Transformative Innovation for better Climate Change Adaptation - Case Study: Emilia-Romagna, Italy

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Contents

Abstract

The aim of this report is to investigate the potential for harnessing key features of Transformative Innovation to improve the design and the implementation of Climate Change Adaptation (CCA) strategies, based on empirical analyses. The study draws on the conceptual framework on this question previously defined for the JRC (European Commission, 2024), and the methodology for case studies articulated in the same report. The case study research comprises overall 14 case study reports covering 16 different territories from across the EU and beyond, casing various institutional contexts, a variety of biogeographical regions within different climate risks, different ranges of population sizes, and representing a diversity of approaches to CCA and transformative innovation[1] . The framework takes the form of an analytical grid, structured into seven sections, each of them representing a key feature of the 'transformative innovation' approach where the features are understood as essential conditions for the design and implementation of CCA strategies with this high level of ambition. Each section sets out the main question(s) to be addressed in relation to its respective transformative innovation feature. This report provides the findings for the region of Emilia Romagna, Italy, as at November 2023, and is the result of a collaboration between the Joint Research Centre (JRC), DG CLIMA and DG RTD.

[1] A full list of the case studies is provided in Annex 2.

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Executive summary

Policy context

Adapting to climate change has become an increasingly urgent priority for the EU and its territories. Given this urgency, and the systemic nature of climate resilience, new ways to accelerate adaptation are considered. Transformative innovation (TI) is at the focus of this report, particularly how it can help support and accelerate adaptation to climate change. The analysis in this report draws lessons for Emilia Romagna (Italy) on how a TI approach is already helping the territory in increasing climate resilience, and what can be done in addition, to further accelerate adaptation. The analysis is based on a theoretical framework along seven dimensions designed to compare TI and Climate Change Adaptation (CCA). It is one out of a series of 14 different case study reports covering 16 territories.

Main findings

Emilia Romagna region is a signatory of the EU Mission on Climate Adaptation. The region has an increased sense of urgency towards climate risks, since the floods of May 2023. Features from transformative innovation can further support the region in its efforts towards systemic change, starting from the following state-of-play.

- Directionality: The authorities and key stakeholders in the region are aware of how climate risks affect key social systems. Public support and advocacy is growing, especially since the May 2023 floods. A transformative approach to sustainability themes can be identified, evident in successive initiatives in the region, with environmental transformation as a major issue. However, there is still a need to focus more on processes and pathways towards system change.

- Instrument portfolios and funding synergies: There are some domestic and EU instruments to support the implementation of regional and local development strategies, including in climate change adaptation. Substantial domestic resources are used primarily for water management (against floods) and land use. A number of projects, including EU-funded projects, have already been implemented in the region in the area of climate change adaptation and innovation. However, activities stay fragmented and regionally uncoordinated, and adaptation and innovation are rarely combined.

- Ensuring cross-domain synergies: Efforts are made for cross-sectoral approaches, coordination of policies, and the mainstreaming of climate change issues (not exclusively adaptation) into different sectoral areas. Smart Specialisation priorities have a multidisciplinary and cross-sectoral dimension and include sustainable transformation. However, there is a need to strengthen synergies at the level of organisational structures.

- Stakeholder involvement: A wide variety of actors shows a good integration and a high level of participation in the CCA process. A supervising management structure seems missing. The region benefits from a strong regional innovation ecosystem, which is more oriented towards mitigation, less so in adaptation.

- Multi-level governance: Many valuable initiatives at the local scale have been carried out in recent years. A stronger integration among regional and local plans still needs good efforts. The region has strong budgetary power, but huge investments and State support are needed. Politically, cooperation between regions and the national level are complex.

- Experimentation: There is a space for creativity and experimentation on potential innovative solutions, although it is not strictly dedicated to CCA.
- Policy intelligence, learning and strategic capacity: Regional and local initiatives strengthen scientific CCA knowledge. The Climate Observatory serves its purpose. Solid regionalisation techniques of climate scenarios have been validated in various previous projects, and are used to support regional and local adaptation planning. Due to the complexity of climate change adaptation and its interdisciplinary nature, the learning process is a continuous process, especially regarding monitoring processes.

