covering 1. identify the policies and range of public support that is available at national and local levels to help businesses invest in innovation, 2. help Local Enterprise Partnerships (LEPs) and their partners to identify opportunities to benefit from, and to contribute to, national policies and funding programmes supporting innovation; and to help them identify opportunities to collaborate with other places across England, 3. inform businesses, universities and others involved in wider research and innovation programmes, 4. support the work of the National Growth Programme Board as well as 5. fulfil the requirements of Regulation (EU) 1303/2013.

Does the source make connection between adaptation topics, between smart specialization topics and across? How?

The Smart Specialization in England has relatively minimal focus for climate-related questions, if we research on 'climate' we found few mentions in the text. For instance, the document discusses in case of the Local Enterprise Partnerships (LEPs) and Smart Specialisation that partners across the area are expected to prepare a Strategic Economic Plan, which must be in accordance with several policies, for e.g. climate change. The situation is similar in case of "low carbon" (1 mention). Sustainability is also less emphasized in the document, sustainable construction solutions are discussed in "The Industrial Strategy Sector Strategies" for Construction, as well as declared that



“Smart Specialisation in England is an approach to investment in innovation which recognises a strong value of an on-going process of learning, continually driving more productive and sustainable investments in innovation at all levels” (p. 4.) The energy nexus is discussed in several cases (for e.g. the Catapult Centre for Offshore Renewable Energy, the role of Research and Innovation Campuses dedicated to thriving environments for businesses, industry, universities and researchers, enabling innovation and delivering impact from research investment in various fields, including energy; Industrial Strategy – development of energy efficient and environmentally friendly planes, energy generation from offshore wind rose, and The Eight Great Technologies covering Key Enabling Technologies (KETs) are an inherent part of Smart Specialisation, as they are technologies which can be used across a number of sectors).

How does the source support climate adaptation objectives at regional, national, and EU levels?

On regional level, the role of LEPs can be highlighted, to use European Structural and Investment Funds (ESIF) which are expected to develop sustainable investments. The Smart Specialization in England aligns with the UK's “Eight Great Technologies” and the National Industrial Strategy for boosting resilience. The Eight Great Technologies (p. 52.) covers: 1. Big data and energy efficient computing, 2. Robotics and autonomous systems, 3. Satellites and commercial applications of space, 4. Life Sciences, genomics and synthetic biology, 5. Regenerative medicine, 6. Agri-science, 7. Advanced materials and nano-technology, 8. Energy technologies (including, energy storage, reduced cost renewables, energy efficiency, bioenergy, transport, next generation nuclear and carbon capture and storage). Although not mentioned, but generally, the strategy aligns with the Europe 2020 strategy for “smart, sustainable, and inclusive growth” expectation of the EU as a main expectation for this period.

How does the source contribute to regional transformation goals and smart specialization strategies?

Place-based approach is assured, as regions were expected to focus on their unique competitive advantages. LEPs were key players in this process working with business and other stakeholders to develop a clear understanding of the sectors and technologies in which they have a comparative advantage and identifying from these a small number of key priority areas on which investments can be focused for maximum impact within their territory.

How does the source support resource allocation mechanisms?

Primarily the European structural and investment funds (ESIF) can be mentioned. The Catapult Centres (for e.g. High Value Manufacturing; Cell Therapy; Offshore Renewable Energy; Satellite Applications; Connected Digital Economy; Future Cities; Transport Systems) received equal funding from the core Innovate UK grant. The document discussed the importance of funding schemes for science. The Strategic Economic Plan was dedicated to form the basis upon which the LEP and its partners could decide how to make best use of a range of all available resources and levers including wide range of sources like City Deals, Regional Growth Fund, Enterprise Zones, the Growing Places Fund and the EU Structural & Investment Funds.

How does the source incorporate social equity, just transition, and cohesion considerations?

Since the document has been developed in 2015, the “just transition” phenomena cannot be directly identified. Nevertheless, in the “Approach to Smart Specialisation in England” it is discussed that Smart Specialisation need to be delivered at both national and local levels since LEP areas are different to each other in terms of population size, capacities and potential and these circumstances





must be taken into consideration. Accordingly, the plan put emphasis on SME support as innovation wasn't just for big cities but for all Local Enterprise Partnerships (LEPs). The Industrial Strategy Sector Strategy for the Automotive sector, Professional Business Services and Construction all highlight the importance of SMEs in the development process.

How does the source support infrastructure robustness?

Innovation infrastructure is a key aspect for the realization of the Smart Specialization Goals, therefore funding is needed for specialist facilities, science parks, and innovation hubs that provide the physical environment for research. Infrastructure development as well as upgrading the test facilities are crucial for the development of “smart” products. The digital connectivity of these infrastructures must be assured.

Short description of methodology, list of used indicators if relevant

The Strategy is built on a status quo assessment developed through mixed methods including stakeholder consultations, SWOT analyses of regional assets, the HE Business and Community Interaction Survey and mapping innovation ecosystems (detailed description can be found in “Effective Monitoring & Evaluation”). For the situational analysis indicator-based evaluation included the following ones: Expenditure on R & D Performed in UK Business 2001 – 2012, Employment on R & D Performed in UK Businesses '01 -'12, Claims for the R&D tax credit by financial year, '01 - '12, Gross Expenditure on R&D (as % of GDP) on regional level, Gross Expenditure on R&D expenditure (GERD), Expenditure on R&D performed in UK businesses (BERD) 2001- 2012, Business R&D Expenditure in the UK by Product Group (2012), R&D tax credit claims by registered office location, 2011-12; Cost of R&D tax credit claims by registered office location, '11-'12; Business Research & Development in the UK (2012) and finally, Business R&D Employment across regions.

To what extent do the strategies address thematic gaps, monitoring frameworks, social justice, and potential risks of maladaptation?

The English S3 model utilizes a multi-level governance structure that successfully combines bottom-up and top-down planning. However, the practical application reveals a need for much stronger coordination between the regional Local Enterprise Partnerships (LEPs) and the national "Eight Great Technologies" framework. While the governance logic is sound, the document is notably thin on specific development priorities and lacks the necessary outcome indicators to evaluate the strategy's success over the long term.

Category	Assessment
Thematic gaps & visibility	Disconnect between regional implementation and the National “Eight Great Technologies.”
Monitoring & data gaps	Lack of specific development priorities and outcome indicators to measure mid- and long-term success.
Social & justice gaps	Not explicitly addressed in the strategic document.
Strategic risks & maladaptations	Potential coordination failures between regional LEPs and national planning levels.

Germany

Germany does not operate a single, centralised national Smart Specialisation Strategy. Instead, the country implements smart specialisation entirely through its federal states (Bundesländer), reflecting the highly decentralised structure of the German innovation system. Research shows that



Germany is so regionally diverse and functionally decentralised that it cannot be regarded as a unified national innovation system; most innovation synergies emerge at the regional (NUTS2) and even local (NUTS3) levels rather than at the federal level. For the 2014–2020 funding period, the European Commission required all German states to prepare their own Regional Research and Innovation Strategies for Smart Specialisation (RIS3) as a precondition for accessing ERDF funds. Each Bundesland therefore developed an independent smart specialisation framework reflecting its economic structure, innovation ecosystem, and regional priorities. These RIS3 documents set out the regions' strategic goals, specialisation fields, and investment directions in research and innovation. According to a comprehensive study conducted for the European Commission, all fifteen German regional strategies were completed and collectively contributed to a modernisation of innovation policy across the federal states, strengthening strategic coordination and stakeholder engagement.

Because of this federal approach, the term “German Smart Specialisation Plan” refers not to a national plan but to the aggregated set of regional RIS3 strategies. These regional plans vary significantly in focus — from high-tech manufacturing and industrial transformation in states like Baden-Württemberg and Bavaria to energy transition, sustainability, and mobility-related specialisations in Brandenburg, Saxony, and others. Their decentralised design allows each state to capitalise on local strengths while contributing to broader European innovation priorities.

In essence, Germany's smart specialisation model is a reflection of its political and economic structure: a bottom-up, region-driven system where innovation priorities are defined locally but operate within the EU's wider S3 policy framework. This approach ensures that cohesion policy funds support research and innovation areas that are closely aligned with regional capabilities, stakeholder needs, and long-term development trajectories. Through this model, smart specialisation in Germany reinforces both regional competitiveness and the overall European objective of fostering place-based, innovation-led growth.

Metropole Ruhr⁵⁷

Does the source make connection between adaptation topics, between smart specialization topics and across? How?

The regional S3 strategy of the Metropole Ruhr connects adaptation-relevant themes primarily through its strong emphasis on Green Technologies, Wasserstoffwirtschaft, Kreislaufwirtschaft, urbane Transformation, und smarte Stadtentwicklung. While the document does not explicitly frame “adaptation” as a policy category, it integrates adaptation-oriented transformations into its strategic specialisation fields. The Green Technologies & Hydrogen domain directly addresses the climate-driven restructuring of industrial energy systems, the move away from carbon-intensive industries, and the deployment of clean resource cycles, all of which support long-term environmental resilience. Meanwhile, the Smart City and Urban Transformation priority area embeds adaptation logics through digital optimisation of infrastructure, enhanced mobility, reduced emissions, and environmentally conscious urban design. Cross-innovations—explicitly encouraged across all domains—allow mobility, energy, logistics, IT (AI, data, cybersecurity), and health to interact with sustainability-oriented transformations, producing a systems-based interconnection between adaptation needs and S3-driven innovation development.