Key conclusions

For each of the seven key transformative innovation features, possible ways towards a transformative climate adaptation approach for Norte include:

- Directionality: Focus more on processes and pathways for system change, such as a strong monitoring system; connecting transformational adaptations more to the innovation system; improving the "climate risk culture", in particular in the private sector.
- Instrument portfolios and funding synergies: Better valorising innovative CCA solutions in project selection systems under the "Sustainability, decarbonisation, biodiversity, resilience" priority of ERDF; promoting CCA in the selection process under "Research, innovation, competitiveness" priority; mainstreaming good practices and solutions developed by the various projects; increasing synergies between different instruments and funding sources; increasing overall funding for adaptation relative to mitigation.
- Ensuring cross-domain synergies: Using a more interdepartmental/systemic CCA approach; managing CCA at the highest (e.g. presidency) level; identifying an institutional CCA leader.
- Stakeholder involvement: transferring good practices in environmental transformation to CCA; orienting the regional innovation ecosystem more towards CCA; setting up a supervisory governance structure for CCA participation process and involving business more strongly.
- Multi-level governance: Ensuring vertical integration in climate planning both top-down and bottom-up, ensuring that the local scale can be a testing ground for national governments, influencing national action; strengthening multi-level governance, cooperation and coordination, despite the complexity of political relations.
- Experimentation: using existing experimentation solutions (e.g. open laboratories, living labs) more for innovation in CCA; including failure-accepting solutions in policy instruments; developing risk-tolerant financing options; encouraging public sector innovation and innovative procurement for private sector experimentation in CCA.
- Policy intelligence, learning and strategic capacity: Implementing more continuous learning, to better understand and implement new solutions such as Nature-Based Solutions (NBS); making further use of international networks for the exchange of knowledge and experience in CCA; disseminating better the knowledge gained through international collaborations; optimizing the use of the new EcosistER project and the ARCADIA project.

1 Introduction

1.1 Profile of the territory

According to the Italian Constitution (Article 114) "the Republic is constituted by Municipalities, Provinces, Metropolitan Cities, Regions and the State. Municipalities, Provinces, Metropolitan Cities and Regions are autonomous entities with their own statutes, powers and functions according to the principles established by the Constitution".

Emilia-Romagna is one of the 20 administrative regions of Italy, situated in the northeast area of the country. It lies between the ranges of the Apennine Mountains (Appennino Ligure, Appennino Tosco-Emiliano) and the Po plain, bordered by the Adriatic Sea on the East. The region has an area of 22,452 square kilometres and, as of 2022, a population of over 4,4 million[2].

Figure 1. Location of Emilia-Romagna region in Italy

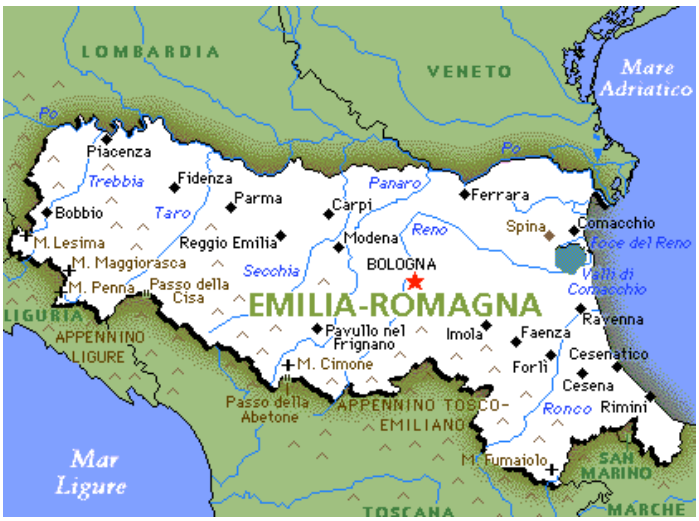
Source: Britannica[3]

Emilia-Romagna is divided into nine provinces: Piacenza, Parma, Reggio Emilia, Modena, Bologna, Ferrara, Ravenna, Forlì-Cesena, and Rimini. The territory of Emilia-Romagna consists of a wide plain south of the Po river, and a more mountainous area near the border with Tuscany, with the peak of Monte Cimone (2165 m). Bologna is the capital of the region. Other important cities include Modena, Parma, Rimini, Piacenza and Ravenna.

[2] http://dati.istat.it (30.09.2023)

[3] https://www.britannica.com/place/Emilia-Romagna (30.09.2023)

Figure 2. Map of Emilia-Romagna region



Source: Maps of Italy blogspot[4]

Emilia-Romagna is one of Italy's leading regions in terms of per capita income and for many years has been classified as one of the richest regions in Europe. Emilia-Romagna is situated in the heart of the country's most industrialised area. Its efficient network of infrastructure, strategic geographical position and good connections to the rest of Italy and the main European cities make the region a key business hub. Small- and medium-sized enterprises are the driving force of the region's economy. Manufacturing still plays a leading role in the overall regional economy, with some of the most important industrial districts in Italy. Such districts relate to many different sectors, the most important ones being automotive, mechanical engineering, ceramics, construction materials, chemicals and pharmaceuticals, clothing and food processing and packaging. With its broad lowland and adequate water supply (from both rainfall and irrigation), Emilia-Romagna is one of the leading agricultural regions of Italy.

Emilia-Romagna is the leader of innovation among Italian regions and is placed in 101st place in Europe in terms of innovativeness (Hollanders and Es-Sadki, 2023). It belongs to the group of "strong innovators".

1.2 Main climate change risks and vulnerabilities

Italy is noticeably vulnerable to natural hazards, and climate change is expected to increase climate-related risks over the coming decades. In Italy, the climate crisis is particularly feared, considering that most of the territory is highly vulnerable to the projected increase in extreme weather events like floods (European Environment Agency, 2020).

[4] http://maps-of-italy.blogspot.com/2011/07/emilia-romagna-map-political-regions.html (30.09.2023)

Most of the Emilia-Romagna region is located in a geographical region belonging to the Po river basin district, which is also extremely vulnerable to climate change, despite its abundant water resources. According to "Climate change mitigation and adaptation strategy for the Emilia-Romagna Region" (2018), the greatest vulnerability is related to water management and the water cycle, namely the increased frequency and intensity of extreme weather and climatic events and the variability in average annual water availability. Therefore, the greatest risks related to climate change is associated with the water cycle (in particular in terms of flooding due to the increased frequency and intensity of extreme precipitation events) and consequently with the availability of water resources. Other risks are (ibid.): forest fires, hydrogeological instability and subsidence, soil degradation and onset of desertification processes, loss of agricultural production, less availability and lower quality of water, coastal erosion, adverse effects on health, increased energy consumption, loss of biodiversity and ecosystem change, adverse effects on economic activities (industry, commerce and tourism), saltwater intrusion. The document includes a sectoral analysis of the main regional vulnerabilities and risks for each area in which the Emilia-Romagna region has been divided (ridge, hilly, lowland, coastal and urban areas).

Table 1. Major effects that the climate risks have on the physical-biological and socio-economic sectors in Emilia-Romagna

Areas	**Ridge area**	**Hilly area**	**Lowland area**	**Coastal area**	**Urban area**
Effects in sectors:					
Tourism	X	X	X	X	X
Urban areas	X	X	X	X	X
Health	X	X	X	X	X
Transport	X	X	X	X	X
Production system	X	X	X	X	X
Land	X	X	X	X	X
Inland waters		X	X	X	X
Air quality			X	X	X
Fishing and aquaculture	X	X	X	X	
Biodiversity and ecosystems	X	X	X	X	
Agriculture	X	X	X	X	
Energy system	X	X	X	X	X
Forests	X	X	X	X	

Source: Climate change mitigation and adaptation strategy for the Emilia-Romagna Region, 2018.