⁵⁷ This summary is based on the following report:

https://www.business.ruhr/fileadmin/Redakteure/Projekte/Smart_Specialisation_Gesundheit/bmr_s3_strategie_220708.pdf





How does the source support climate adaptation objectives at regional, national, and EU levels?

Several climate adaptation objectives are supported indirectly across the strategy. The most significant contribution lies in the decarbonisation and sustainable restructuring of the regional energy system, driven by the hydrogen economy, renewable integration, and sector coupling, which respond to the high emission baseline of the region and the pressing need to realign industrial value chains with climate-neutral pathways. Adaptation also appears through improved resource efficiency, circular material flows, and innovations that reduce energy and resource intensity in heavy industries. Urban adaptation goals are addressed through Smart City initiatives that aim to reduce congestion, optimise energy flows in the built environment, introduce smart grids, and modernise climate-sensitive urban infrastructures. Although traditional adaptation themes such as flood protection or biodiversity protection do not appear, energy and urban transformation together embed climate stabilization and resilience-building as part of the economic transformation.

How does the source contribute to regional transformation goals and smart specialization strategies?

The strategy is deeply oriented toward transforming the Metropole Ruhr from an industrial, coal-dependent region into a knowledge-based, innovation-intensive, climate-neutral metropolitan economy. It identifies structural change as both challenge and opportunity, highlighting the need to leverage existing competencies in metallurgy, logistics, chemistry, and industrial infrastructure while shifting them toward sustainable, digital and clean-tech pathways. Structural transformation goals include: securing competitiveness during industrial decarbonisation; strengthening research-industry interlinkages; supporting start-ups and new technology applications; and modernising urban environments through smart systems. Virtually all six S3 domains contribute to this overarching transition by aligning technological innovation with climate goals, social needs and economic renewal.

How does the source support resource allocation mechanisms?

Although the document does not outline explicit budgetary breakdowns, it describes clear mechanisms through which resources are to be focused and mobilised. The Business Metropole Ruhr GmbH acts as the core orchestrator for regional resource allocation, coordinating cross-municipal initiatives, structural fund absorption (notably EFRE), and strategic prioritisation of projects in key S3 domains. Resource allocation is intended to follow the Entrepreneurial Discovery Process (EDP), ensuring that funding flows toward initiatives with strong regional competencies, scalability potential, and alignment with strategic themes. Specific emphasis is placed on supporting start-ups, applied research facilities, incubators/accelerators, Living Labs, Wasserstoff-Reallabore, and the transformation of industrial sites into innovation campuses (e.g., Mark 51°7, CleanPort, Smart Region Emscher-Lippe). This system effectively channels resources toward adaptation-relevant and digital-transformation-oriented activities.

How does the source incorporate social equity, just transition, and cohesion considerations?

The strategy recognises that the region's long industrial history and ongoing coal exit create significant social vulnerabilities, and it positions S3 as a vehicle to support a just and socially balanced transformation. Demographic pressures—particularly shrinking labour force and high unemployment—are addressed through the expansion of qualification, the attraction of skilled labour, and the integration of educational institutions into innovation networks. Social equity considerations also emerge in Smart City projects that enhance digital participation, such as digital



neighbourhood initiatives that involve disadvantaged districts, and e-government services that aim to include broader segments of society. However, while the strategy acknowledges social disparities and labour market risks, explicit just-transition measures (e.g., compensation mechanisms, targeted programmes for vulnerable workers) remain underdeveloped. The emphasis is more on employability, skills development, and regional inclusion through innovation, rather than on explicit socio-environmental vulnerability management.

How does the source support infrastructure robustness?

Infrastructure robustness is a central thread throughout the strategy, especially across three domains: energy, logistics, and urban systems. The hydrogen transformation is framed around the need for a resilient, decarbonised energy system capable of replacing fossil fuels while maintaining industrial productivity, including robust distribution networks, electrolysis capacity and storage technologies. The logistics sector contributes through 5G-enabled digitalisation, smart port operations, and high-capacity rail and waterway infrastructure, positioning the region as a continental hub capable of withstanding supply chain shocks. In parallel, Smart City initiatives focus on digital and physical robustness through smart grids, integrated mobility systems, digital traffic management, and tech-enhanced public infrastructure. Collectively, these approaches enhance the region's capacity to manage environmental, technological, and market disruptions.

Short description of methodology, list of used indicators if relevant

The strategy is grounded in a combined quantitative–qualitative methodology, including economic specialisation analysis (location quotients, employment shares), growth dynamics assessments, SWOT analysis, demographic projections, innovation system mapping, and identification of local competencies across all 15 municipalities. It draws heavily on the Entrepreneurial Discovery Process to validate regional priorities. For monitoring, the strategy outlines the need for indicator development but does not yet provide concrete KPIs. It indicates that indicators should support assessment of S3 implementation, resource allocation, progress toward strategic goals, and alignment across municipalities. The Business Metropole Ruhr, which already publishes annual economic reports, is identified as the institution best suited to coordinate monitoring.

To what extent do the strategies address thematic gaps, monitoring frameworks, social justice, and potential risks of maladaptation?

The Metropole Ruhr strategy is comprehensive but shows significant gaps in ecological resilience. While it excels in themes of decarbonization and hydrogen technology, it largely ignores "soft" adaptation measures such as water management, heat resilience, and biodiversity. The region's complex administrative structure—consisting of 15 municipalities with uneven innovation capacities—presents a major implementation challenge. There is also a strategic concern regarding an over-reliance on hydrogen, which could lead to a new technological lock-in.

Category	Assessment
Thematic gaps & visibility	Explicit ecological adaptation (water, heat, biodiversity) is largely absent in favour of mitigation.
Monitoring & data gaps	Monitoring remains conceptual with no defined indicator suite or measurable targets.
Social & justice gaps	Just transition mechanisms are only treated indirectly; no plan for differential social impacts of structural change.
Strategic risks & maladaptations	Potential technological lock-in due to over-reliance on hydrogen; complex regional implementation challenges.





Berlin und Brandenburg

Does the source make connection between adaptation topics, between smart specialization topics and across? How?

innoBB 2025 frames adaptation mostly through system modernization and cross-cluster collaboration rather than through a dedicated climate-adaptation chapter. The strongest bridges to Smart Specialisation (S3) are the horizontal themes of digitalisation, testbeds (Reallabore), skills, and startups, which are designed to work across the five clusters—Health, Energy, Mobility & Logistics, ICT/Media/Creative, and Optics/Photonics. In practice, this means that resilience-relevant shifts—such as decentralised energy, smart grids, intermodal and autonomous mobility, and data-driven process optimisation—are embedded as cross-cutting, S3-style priorities that connect clusters and accelerate knowledge spillovers. Thus, adaptation enters the strategy indirectly via S3 domains like digital transformation and energy transition, rather than through biodiversity or water-management tracks.

How does the source support climate adaptation objectives at regional, national, and EU levels?

The document supports adaptation objectives implicitly by prioritising resilient energy and mobility systems. The Energy cluster emphasises integrating renewables, storage, and sector coupling to create flexible, robust grids, while the Mobility cluster seeks system-level optimisation, electrification, and digitalisation (including test environments for connected and autonomous mobility). These directions strengthen the region's ability to withstand climate variability and energy-system shocks even though topics such as heatwaves, drought, or ecosystem services are not addressed explicitly. Adaptation is therefore pursued as a co-benefit of energy transition and system modernisation, not as a stand-alone policy field.

How does the source contribute to regional transformation goals and smart specialization strategies?

The strategy sets two overarching transformation goals: to position Berlin–Brandenburg as a leading European innovation space and to develop solutions to societal challenges. It operationalises these goals by deepening cluster specialisation, intensifying “Cross-Cluster” work, and opening innovation processes through testbeds and open innovation. Sustainability is defined as a guiding principle aligned with green economy and clean technologies, while internationalisation is framed as integral to competitiveness. Together, these choices aim to transform the regional economy toward higher-value, research-intensive activity with faster diffusion from research to market via cluster masterplans and demonstrators.

How does the source support resource allocation mechanisms?

While the document does not detail budget lines, it specifies the instruments and loci where resources are mobilised. The Länder commit to aligned innovation and technology funding, co-financing cluster management structures, and expanding regional innovation infrastructures such as science and technology parks, incubators, and accelerators. Additional resources are to be drawn from federal and EU programmes, with selection and prioritisation channeled through cluster masterplans and the governance of cross-cluster initiatives. This architecture effectively allocates funding toward collaborative R&D, demonstration in Reallabore, startup scaling, and SME participation—i.e., toward activities that translate strategy into measurable projects.

How does the source incorporate social equity, just transition, and cohesion considerations?





Equity considerations appear through the labour and skills agenda rather than through distributional climate-justice instruments. The strategy underscores Fachkräftegewinnung, lifelong learning, and stronger ties between clusters and education providers, including dual study and continuing-education formats. It addresses the risks of digital and organisational change by highlighting “Gute Arbeit,” workers’ representation and participation in designing digital processes, and the attraction of international talent to fill gaps. In this way, the social dimension of transition is mediated via employability, skills alignment, and the quality of work—important ingredients of a just transition even if explicit social-equity targets or vulnerable-group programs are not articulated.

How does the source support infrastructure robustness?

Robustness is advanced through three levers. First, the energy system transition emphasises decentralisation, storage, and intelligent grids to improve stability and flexibility under higher renewable penetration. Second, mobility and logistics aim for intermodal integration, rail digitalisation, and test corridors for connected/autonomous transport—features that enhance continuity and safety while reducing congestion and emissions. Third, the pervasive digitalisation of processes and services across clusters (including data governance, usability and security concerns) supports operational resilience and responsiveness. Together, these choices enhance the region’s capacity to withstand shocks while maintaining function across energy, transport, and digital infrastructures.

Short description of methodology, list of used indicators if relevant

Methodologically, innoBB 2025 relies on qualitative, participatory strategy development that brings together economic and scientific actors, cluster organisations, and external experts to update priorities since the 2011 baseline. Implementation is structured through cluster-specific masterplans that translate the umbrella strategy into thematic fields, cooperation formats, and actions. For measurement, the document installs an Ergebnis- und Wirkungsmonitoring (EWM) system to document activities, identify trends, and assess contribution toward goals defined both in the umbrella strategy and the masterplans. It does not enumerate KPI tables or numeric targets in the text; instead, it sets out a governance-oriented monitoring approach that tracks projects, collaborations, and progress qualitatively and through internal indicators maintained by the EWM.

To what extent do the strategies address thematic gaps, monitoring frameworks, social justice, and potential risks of maladaptation?

The joint strategy for Berlin and Brandenburg focuses heavily on energy-system resilience but lacks explicit thematic articulation for broader ecological risks. Critical issues such as drought, water management, and heatwaves are missing from the primary innovation clusters. Moreover, the monitoring regime is primarily conceptual, lacking published KPIs that would allow external stakeholders to verify progress. While the strategy addresses “Good Work,” it fails to connect innovation goals with spatial justice or the unevenly distributed burdens of climate change.

Category	Assessment
Thematic gaps & visibility	Climate adaptation lacks thematic articulation; critical risks like drought and heatwaves are not addressed.
Monitoring & data gaps	Lack of published, strategy-level KPIs or targets prevents external verification of progress.
Social & justice gaps	No concrete instruments for spatial justice or measures targeting vulnerable communities.



Strategic risks & maladaptations	Failure to connect innovation logic with the unevenly distributed burdens of climate adaptation.
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France

France has allocated the creation, implementation and management of Smart Specialisation Strategies to its regions, as can be expected from a regionalised country. This is in line with the distribution of competences throughout the governance hierarchy of the republic. As France is a relatively large European state with regions exhibiting considerable diversity and contrast in numerous relevant aspects, also incorporating overseas territories, the regions are the custodians of these development strategies. In turn, it is these NUTS-2 level regions who then delegate tasks to the NUTS-3 level *départements*, and further down to the LAU-1 *arrondissements* and LAU-2 *communes*.

Within France, the regions chosen as a sample were *Île-de-France*, being a core region, and *Provence-Alpes-Côte-d'Azur* (--> PACA), a peripheral one, but with great potential.

*Île-de-France et bassin de la Seine*⁵⁸

The Île-de-France Region has devised its ERDF-ESF+ programme for the 2021-2027 period between July of 2019 and January 2022, whose priorities were being resolutely green, innovative, fair and inclusive, heralding a novel aspect of looking at the decade ahead, with digitalisation, green transition and social change in the heart of France. The COVID-19 pandemic has clearly had an impact on the programme, catalysing and hastening changes. With a population of some 12 million inhabitants, more than what most European countries have, Île-de-France is the most populous and densely populated region in France, and it is also the most productive in terms of GDP across the whole of Europe. Notwithstanding, the region is also characterised by disparities; economic disparities in the distribution of wealth and skills, resulting in social disparities, including access to services and care, but also, contrasts within the natural and built environment, in a mosaic of rural and highly urbanised landscapes (p9). During the pandemic, the socio-economic disparities have undeniably come to the forefront, highlighting what was already there, but less visibly; unemployment shot up during the lockdowns, and positive changes in neighbouring regions have failed to spill over into Île-de-France.

Does the source make connection between adaptation topics, between smart specialization topics and across? How?

The document connects adaptation with smart specialisation in several ways; primarily there is evidence for this in aiming to transform into sustainable cities (p10), improve healthcare and services (idem) by means of cutting edge technologies. There is strong emphasis on resolving social issues and improving social (knowledge) capital. The document links to EAFRD, the National Strategic Plan of the CAP, in preserving biodiversity and Natura2000 protected areas.

How does the source support climate adaptation objectives at regional, national, and EU levels?

The document references:

- state-region plan contracts (CPER), regional, national and European recovery plans (p8)

⁵⁸ The regional programme is officially drawn up for the Île-de-France region, and Bassin de la Seine, an inter-regional cooperation between the regions around the Seine Valley.



- The National Integrated Energy-Climate Plan (p13)
- National Climate Change Adaptation Plan (p13)
- The National Strategic Plan (p17)

How does the source contribute to regional transformation goals and smart specialization strategies?

The main objective of the document is to define transformation goals, including smart specialisation strategies, on the regional level, for the particular region in question. It is nested within the European and French development and transformation frameworks and objectives. Goals and strategies for lower levels of governance (NUTS-3, LAU-1, LAU-2) are not addressed in this document in much detail.

- The Île-de-France region has elected to focus on three key areas:
- Supporting research, innovation, digital transformation and the competitiveness of SMEs,
- Supporting the ecological transition and the circular economy,
- Supporting job creation initiatives, vocational education and training and reducing the number of school drop-outs.

Additionally to ERDF and ESF+, the document also references EAFRD within CAP.

How does the source support resource allocation mechanisms?

The strategic document has been prepared by the region of Île-de-France for itself. The document does not specify any beneficiaries, as calls for funding will be published and funding can thus be contested by prospective beneficiaries. It is implied, though, that alongside existing R&D&I facilities and businesses, startups will be considered for funding as well. Nevertheless, references to climate-related objectives remain superficial, often implied. Some buzzwords are repeated often, but little detail is given to specific objectives, mechanisms or vehicles of support.

How does the source incorporate social equity, just transition, and cohesion considerations?

For each priority, and for each objective, the source systematically addresses the target groups (demographics of people, as well as organisations), highlights the measures to guarantee equality, inclusivity and non-discrimination, indication of the specific targeted territories, including the planned use of territorial tools, and intended use of financial instruments. However, the measures to guarantee equality, inclusivity and non-discrimination lack detail and specifics; though sources of funding and even broad objectives and priorities are indicated, there is little written about the concrete measures that are to be taken. Beyond this, there is very little written about a just transition. In terms of cohesion, the document repeatedly emphasizes its adherence to the principle of Do No Significant Harm (DNSH) of minimising adverse impacts on contemporary or parallel projects with different or similar objectives. Furthermore, the programme document addresses the interregional, cross-border and transnational impacts and actions to be taken.

How does the source support infrastructure robustness?

The document calls for an increase in scientific potential in the Île-de-France region. Though there are major facilities attracting research talent, there is a gap in public funding and these places of R&D&I cannot rely sustainably on a self-financing model. There is noticeable underfunding in R&D, as currently 69% of all research expenditures in the region are by large corporations, with SMEs and startups remaining underfunded. The region aims to strengthen the link between research, large corporations and SMEs through a focus on sustainable cities and improved public health. The document does not name specific research bodies or organisations, though it does address these in general terms: incubation hubs, universities and economic poles.



Throughout this document, infrastructure is generally used predominantly in the context of green infrastructure, as a means of undoing the damage and pressures from human activities, such as urbanisation, linear infrastructure and lighting (p47).

Short description of methodology, list of used indicators if relevant

Priority 1: Supporting research, innovation, digital transformation and the competitiveness of SMEs in Île-de-France (p24)

Specific objective 1.1. Develop and improve research and innovation capacities and the use of advanced technologies (ERDF)

- Performance indicators (units)
 - Companies receiving support (number of)
 - Companies supported through business grants (number of)
 - Researchers working in supported research centres (FTE)
 - Nominal value of research and innovation equipment (euro)
- Outcome indicators (units)
 - Private investment complementing public support (euro)
 - Patent filings (number of)
 - Copyright and Trade Mark filings (number of)

Specific objective 1.2. Leveraging the benefits of digitalisation for the benefit of citizens, businesses, research organisations and public authorities (ERDF)

- Performance indicators (units)
 - Value of products and services developed (euro)
 - Institutions benefiting from developed products or services (number of)
 - Population benefiting from developments (persons)
 - Integrated territorial development strategies receiving funding (number of)
- Outcome indicators (units)
 - Users of products and services developed publicly (number of, annually)
 - Users of products and services developed privately (number of, annually)

Specific objective 1.3. To strengthen sustainable growth and competitiveness of SMEs and job creation in SMEs, including through productive investments (ERDF)

- Performance indicators (units)
 - Companies receiving support (number of)
 - Companies receiving grants (number of)
 - Companies supported by financial instruments (number of)
 - Companies receiving non-financial support (number of)
 - Business incubation capacity created (number of)
- Outcome indicators (units)
 - Private investment complementing public support (euro)
 - Incubated SMEs one year after foundation (number of)

Priority 2: Supporting the ecological transition and towards a circular economy in Île-de-France (p36)

Specific objective 2.1. Promote energy efficiency measures and reduce greenhouse gas emissions (ERDF)

- Performance indicators (units)





- Housing units with energetic upgrade (number of housing units)
- Population benefiting from integrated territorial development strategies (persons)
- Number of ITDSs receiving funding (number of strategies)
- Outcome indicators (units)
 - Annual primary energy consumption (MWh/a)
 - GHG emissions, approx. (tonnes of CO₂e/a)