Urbanised areas are considered climate "hotspots" due to their complex system. The expected intensification of extreme weather events, especially heat waves (and the urban heat island phenomenon) and intense precipitation in the coming decades, is one of the main factors increasing climate risk in cities.

Figure 3. Floods in Emilia-Romagna, May 2023

Source: Photo Civil Protection Emilia-Romagna[5] (30.09.2023)

In May 2023, vast areas of the Emilia-Romagna region were impacted by devastating flooding. Following a period of drought, torrential rains on 02 May 2023 caused flooding and landslides in several provinces, in particular Bologna, Ravenna and Forli-Cesena. This is a tangible example of the risks facing the region becoming a reality.

1.3 State-of-play of CCA and innovation strategies

Currently, the basis for the implementation of climate change adaptation measures in Italy at the national level is the **National Strategy for Adaptation to Climate Change (NAS)** that was adopted back in July 2015. The Strategy analysed the most relevant climate change impacts on 12 socio-economic and natural sectors, and suggested a set of adaptation measures to cope with such impacts.

[5] https://www.protezionecivile.gov.it/en/galleria-flickr/maltempo-emilia-romagna-2023-0/ (30.09.2023)

Table 2. Policy documents related to CCA and Innovation

Document title	Short description	Year of adoption
National level		
National Strategy for Adaptation to Climate Change (NAS)	The Strategy analysed the most relevant climate change impacts on 12 socio-economic and natural sectors, and suggested a set of adaptation measures to cope with such impacts. Italy aims to become a climate resilient society fully adapted to the inevitable impacts of climate change by 2050.	2015
Plan for Ecological Transition (PET)	It is a national, multi-sectoral plan for the period 2022-2050. Its main objective is to coordinate policies, integrating them with digitalisation and energy transition, which will lead, through a schedule of measures and actions, to the transformation of the national system so that it is able to achieve the goals set at international level. Adaptation to climate change is one of the 5 macro-objectives.	2022
Regional level		
Climate change mitigation and adaptation strategy for the Emilia-Romagna Region	The strategy provides an overall reference framework for the regional sectors, administrations and organizations involved, also to assess the implications of climate change in the various sectors concerned. The document represents the integrated strategy for mitigation and adaptation measures. For each sector, the Strategy identifies adaptation and mitigation actions for the short-term (by 2020) and for the medium-term (beyond 2020), as well as strategic guidelines.	2018
Pact for Work and Climate	The document was prepared by region's authorities, together with economic stakeholders, trade unions and trade associations. I is focused on labour and the environment (with 2030 as its horizon), and aims at environmental transition. The Pact is among the cross-cutting pillars that are required to generate new sustainable development.	2020
2030 Agenda Strategy for Sustainable Development of the Emilia-Romagna Region	The most important development strategy at the regional level. The strategy also emphasises that the region is working to accelerate adaptation to the impacts of climate change, adopting a systematic approach to all future standardisation, planning and programming activities and encompassing all sectoral policies, with a 2030 horizon.	2021
Smart Specialisation Strategy (RIS3) for Emilia-Romagna Region 2021-2027	This is the most important document regarding innovation at the regional level. The strategy assigns research and innovation a driving role in the transition towards fairer and more sustainable production and consumption models.	2021

Source: own elaboration.