Specific objective 2.2. Promote renewable energy in accordance with Directive (EU) 2018/2001 on renewable energy sources, including the sustainability criteria set out therein (ERDF)

- Performance indicators (units)
 - Increase in renewable energy production capacity (MW)
- Outcome indicators (units)
 - Total annual renewable energy production (MWh/a)
 - GHG emissions, approx. (tonnes of CO₂e/a)

Specific objective 2.6. Promote the transition to a circular and resource-efficient economy (ERDF)

- Performance indicators (units)
 - Population benefiting from ITDSs (persons)
 - Number of ITDS receiving funding (number of strategies)
 - Investment into sorted waste collection facilities (euro)
 - Waste to be reused (tonnes/year)
 - Information, education or sensitisation campaigns (number of actions)
- Outcome indicators (units)
 - Recycled waste (tonnes/year)
 - Waste used as raw material (tonnes/year)
 - Sorted waste collected (tonnes/year)

Specific objective 2.7. Improve the protection and preservation of nature and biodiversity and strengthen green infrastructure, particularly in urban areas, and reduce all forms of pollution (ERDF)

- Performance indicators (units)
 - Area of green infrastructure receiving funding (hectares)
 - Population benefiting from ITDSs (persons)
 - Number of ITDS receiving funding (number of strategies)
 - Number of actions aimed at avoiding, reducing or offsetting the impacts of human activity on areas of ecological interest (number of actions)
- Outcome indicator
 - Population with access to new or improved green infrastructure (persons)

Priority 3: Supporting biodiversity and flood control in the Seine River basin (p50)

Specific objective 2.4. Promoting adaptation to climate change, disaster risk reduction, and resilience, taking into account ecosystem-based approaches (ERDF)

- Performance indicators (units)
 - New or reinforced flood protection structures on the coastline, riverbanks and around lakes (kilometres)
 - Green infrastructure put in place or redeveloped for adaptation to climate change (hectares)
 - Number of flood risk prevention measures (number of actions)
- Outcome indicator
 - Population benefiting from flood protection measures (persons)

Specific objective 2.7. Improve the protection and preservation of nature and biodiversity and



strengthen green infrastructure, particularly in urban areas, and reduce all forms of pollution (ERDF)

- Performance indicator (units)
 - Number of actions aimed at avoiding, reducing or offsetting the impacts of human activity on areas of ecological interest (number of actions)
- Outcome indicator
 - Kilometres of improved or restored green and blue corridors (kilometres)

Priority 4: Supporting business creation, vocational training and the fight against school dropout in Île-de-France (p56)

Specific objective 4.1. Improve access to employment and activation measures for all job seekers, particularly young people, especially through the implementation of the Youth Guarantee, for the long-term unemployed and groups disadvantaged in the labour market, and for inactive persons, as well as through the promotion of self-employment and the social economy (ESF+)

- Performance indicators (units)
 - Total number of participants (persons)
 - Unemployed, including the long-term unemployed (persons)
 - Total number of women supported (participants)
 - Number of social economy organizations supported (number of organisations)
- Outcome indicators
 - People employed after participating (persons)
 - Increase in the number of social economy organisations (% increase)

Specific objective 4.6. Promote equal access to and completion of inclusive and high-quality education and training pathways, particularly for disadvantaged groups, from early childhood education and care to adult education and training, including general education, vocational education and training, and higher education, and facilitate mobility for learning purposes for all and accessibility for people with disabilities (ESF+).

- Performance indicators (units)
 - Total number of participants (persons)
- Outcome indicators
 - Participants identified as dropouts following education or training at the end of their participation (persons)

Specific objective 4.7. Promote lifelong learning, including skills development opportunities and flexible retraining for all, taking into account entrepreneurial and digital skills, better anticipate changes and new skills requirements based on labour market needs, facilitate career transitions and promote occupational mobility (ESF+)

- Performance indicators (units)
 - Unemployed individuals, including the long-term unemployed (persons)
 - Participants with a lower secondary education diploma or equivalent (persons)
 - Participants with an upper secondary education diploma or a non-tertiary post-secondary diploma (persons)
 - Participants with a higher education diploma (persons)
- Outcome indicators
 - Participants who obtain a qualification upon completion of their participation (persons)
 - Individuals who are employed upon completion of their participation (persons)

To what extent do the strategies address thematic gaps, monitoring frameworks, social justice, and potential risks of maladaptation?





The Île-de-France strategy targets critical socio-economic and environmental issues but suffers from a lack of geographic and sectoral precision. Despite the region being one of the world's premier tourist destinations, the tourism sector is entirely absent from the document. The priorities are often too broad, making it difficult to determine exactly where actions will be implemented or who will benefit from them. Additionally, the document was written before the emergence of recent global shifts, such as the cost-of-living crisis.

Category	Assessment
Thematic gaps & visibility	Critical omission of the tourism sector despite its massive economic weight in the region.
Monitoring & data gaps	Unclear geographic targeting; defined indicators do not specify where actions occur or who the beneficiaries are.
Social & justice gaps	Broad priorities obscure the impact on socio-economic differences.
Strategic risks & maladaptations	Failure to anticipate emerging crises such as the cost-of-living crisis or geopolitical shifts.

The 2014-2020 Regional Innovation Strategy of Provence-Alpes-Côte-d'Azur (PACA)

This regional innovation strategy has been created in cooperation with PWC. Five key areas, intersecting major societal and environmental challenges with emerging businesses, have been selected:

1. Sustainable housing and urban ecology (Energy Transition and Efficiency), in order to
 - increase renewable energy production (floating wind turbines),
 - reduce energy consumption through improved building insulation and the implementation of smart grids.
2. Risks - Safety – Security, in order to
 - protect against natural (floods, fires, etc.) and industrial risks,
 - ensure maritime safety (Toulon naval base),
 - protect the safety of people and property.
3. Health and well-being - Food
 - to address the aging population and contribute to reducing territorial inequalities in healthcare,
 - improve patient care and early detection (prevention, diagnostic support, and development of new medical technologies),
 - prevent illness through a healthy and balanced diet (promoting the Mediterranean diet and an eco-responsible agri-food sector).
4. Smart and Sustainable Mobility
 - to reduce air pollution and facilitate the "clean" movement of people and goods,
 - create energy-efficient port and airport infrastructure,
 - strengthen regional industrial competitiveness by inventing the vehicles of the future (ships, airships, and helicopters),
 - promote ship maintenance, dismantling, and recycling of end-of-life vessels.
5. Tourism - Cultural Industries and Digital Content
 - to develop the tourism offering and increase the international clientele (internet portals, mapping, tourist circuits, online booking platforms, and digital applications for smartphones).

Does the source make connection between adaptation topics, between smart specialization topics and across? How?

Innovation and technological development are the key themes in this document. There is some, though negligible evidence of connecting adaptation topics and smart specialisation. However, as



this document is now relatively old, some topics and areas would be approached differently nowadays. Digitalisation, resource efficiency, human resources, technological and social innovation are recurring topics, however, they encompass a broad spectrum of initiatives and actions in light of the competences of the region.

How does the source support climate adaptation objectives at regional, national, and EU levels?

The document is primarily concerned with the region, acknowledging it within the European and national hierarchy, but it does not extensively explain the interconnections between the levels.

EU level:

The strategy explains where the key target areas fit within European objectives, however, in general, it does not explain how these allow European objectives to be better met. The main themes are research and development, innovation and competitiveness, poles of economic activity, but climate adaptation is not a topic that's in the focus.

National level:

There is some, but negligible reference to national targets and objectives, however, the document is primarily focused on the regional level. Furthermore, the focus of the document is not on climate change or adaptation; it does come up, but it is first and foremost treated as a food and agriculture problem.

Regional level:

The document defines targets for the region, however, not for climate adaptation. There is all but no reference to anything specific in terms of climate adaptation.

How does the source contribute to regional transformation goals and smart specialization strategies?

This is its primary objective. There are numerous instances where the document directly addresses S3 (or 3S, used interchangeably). As before, the focus is on existing competences; R&D and innovation is directed at the five key areas:

- Sustainable housing and urban ecology (Energy Transition and Efficiency)
- Risks - Safety – Security, in order to
- Health and well-being - Food
- Smart and Sustainable Mobility
- Tourism - Cultural Industries and Digital Content

How does the source support resource allocation mechanisms?

It relies on existing resource allocation mechanisms but does not go into great detail into how exactly these will be employed in practice. The document does not reference state-region plan contracts. However, it does reference European financing mechanisms such as ERDF, JEREMIE, Horizon 2020. Further, it outlines the PACA co-investment fund (p53) and the investment bank BPIfrance.

How does the source incorporate social equity, just transition, and cohesion considerations?

The aspects of social cohesion, inclusivity and equality are addressed in a handful of instances, but primarily in light of digitalisation, which is regarded as a vehicle of these. Transition in the context of climate adaptation is not addressed at all, only in a technological sense, i.e. digitalisation.





How does the source support infrastructure robustness?

Infrastructure maintenance and upgrade is mentioned in a diversity of contexts: research, data storage and digital infrastructure, broadband internet, shipping ports and airports, roadways, (smart) electric grids. There is no mention of green infrastructure.

Short description of methodology, list of used indicators if relevant

Upstream resource development

1. Prepare the future strategic business units (SBUs)

Energy transition and efficiency

1. Develop a comprehensive service offering for thermal renovation in Mediterranean climates
2. Promote the management and security of smart electrical grids
3. Develop renewable energy production

Risk, safety, and security

1. Promote comprehensive environmental monitoring and crisis management solutions
2. Strengthen the technological competitiveness of security solutions and diversify applications

Health

1. Improve patient care through early screening, medical diagnostic support, and the development of medical devices.

Smart and Sustainable Mobility

1. Promote user-centric mobility solutions for optimizing the management of people and goods flows.
2. Develop new energy-efficient and safe port and airport services and infrastructure.

Cultural Industries - Tourism - Digital Content

1. Develop e-tourism solutions and increase the international customer base.
2. Create links between transmedia and the smart city. igente

Supporting the Growth of High-Potential Innovative Businesses

1. Identify and support high-potential businesses through the different phases of their development
2. Build a clear service offering and solutions tailored to the profiles of businesses
3. Stimulate the most promising innovation projects: service innovation
4. Stimulate the most promising innovation projects: innovation through use

Strengthening the Regional Ecosystem

1. Foster innovation in local areas
2. Promote skills development aligned with future-oriented professions (DAS)
3. Strengthen innovation through digital technology

Promote social innovation and The emergence of new economic models

1. Promote social innovation and the emergence of new economic models
2. Support the growth, consolidation, and sustainability of social enterprises
3. Support the emergence and sustainability of socially innovative dynamics in local areas

Governance and management

Ensure operational management, coordination of implementation, and monitoring of the





structuring programs of the 3S.

To what extent do the strategies address thematic gaps, monitoring frameworks, social justice, and potential risks of maladaptation?

The PACA regional innovation strategy (2014-2020) is characterized by a strong technological bias. While social innovation is mentioned, it remains vaguely defined and lacks clear implementation pathways. The most significant oversight is the practical absence of climate adaptation from the strategic framework. By focusing almost exclusively on technological solutions, the strategy risks neglecting the non-technical and social innovations necessary for a comprehensive regional transition.

Category	Assessment
Thematic gaps & visibility	Climate adaptation is practically absent from the strategy.
Monitoring & data gaps	No specific indicator system for climate-related or social outcomes mentioned.
Social & justice gaps	Social innovation is present but lacks clear definition and implementation tools.
Strategic risks & maladaptations	Over-reliance on technological solutions (technological bias) at the expense of non-technical innovation.

3.6 Linking climate adaptation and smart specialization

The analysis of the project portfolio has revealed that the relationship between climate adaptation and smart specialization is not simply a matter of matching themes. Within the selected CORDIS projects, the strongest patterns did not appear as direct correspondences between specific adaptation domains and individual S3 priorities. Instead, the portfolio showcased recurring combinations of problem framing, governance design, digital infrastructure, territorial enabling factors, and implementation pathways. Three key findings are particularly important for interpreting regional and national S3 strategies. First, the project material demonstrates a strong and consistent connection between risk, vulnerability, governance, and justice, alongside digital transformation. Second, biodiversity and ecosystem-based approaches frequently emerged alongside urban or territorial implementation. Lastly, energy transition and sustainable agriculture stood out as the most distinct specialized pathways through which adaptation is integrated into broader regional transformation agendas. Thus, the strategic documents discussed below should not be viewed in isolation from the project-based evidence. Instead, they provide an opportunity to evaluate whether the same patterns can be observed at the level of territorial development frameworks and S3 priorities.

This comparative step is crucial because the project analysis indicated that the strongest connections between adaptation and S3s occur when adaptation is integrated into broader regional transformation processes, rather than being treated as a standalone environmental goal. The regional and national strategies examined here provide an opportunity to test this idea using different materials. Unlike project objectives and reporting summaries, S3 documents operate at the policy level, focusing on investment priorities and territorial planning. They therefore reveal not only whether adaptation-related themes are present, but also their strategic significance, their integration into implementation structures, and their connection to monitoring and cohesion concerns. In this context, the following matrix should be viewed as an analytical tool that bridges





project-based findings and the subsequent synthesis. It does not replace the qualitative case descriptions provided earlier; instead, it enables comparison within a shared analytical framework that emphasizes adaptation themes, linkages to smart specialization, the nature of integration, and the primary gaps and opportunities identified in each strategy.




Table 1. Cross-analysis matrix of adaptation themes and smart specialisation linkages in selected S3s

<i>Region / strategy</i>	<i>Adaptation themes</i>	<i>Main smart specialisation linkages</i>	<i>Type and strength of integration</i>	<i>Gaps</i>	<i>Opportunities</i>
<i>Metropole Ruhr</i>	Infrastructure and the built environment; energy-related adaptation; urban transformation; governance and coordination; partial health dimension	Green technologies, hydrogen economy, circular economy, AI, cybersecurity, smart city, logistics, health	Strong, but largely implicit: adaptation is embedded in industrial, energy, urban and digital transformation rather than framed as a stand-alone adaptation strategy	No explicit ecological adaptation; biodiversity, flood resilience, water management and heat adaptation are missing; just transition remains indirect; no concrete KPI set; coordination across municipalities is a challenge	Existing hydrogen, digital, logistics and smart-city capacities could be linked more explicitly to adaptation, resilience monitoring, inter-municipal governance and social inclusion
<i>Berlin–Brandenburg</i>	Infrastructure resilience; energy-system robustness; mobility adaptation; governance, skills and cross-cluster coordination	Digitalisation, Reallabore, energy, mobility and logistics, startups, cross-cluster innovation	Medium to high, mostly indirect: adaptation appears as a co-benefit of system modernisation and cluster integration	Biodiversity, water, ecological infrastructure, heatwaves and drought remain weakly articulated; social vulnerability is not explicit; adaptation indicators are absent	Strong digital and energy priorities could support a more explicit resilience agenda, especially if linked to ecological and justice-sensitive dimensions
<i>Île-de-France</i>	Urban transformation; health and wellbeing; social cohesion; biodiversity protection in a limited form; built and natural environment concerns	Digital transformation, SME competitiveness, ecological transition, circular economy, training and jobs	Medium, partly explicit, but unevenly translated into adaptation logic	Broad priorities; weak territorial targeting; unclear beneficiaries; insufficient treatment of specific critical pressures; tourism and cumulative pressures are not clearly integrated	The existing green, digital, health and social priorities could be more directly translated into explicit urban and regional adaptation pathways
<i>Provence-Alpes-Côte-d'Azur (PACA)</i>	Risk, safety and security; health and wellbeing; food; sustainable housing	Energy transition, smart grids, renewables, mobility, digital content,	Medium, but weakly adaptation-explicit and partly framed through an	Adaptation is not a central organising principle; inter-scalar and long-term resilience framing is	The strong orientation towards risk, health, energy, mobility and housing could be rearticulated





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	and urban ecology; mobility	tourism, health technologies	earlier innovation logic	limited; biodiversity and ecosystem-based resilience remain underdeveloped	more clearly in climate adaptation terms, especially in a Mediterranean context
<i>Austria (RTI Strategy 2030)</i>	Risk and governance only indirectly; infrastructure robustness through research and digital infrastructures; energy and resource efficiency	Digitalisation, resource efficiency, energy innovation, research infrastructures	Medium, but mainly national and indirect	No regional dimension; adaptation is embedded in other priorities; no separate adaptation indicator system; social justice and vulnerability are marginal	The strong research and digital infrastructure base could support a more explicit regional adaptation orientation and a clearer resilience-related monitoring framework
<i>Hungary (National S3)</i>	Energy-climate nexus; resource-efficient economy; partial regional resilience; governance through regional platforms	Energy transition, resource-efficient economy, digital infrastructure, regional innovation platforms, EDP, agriculture/food in innovation terms	Medium, with stronger territorial logic than in some other national cases, but still mostly framework-level	No systemic adaptation logic; social justice and inequalities are absent; county-level innovation data are weak; broad priorities risk resource fragmentation	Regional typologies, EDP and regional platforms provide a useful basis for more place-based and adaptation-explicit prioritisation
<i>United Kingdom / England</i>	Adaptation only weakly, mostly through resilience, sustainability and low-carbon innovation; partial energy and technological robustness	Energy technologies, agri-science, big data, advanced materials, LEPs, innovation investment	Low to medium, largely indirect	Minimal direct climate focus; very limited explicit adaptation framing; sustainability remains secondary; territorial adaptation logic is weak	Existing innovation ecosystems and LEP-based structures could be used to introduce clearer resilience-oriented and adaptation-sensitive investment priorities



When examining the selected strategies in relation to the earlier project analysis, the first key conclusion is that there is indeed a relationship between climate adaptation and smart specialization. However, in most cases, this relationship remains implicit, partial, and unevenly structured. This pattern reflects what has already been identified in the project portfolio. In the analysis based on CORDIS, adaptation themes were rarely connected to smart specialization through direct thematic correspondence. Instead, they were implemented through enabling capacities such as digital platforms, governance arrangements, decision-support tools, territorial implementation, and innovation-oriented pathways. Regional and national strategies show a similar pattern. In most of these strategies, adaptation does not appear as a separate strategic chapter or priority area. Instead, it is integrated into broader transformation agendas, including industrial modernization, energy transition, smart city development, mobility innovation, health innovation, and digitalization. This is particularly evident in the Ruhr and Berlin-Brandenburg cases, where substantial content related to adaptation exists but is primarily framed in terms of energy systems, industrial restructuring, logistics, smart infrastructure, and digital capabilities, rather than through explicit adaptation categories. A similar pattern is observed in Austria, where adaptation is largely viewed as an issue of technological innovation, and in the case of England, where even low-carbon and sustainability language is comparatively weak.