NAS foresees the adoption of the **National Plan for Climate Change Adaptation (NAP)** – implementation document. Throughout 2016 and 2017, the NAP was elaborated as a follow-up to this process, but has been relegated from the policy attention since 2018. One of the problems raised by the regions during the regional conference (**Conference of the Regions and the Autonomous Provinces)** was the questionable nature of this document. In their view, it was something between a strategy and a plan, lacking concrete actions or the means to implement them. It returned to the agenda in 2021. The Ministry of Environment and Energy Security is now working on the development and approval of the national adaptation plan, the last drafted version comes from 2023[6]. Nevertheless, the document has not yet been formally adopted by the government, thus, currently the only approved national document in place is the NAS, which provides only broad proposed areas of interventions, without specific actions, indicators and roles to implement it.

In 2022, the **Plan for Ecological Transition (PET)** was adopted in Italy. It is a national, multi-sectoral plan for the period 2022-2050. Its main objective is to coordinate policies, integrating them with digitalisation and energy transition, which will lead, through a schedule of measures and actions, to the transformation of the national system so that it is able to achieve the goals set at international level. Adaptation to climate change is one of the 5 macro-objectives. Various climate change adaptation measures are planned to be implemented, affecting territory, biodiversity and economic activities. Interventions are therefore proposed to combat hydrogeological instability and increase the resilience of natural and anthropogenic systems and water resources.

In December 2015, the Emilia - Romagna Region approved the Pathway towards an integrated strategy to combat climate change (DGr 2200/2015). The "**Climate change mitigation and adaptation strategy for the Emilia-Romagna Region**" document was approved by Assembly Resolution no. 187 of 29 December 2018. The strategy provides an overall reference framework for the regional sectors, administrations and organizations involved, also to assess the implications of climate change in the various sectors concerned. The document represents the integrated strategy for mitigation and adaptation measures "*with the aim of 'holding together' these two aspects in the fight against climate change which are seemingly disconnected, but in fact strongly interconnected in natural and man-made, as well as complex and varied environments*." The regional authorities are thinking of updating this strategy, particularly in the area of the monitoring system and the definition of indicators for adaptation (as another document has already been developed for mitigation), but after the floods in May they are more inclined to develop an adaptation plan, to move from the strategy to the plan. The regional government is also trying to create a Law on Climate, by the end of next year.

Moreover, in 2021 the "**2030 Agenda Strategy for Sustainable Development of the Emilia-Romagna Region**" was approved (Council Resolution no. 1840/2021). The document is rooted in the regional council's "2020-2025 Mandate Programme and in the Labour and Climate Pact" (**Pact for Work and Climate**) signed on 14 December 2020 with the institutional, economic and social partnership and the metropolitan city of Bologna. From its earliest years, the metropolitan city of Bologna has therefore been at the forefront in implementing the principles of sustainable development. Reinforcing its commitment and involvement on sustainability issues, the metropolitan city of Bologna has placed environmental, economic and social sustainability at the forefront of the founding principles of the 2018 Metropolitan Strategic Plan 2.0, the policy approved by the

[6] https://va.mite.gov.it/en-GB/Oggetti/Documentazione/7726/11206 (30.09.2023).

metropolitan council, which guides the actions of the metropolitan city, the municipalities and unions of municipalities, identifying strategic, medium- and long-term objectives. Bologna also implemented its own **Adaptation Plan** in 2015, and then, in 2018, the update of the adaptation plan merged into the drafting of the **Action Plan for Energy and Climate** containing: a new climate profile with the reworking of scenarios to 2050, a summary of adaptive capacity factors and vulnerability analysis linked to three areas of contrast such as heat waves in urban areas, extreme events and hydrogeological risk, drought and water shortage.

Emilia Romagna has been very active in climate adaptation planning and implementation paths. Regarding **urban adaptation planning**, more and more cities in Emilia-Romagna (and Italy) have adopted a plan. Besides Bologna's initiatives, many other of the Italian municipalities already adopted a local adaptation plan (or a local mitigation and adaptation plan) or a SECAP (Sustainable Energy and Climate Action Plan), or are concluding its adoption. Some of them were developed as part of the action plans that municipalities submit as signatories of the Covenant of Mayors (e.g. the Adaptation Strategy of the city of Reggio Emilia in 2021; adaptation plans of the municipalities of Cervia and Finale Emilia). More locally based adaptation plans are also being developed, including as part of EU co-funded projects (e.g. "Adaptation plan/design of interventions/pilot interventions on Sacca di Goro in the Po River Delta").