This implicitness has both strengths and limitations. On the positive side, it indicates that adaptation-relevant transformations are beginning to be integrated into S3-type strategies through investment priorities that are politically and economically significant. In practice, this may facilitate financing for adaptation and help align it with industrial and regional development agendas. Project analyses suggest a similar conclusion: the strongest connections between adaptation and S3 occur when adaptation is embedded in broader regional transformation processes. This is especially true in areas such as digital infrastructures, infrastructure resilience, territorial implementation, and innovation platforms. Examples from S3 illustrate this point. For instance, the Ruhr region demonstrates how hydrogen, circular economy initiatives, digitalization, logistics, and smart city agendas can collectively support decarbonization, urban transformation, and system robustness. Similarly, the Berlin-Brandenburg region shows how energy transition and mobility transformation can lead to adaptation-relevant effects through sector coupling, decentralized systems, digital optimization, and cluster-based spillovers. Although Île-de-France is more socially oriented, it also suggests that elements such as green transition, digital transformation, SME competitiveness, biodiversity protection, and social inclusion can be combined into a broader framework that supports resilience.

The limitations of this implicit feature are significant. One major issue is the lack of explicit adaptation framing. When adaptation is not recognized as such, it often lacks the necessary policy weight, visibility, and ability to be monitored. This is particularly evident in cases from Austria, England, and, to some extent, Ruhr and Berlin-Brandenburg. In Austria, adaptation is largely integrated into broader priorities such as technology, research, energy, and resource efficiency, without a regional approach or a separate indicator framework for adaptation. In England, the strategic document gives minimal direct attention to climate, low carbon, or sustainability issues, despite clear connections to energy technologies, agri-science, and big data. In the Ruhr area, there is still a notable absence of explicit climate adaptation, even though the strategy strongly supports mitigation, decarbonization, smart infrastructure, and industrial renewal. Likewise, in Berlin-Brandenburg, adaptation is primarily viewed as a co-benefit of modernizing energy and mobility systems. In all these cases, the lack of explicit framing for adaptation makes it more challenging to assess how effectively these strategies address vulnerability, climate impacts, or resilience in a systematic way.





The second major pattern identified is thematic asymmetry. The project analysis revealed that the strongest project clusters focus on biodiversity and ecosystem-based approaches, urban and infrastructural adaptation, as well as risk and vulnerability. Conversely, digital transformation emerged as the primary transversal enabling factor, while energy transition and sustainable agriculture surfaced as smaller yet significant pathways. However, the strategic documents only partially reflect this distribution. The domains that easily align with the S3 framework are those that already exhibit a robust innovation and investment rationale, including digital transformation, energy systems, industrial modernization, mobility, infrastructure, and health technologies. In contrast, several themes relevant to the IPCC regarding adaptation remain underdeveloped. These include biodiversity and ecosystem-based adaptation, water management, green-blue infrastructure, heat adaptation, and drought-related resilience. Ruhr and Berlin–Brandenburg are prime examples of this pattern: both regions exhibit strong profiles in energy, mobility, industry, and digital sectors, yet they largely neglect biodiversity, ecological infrastructure, and specific strategies for water or heat resilience. Austria demonstrates a similar trend at the national level. Even the PACA region, which articulates concerns about risk, safety, health, food, and sustainable housing more strongly, does not prioritize ecosystem-based adaptation in its strategic framework.

A significant gap that emerges when reviewing the regional strategies alongside the project portfolio concerns social vulnerability, justice, and the differentiated burdens that come with adaptation. In analyzing the projects, the most prominent theme related to adaptation was the interaction between risk, vulnerability, governance, and justice. Many projects tackled adaptation through decision-support tools, local and regional planning, participatory processes, and a clear focus on fairness and support for vulnerable groups. However, the strategy documents do not fully reflect this approach. Some documents do address issues such as skills development, social innovation, employment, training, and inclusive growth, but these connections are not typically made to climate-related exposure, uneven adaptation capacities, or concepts of territorial justice. For instance, Ruhr acknowledges social disparities and labor market risks in the context of industrial transitions, but mechanisms for a just transition remain underdeveloped. Berlin–Brandenburg mentions quality of work, skills, and participation, yet does not explicitly tie these to climate vulnerability or the unequal burdens of adaptation. Similarly, Austria only marginally addresses social cohesion through talent development and research careers, while Hungary offers little discussion on social justice and inequalities in relation to adaptation issues. Île-de-France stands out as the strongest example in this regard, as it places social disparities and access to services more prominently in the regional framework, but even here, the connection to climate adaptation logic is still incomplete. Overall, it appears that social cohesion is more often addressed in the strategies as a labor market or inclusion issue rather than as a fundamental aspect of climate adaptation.

A significant issue in EU projects is the monitoring and evaluation of adaptation efforts. One finding from project-based research indicates that adaptation is often facilitated through intermediate infrastructures, such as assessment frameworks, models, climate services, monitoring systems, and decision-support environments. This suggests that the operationalization of adaptation is a crucial component of the process. However, the strategy documents tend to be insufficient in this area. For example, Ruhr highlights the need for indicators but has yet to define a specific set of KPIs. In the Berlin–Brandenburg region, although there is a structured monitoring system, it fails to track adaptation capacity or environmental resilience because adaptation is not prioritized. Austria has developed performance and innovation indicators, but lacks a distinct monitoring framework specifically for adaptation. Hungary includes numerous innovation-related indicators across various



sectors, such as energy, services, agriculture, and frontier technologies, but still does not have a cohesive adaptation strategy and faces limitations in data collection at the county level. Île-de-France features many program indicators, particularly in social and employment domains, yet adaptation goals remain too vague to be monitored effectively as a strategic objective. The lack of adaptation-specific indicators is not merely a technical issue; it represents a structural limitation. Without measurable targets related to adaptation, it becomes challenging to identify gaps in implementation, compare progress across regions, or evaluate whether a strategy is genuinely enhancing resilience or simply modernizing certain sectors.

The selected strategies highlight several important opportunities, with digital transformation emerging as the most significant. This transformation serves as a critical bridging infrastructure and aligns closely with the project portfolio, where it has been identified as the key horizontal enabling factor. In the project materials and the S3 examples, digital tools are not merely technological add-ons; rather, they are essential for making resilience actionable. This occurs through various means, including modeling, smart grids, testbeds, smart mobility, digital optimization, cybersecurity, data services, and platform-based coordination. Regions such as Ruhr and Berlin–Brandenburg excel in these areas, and similar trends can be observed in Île-de-France and, more indirectly, in Austria and Hungary. This evidence suggests that digital transformation is the most developed and transferable approach for strengthening adaptation within S3-type frameworks. The second opportunity lies in energy transition and infrastructure modernization. The project portfolio indicates that energy transition and sustainable agriculture are the most prominent specialized pathways through which adaptation is integrated into regional transformation agendas. The strategic material strongly supports the first part of this proposition, although it is less clear regarding the second part. Energy transition is highly visible in regions such as Ruhr, Berlin-Brandenburg, PACA, Austria, Hungary, and England. In each case, energy transition is associated with decarbonization, system modernization, storage, resource efficiency, or cleaner mobility. What is missing is not the energy agenda itself, but its clearer interpretation as part of adaptation and resilience policy. This suggests that one of the most realistic future opportunities lies not in creating new strategic priorities, but in reframing existing ones. Concepts like energy system flexibility, robust distribution networks, smart grids, thermal renovation, and sector coupling can all be articulated more effectively as capacities for both mitigation and adaptation. This approach would better align strategic documents with project-based evidence, demonstrating that energy transition becomes relevant to adaptation precisely when issues of infrastructure robustness, distributional concerns, and territorial implementation are clearly addressed. One important opportunity relates to territorial and institutional capacity. The project analysis consistently highlighted key factors such as region, capacity, monitoring, replication, and partnership as essential for effective adaptation strategies. There is significant potential in existing strategic documents, even if their development is uneven across different areas. For instance, the Ruhr region benefits from strong cluster coordination and an established regional orchestrator in Business Metropole Ruhr. The Berlin–Brandenburg area employs cross-cluster governance and Reallabore, while Hungary relies on the EDP and regional innovation platforms. Île-de-France is integrated into various national and European planning frameworks. These constitute forms of institutional capital that could facilitate the integration of climate adaptation in future updates. The critical issue is not the existence of governance structures but whether they explicitly include adaptation-related objectives, indicators, assessments of territorial vulnerability, and criteria for justice-sensitive implementation. In other words, while many governance foundations are already present, there is a need for their systematic application toward climate adaptation initiatives.





4 Discussion

Best practices

The report's primary empirical contribution lies in integrating three complementary layers of evidence: the CORDIS-based project portfolio, the Climate-ADAPT best practice collection, and the review of selected national and regional smart specialization strategies. Together, these sources demonstrate that the relationship between climate adaptation and smart specialization is both present and complex. This relationship appears across all three layers, but is expressed through different mechanisms. The project portfolio emphasizes adaptation as a field shaped by innovation, governance design, and enabling infrastructures. The best practice collection focuses on implementation methods and local delivery. Meanwhile, the strategic documents illustrate how these connections are reflected in territorial priority-setting, investment logic, and institutional frameworks. This multi-source perspective aligns with the report's methodological design, which aimed not only to find and list sources but also to develop an analytical framework that identifies cross-domain linkages, dimensions of social cohesion, infrastructure robustness, and knowledge gaps.

Within the project portfolio, several initiatives clearly connect adaptation with smart specialization, namely CLIMAAX, CARMINE, ACCREU, DIRECTED, and MULTICLIMACT. These projects are significant because they illustrate how concepts like risk, vulnerability, governance, and justice can be applied through various frameworks, decision-support environments, interoperable data systems, and territorial planning tools. They are significant not only for addressing climate risks, but also for demonstrating that adaptation becomes actionable when supported by essential infrastructures such as modeling, monitoring, and institutional coordination. As a result, these initiatives are particularly important for understanding the governance and digital aspects of adaptation. Similarly, projects like A-Agora, CLIMAREST, DaWetRest, DesirMED, and CARDIMED serve as excellent examples of how biodiversity, ecosystem restoration, and nature-based solutions can be linked to regional implementation, stakeholder engagement, monitoring, and replication. These cases are particularly valuable as they connect ecological adaptation directly to territorial transformation and implementation pathways. Another significant group of projects highlights the intersection of adaptation with the built environment, urban systems, health, and energy transformation. Projects like ARCH, CLARION, ICARIA, MULTICLIMACT, CLIMRES, UrbanAIR, and CLIMABOROUGH demonstrate that adaptation in the built environment extends beyond mere hazard protection. It involves planning, maintaining service continuity, integrating digital support systems, and participating in urban experimentation. In parallel, projects such as adJUST, JUST4CARE, JUSTSAFE, FairFuture, Smart-BEEjS, ASCEND, and ENERPOL are noteworthy for introducing issues of equity, inclusion, and energy system transformation into the adaptation discussion. These examples are particularly important for the report, as they show that the connection between adaptation and smart specialization is strongest when resilience is approached not just as a technical challenge but also as a matter of governance, social feasibility, and territorial equity.

The implementation-oriented cases present a different yet equally important set of examples. The best practices from Climate-ADAPT and mission-based initiatives indicate that the most transferable and visibly impactful actions often involve participation and partnerships, water and flood management, capacity building, evidence-based planning, nature-based solutions, cooling interventions, and ecosystem restoration. These examples demonstrate that effective adaptation





practices often rely on local stakeholder engagement, place-based planning, practical risk management, and context-specific ecological or infrastructural interventions. While the CORDIS portfolio excels at illustrating how adaptation is designed and structured, the best-practice collection demonstrates at showing how adaptation is implemented and sustained in local and regional contexts.

Co-benefits

One of the key findings of the report is that the connection between adaptation and smart specialization is most evident through co-benefits. The selected EU projects indicate that adaptation and smart specialization do not constitute a single integrated policy area. Instead, they intersect through shared operational logics. In the project portfolio, these common themes are reflected in the implementation of adaptation themes via digital infrastructures, energy system transformation, territorial implementation, and innovation-oriented pathways. Similarly, in the strategy documents, this pattern is reflected through green technologies, smart mobility, circular economy, health innovation, digitalization, and resource efficiency. In the best practice examples, it is evident through partnerships, local planning, water management, cooling measures, and ecosystem restoration. The common thread across all three layers of evidence is that adaptation is most effectively integrated into broader regional development agendas when it generates multiple policy-relevant benefits, rather than being viewed as a single-sector goal.

Digital transformation serves as a prominent example of an enabling factor in various projects. According to the analysis based on CORDIS, it emerged as the strongest transversal element linked to risk assessments, climate services, digital twins, data platforms, modeling systems, monitoring environments, and decision-support tools. According to the findings, digital transformation is not only a technical advancement but also an institutional shift, redefining participation, co-production, and access to evidence. In strategic documents, digitalization is identified as one of the most significant and transferable means of enhancing adaptation within S3s, particularly in regions such as Ruhr, Berlin–Brandenburg, Île-de-France, Austria, and Hungary. However, best practice examples introduce an issue that might be considered: while digital tools are present, they do not dominate the landscape. This suggests that digital transformation functions most effectively as an enabling condition at the project and strategy level. Ground-level implementation often relies more on partnerships, planning, water-related interventions, and place-based ecological measures. The benefit of this approach is that digital transformation enhances innovation, coordination, monitoring, and resilience, even when adaptation is not the primary focus.

The energy transition represents a significant area for co-benefits. The analysed project portfolio indicates that energy transition is not just a general smart specialization topic; rather, it is a strategically important pathway that highlights the relevance of adaptation in terms of infrastructure robustness, energy poverty, unequal distribution of transition benefits, and system vulnerability. This relationship is strongly supported by the strategy review. Energy transition is prominently featured in regions such as Ruhr, Berlin–Brandenburg, PACA, Austria, Hungary, and England, where it is linked to decarbonisation, system modernisation, resource efficiency, energy storage, smart grids, hydrogen technology, and cleaner mobility options. Our findings reveal that the link between energy transition and adaptation does not hinge on whether a strategy identifies itself explicitly as adaptation-oriented. Instead, it depends on how energy priorities are expressed, particularly in terms of system robustness, territorial implementation, and the consequences of distribution. Ultimately, the logic of co-benefits is clear: the same investments that promote climate



neutrality can also enhance adaptation, as long as they are framed in relation to resilience, vulnerability, and the specific needs of different territories. A third co-benefit area is the built environment. The project analysis showed that infrastructure and the built environment are among the strongest adaptation themes, especially where climate risks threaten buildings, mobility systems, public services, ports, historic areas, and urban operational systems. These projects also showed that built-environment adaptation frequently intersects with digital services, energy systems, ecological design, and social inclusion. The strategy documents reinforce this conclusion. Ruhr, Berlin–Brandenburg, Île-de-France, and PACA all contain strong urban, mobility, or infrastructural dimensions that can be read as adaptation-relevant even where climate adaptation is not explicitly named. The best practice collection deepens this further by showing that the built environment becomes adaptation-relevant in implementation terms through cooling interventions, climate-proof transport, green infrastructure, resilient construction, and local evidence-based planning. This makes the built environment one of the most effective shared spaces in which adaptation and smart specialisation can generate multiple benefits simultaneously.

Knowledge gaps

The report highlights several structural gaps identified in the reviewed documents. The **first gap** is the weak and often indirect occurrence of maladaptation. In the keyword analysis, maladaptation did not appear as a major theme. Instead, references to maladaptive risks were found indirectly through associated terms such as vulnerability, social justice, governance, and the unequal distribution of adaptation benefits. The project-based analysis confirmed this observation, revealing that many projects recognize issues related to distribution, processes, and territory without explicitly labeling them as maladaptation. Additionally, the best-practice materials lead to a similar conclusion. They contain very limited explicit content on maladaptation but include a much broader range of practices focused on vulnerable groups, preparedness, risk communication, and inclusive adaptation. It can be stated that maladaptation is more readily identified as a practical risk related to exclusion, poor targeting, or weak governance rather than as a stable category for analysis. Overall, maladaptive risks should be identified through the lens of governance failures, inadequate territorial targeting, lack of monitoring, and socially uneven outcomes.

A **second gap** is thematic imbalance. Throughout the three evidence layers, topics like digital transformation, energy transition, infrastructure modernization, and mobility are more easily integrated into innovation and regional development frameworks than adaptation themes such as biodiversity, water, health, or social vulnerability. While the project portfolio partially addresses this through biodiversity and ecosystem-based initiatives, the strategy review indicates that regional and national S3 documents are still more likely to emphasize technological and economic priorities over ecological adaptation and social issues related to vulnerability. The best practices highlight this contrast, as water management, heat hazards, cooling interventions, and nature-based solutions are more prominent at the implementation level than in strategic planning. This disparity points to a broader knowledge problem: some adaptation themes are well-represented in projects, others perform better in implementation, while some remain underrepresented in both areas. As a result, the overall field is not only fragmented but also unevenly distributed across different knowledge layers.

A **third gap** in the report relates to climate justice and social cohesion. The methodological framework highlights social equity, just transitions, and cohesion as essential analytical questions. The project portfolio demonstrates that justice is relevant, particularly at the intersection of digital





transformation, infrastructure resilience, and the energy transition with vulnerable groups, distributional concerns, and governance issues. However, discussions of justice often arise implicitly rather than explicitly. The strategy documents emphasize skills, jobs, human capital, innovation ecosystems, and inclusion, yet they rarely connect these topics to climate-related risks, unequal burdens, or territorial justice. Île-de-France is relatively effective in addressing these issues, as it more explicitly integrates concerns about social disparities, the green transition, health, and the labor market than most other regions. Nevertheless, even there, the application of these concerns within a comprehensive climate adaptation framework is still incomplete.

Finally, the **fourth significant gap** identified is operationalization. The report clearly indicates that while adaptation-related priorities are often included in strategic documents, they are not translated into specific indicators, monitoring systems, or metrics for adaptation outcomes. This presents a major limitation. One of the key findings from the project portfolio is that adaptation is frequently organized through intermediate infrastructures, such as climate services, monitoring systems, models, and decision-support environments. However, this approach is not adequately reflected in many of the strategies reviewed. Examples from Ruhr, Berlin–Brandenburg, Austria, Hungary, and Île-de-France demonstrate that when adaptation is not accompanied by operational metrics, the integration at the strategy level tends to remain broad and mostly declarative. This creates a gap between stated goals and measurable progress. It also restricts the capacity to benchmark performance across different regions, identify maladaptive trends, and compare the relative strengths of various forms of just resilience.

Next steps

The findings of D2.1 provide an empirical foundation for the next two tasks in WP2. The report has identified key adaptation themes, the most visible smart specialization linkages, the strongest implementation patterns, and the main gaps related to social cohesion, maladaptation, territorial operationalization, and monitoring. Among the reviewed documents, the most consistent adaptation themes include risk, vulnerability, and governance; biodiversity and ecosystem-based approaches; as well as infrastructure and the built environment. Digital transformation stands out as the primary transversal smart specialization linkage, while energy transition and sustainable agriculture are recognized as specific yet relevant pathways. However, the report indicates that climate justice is not well articulated, maladaptation is often implied rather than explicitly stated, and adaptation-specific monitoring is underdeveloped in both project and strategy materials. Task T2.2 will conduct a systematic review of the scientific literature on assessment approaches to climate justice, climate resilience, and maladaptation. This review will utilize databases such as Web of Science and Scopus, as well as EU knowledge sources like Climate-ADAPT, the Smart Specialisation Platform, and CORDIS. The results of D2.1 will guide the focus of this review, particularly in addressing the weak explicit treatment of maladaptation, the inconsistent treatment of justice across various projects and strategies, and the lack of a common assessment language linking social equity, territorial differentiation, and adaptation outcomes. Furthermore, the review will examine how existing approaches account for regional variation, as D2.1 highlights significant differences between project logic, best-practice implementation, and territorial strategy frameworks.

For T2.3, the connection to D2.1 is even more explicit. T2.3 will develop a foundational framework and specific indicators for just climate resilience. These indicators aim to assess how climate risks and adaptation benefits are distributed among different socioeconomic groups, particularly the most vulnerable populations, while focusing on social cohesion and geographical location. The framework



will emphasize inclusive participation, multi-level governance, and flexibility, enabling its implementation across various pilot contexts and alignment with EU adaptation monitoring systems, including the resilience assessments conducted by the European Environment Agency. D2.1 provides the empirical groundwork necessary for this task. It demonstrates that a just resilience framework cannot be treated as a one-size-fits-all concept. Instead, it must be organized by adaptation themes and territorial scales since the reviewed documents indicate that areas such as water management, biodiversity and ecosystem-based approaches, infrastructure, health and well-being, agriculture and food systems, as well as risk, vulnerability, and governance, each present unique combinations of social, ecological, territorial, and institutional challenges.

The report suggests a framework where "just resilience" is outlined through a common set of principles, which can be implemented differently across various themes and scales. The common principles – derived from the findings in this report – include distributive justice, procedural inclusion, multi-level governance, territorial sensitivity, and the avoidance of maladaptive outcomes. The thematic distinctions are also clearly defined in this report. For instance, issues related to risk and governance must focus on exposure, vulnerability, participation, and decision-support capacity. When it comes to infrastructure and the built environment, the emphasis should be on service continuity, heat exposure, and resilience planning. Biodiversity and ecosystem-based adaptation require attention to restoration, ecosystem functioning, and green-blue systems. Health and wellbeing must prioritize heat risk, vulnerable populations, and cooling-related measures. Finally, agriculture and food systems should focus on water access, the robustness of productive systems, and landscape resilience. In this context, D2.1 has already established the thematic framework upon which T2.3 can develop a more formal just resilience framework and indicator structure.





5 Conclusions

The purpose of D2.1 is to review and consolidate the European Union's knowledge on climate adaptation and smart specialization. This was achieved by gathering evidence from various projects, knowledge platforms, strategic documents, datasets, indicators, and practical materials. The primary contribution of the report is its demonstration that these two areas are interconnected within the EU knowledge landscape, although not uniformly or coherently. The analyzed documents indicate that climate adaptation and smart specialization are not completely separate policy domains. However, it also reveals that their relationship is not yet mature, systematic, or clearly defined. Instead, what emerges is a fragmented but meaningful area of interaction where climate adaptation increasingly relates to regional transformation, innovation systems, territorial planning, and governance arrangements. This connection often occurs through indirect and uneven pathways rather than through explicit strategic alignment. The report concludes that the relationship between climate adaptation and smart specialization is not straightforward and cannot be understood through simple one-to-one connections.

Evidence presented in Chapter 4 demonstrates that the strongest links are not merely pairings of one adaptation theme with one smart specialization topic. Instead, these links arise from recurring combinations of how problems are framed, the infrastructures that enable solutions, the design of governance, and the implementation strategies in specific areas. This is particularly evident in the analysis of projects. Among the CORDIS-derived project portfolios, the most significant themes for adaptation include risk, vulnerability, and governance; biodiversity and ecosystem-based approaches; and infrastructure and the built environment. Meanwhile, digital transformation emerges as the key transversal link for smart specialization. Energy transition and sustainable agriculture are identified as narrower but distinct pathways. The keyword and objective-based analyses support this interpretation. In the project portfolio, climate adaptation is not presented as a narrowly defined technical field. Instead, it is described in terms of resilience, participation, vulnerability, co-creation, stakeholder engagement, actionable knowledge, digital mediation, and sustainability. It can be stated that adaptation in EU-funded projects is increasingly implemented through systems of assessment and coordination, rather than through isolated measures. Risk and vulnerability are made actionable through decision-support environments, modeling systems, climate services, and multi-hazard approaches. Biodiversity and ecosystem-based adaptation are linked to restoration, nature-based solutions, stakeholder systems, demonstration platforms, and territorial roadmaps. Infrastructure adaptation is associated not only with protection from climate hazards but also with service continuity, system functionality, local planning, and high-resolution data environments.

The Climate-ADAPT best practice collection provides an important additional perspective on adaptation efforts. While the project portfolio effectively highlights how adaptation is structured within research and innovation processes, the analyzed best practices illustrate how adaptation is implemented in practical terms. These best practices emphasize key areas such as participation and partnerships, water and flood management, capacity building, evidence-based planning, nature-based solutions, heat-related measures, and local cooling interventions. Although these categories are present in the project portfolio, they are less prominent compared to the implementation-oriented evidence. The comparison between these two sources shows a difference in focus rather than a contradiction. Project-based evidence reveals how adaptation is designed and organized, while best-practice evidence demonstrates how it is delivered and maintained in real-world settings.





Together, these two sources provide a more comprehensive understanding of adaptation in the EU context than either could offer alone.

The regional and national smart specialization strategies provide an analytical layer for understanding adaptation. A review of these strategies indicates that adaptation-related content is already included in many S3-type documents, although it is usually not presented as a prominent organizing principle. The key areas where adaptation and smart specialization intersect include digitalization, energy transition, mobility, industrial modernization, urban transformation, and infrastructure development. However, the review highlights that these intersections are often implicit. Climate adaptation is frequently incorporated within broader priorities focused on technology, the economy, or competitiveness, rather than being explicitly defined as a strategic area in its own right. The case-based review of strategies reveals that these shortcomings are not just occasional; they are recurring structural issues. In many instances, ecological adaptation is underdeveloped, discussions on social vulnerability and territorial justice are weak, and there is a lack of adaptation-specific monitoring or indicator systems. Thus, while a connection between S3 and adaptation exists, it often remains partial, weakly operationalized, and more focused on technological and economic aspects than on justice-sensitive or ecosystem-based resilience.

The report identifies several cross-cutting limitations that currently shape the field. One major issue is the inadequate explicit treatment of maladaptation. While maladaptive risks can be identified in the reviewed sources, they are rarely labeled as such. Instead, they often emerge through related concerns, such as vulnerability, unequal distribution, exclusion of vulnerable groups, lack of participation, weak territorial targeting, or absence of monitoring. This pattern indicates that maladaptation is primarily recognized in the current knowledge base as an indirect concern. Consequently, identifying maladaptive trajectories may be more challenging than replicating them, particularly when adaptation is incorporated into broader development or innovation agendas without a clear framework to evaluate social and territorial impacts.

A second limitation concerns climate justice and social cohesion. The review framework explicitly asked how well EU climate adaptation and smart specialization policies and projects address social cohesion and promote just climate resilience. The findings are mixed. While justice-related concerns are present throughout the documents, they are typically not expressed consistently or in a fully operational manner. Projects increasingly address issues of vulnerability, inclusion, and justice, especially in the contexts of governance, digital transitions, infrastructure, and urban systems. Best practices often highlight the visibility of vulnerable groups, participation, and local capacity. S3s sometimes mention skills, jobs, inclusion, or human capital but rarely connect these aspects to climate exposure, unequal burdens, or territorial justice. Thus, the report identifies not an absence of relevant content, but rather a lack of coherence. Climate justice is not yet embedded consistently across the reviewed knowledge base, making it difficult to establish a shared and comparable understanding of just resilience. A third limitation is the insufficient development of monitoring and indicators. While adaptation is frequently discussed, it is much less often operationalized in measurable and comparable ways. This issue applies to both strategic documents and project environments. The report consistently shows that adaptation-specific indicators, monitoring systems, and evaluative frameworks are often lacking or underdeveloped. Without adaptation-sensitive metrics, it remains challenging to assess whether resilience is actually being strengthened, if benefits are distributed fairly, or whether maladaptive patterns are emerging.



The overall conclusion of D2.1 is both analytical and strategic. From an analytical perspective, the report shows that the EU knowledge landscape contains actions and documents linking climate adaptation to smart specialization. However, this is unevenly distributed across various projects, strategies, and practical sources. From a strategic standpoint, the report suggests that the most promising path for stronger integration does not lie in developing entirely new thematic categories. Instead, it advocates for making existing connections more explicit, justice-sensitive, territorially differentiated, and operationally measurable. The strongest links are found where climate adaptation is integrated into broader regional transformation processes, particularly in areas such as digital transformation, energy transition, ecosystem-based practices, infrastructure resilience, and territorial governance. Conversely, the weakest areas remain maladaptation, climate justice, and monitoring.





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