As regards innovation strategy, the most important document at regional level is **Smart Specialisation Strategy (RIS3) for Emilia-Romagna Region 2021-2027** approved in June 2021. The document is in line with the objectives of the Pact for Work and Climate, signed by the Emilia-Romagna Region, and the Regional Strategic Document 2021-2027. The strategy assigns research and innovation a driving role in the transition towards fairer and more sustainable production and consumption models.

2 Analysis against conceptual framework: Transformative Innovation for better Climate Change Adaptation

In a separate analytical framework report for territories (European Commission, 2024), seven key features of Transformative Innovation have been identified as essential conditions for the design and implementation of CCA strategies. These features can be summarised as follows:

1. **Directionality:** defining goals and scope of strategic action, as well as articulating impacts, in a way which reflects societal challenges with wide appeal, formalised through endorsement at highest political level to secure engagement of all relevant authorities and stakeholders.
2. **Articulating instrument portfolios and defining synergies between funding sources:** establishing all-encompassing instrument portfolios addressing the whole innovation cycle and the various aspects of CCA, paired with adequate funding resources.
3. **Ensuring Cross Domain synergies:** favouring whole-of-government approaches to ensure greater horizontal coherence between various thematic policy areas (R&I, agriculture, environment, mobility, health etc.), resulting in coordinated mixes of instruments of different types.
4. **Increasing breadth and depth of stakeholder involvement:** working towards social acceptance of new solutions and shaping of innovative developments, as well as improving public trust, opening up public debates, managing diverse and sometimes conflicting views over alternative pathways.
5. **Setting up effective multi-level governance models:** maximising potential of vertical synergies, recognising complementary roles for various governance levels - local, regional, national and EU;
6. **Making room for experimentation:** providing adequate spaces for risk-taking and creativity - ensuring a risk-tolerant environment to facilitate development of new and/or radical solutions.
7. **Securing high levels of policy intelligence, learning and strategic capacity:** building strong evidence-based policy learning capacities, based on a solid knowledge base and special skills to manage transitions, as necessary companions to the transformative innovation approach.

The analysis below follows this framework. The key characteristics of the territory's approach to CCA strategy development and implementation and their linkages with innovation policies and strategies, as revealed by the case study research, are explored in turn, in relation to the above seven features.

2.1 Directionality

Box 1. Summary on directionality

The authorities and key stakeholders in the Emilia-Romagna region are aware of climate change and its challenges, including climate risks affecting key social systems. A sense of urgency is becoming more apparent, and public support and advocacy is growing. The regional climate

strategy addresses both mitigation and adaptation challenges and adopts an integrated approach on the basis of sectoral plans. A transformative approach to sustainability themes can be identified, evident in successive initiatives in the region (Pact for Work and Climate, Agenda Strategy for Sustainable Development, RIS3), with environmental transformation as a major issue. The documents refer also to just transition. The 2030 Agenda Strategy also highlights the need to develop a culture of responsible consumption and production, and a culture of "climate risk" in the design of public works (sizing and innovation) and among stakeholders. However, there still needs to be a focus on processes and pathways to system change, above all the creation of a strong monitoring system, which has not yet been achieved.

> *The Emilia-Romagna Region is aware that climate change necessitates significant economic and social choices, as well as behavioural changes. In every sector. Without exception. This is not alarmism, but common sense. It is a necessity. It is an obligation. Not just in economic terms, but also socially and morally.*
>
> *Source: "Climate change mitigation and adaptation strategy for the Emilia-Romagna Region".*

2.1.1 Current Status

The **Climate change mitigation and adaptation strategy for the Emilia-Romagna Region** identifies measures and actions to cope with current climate variability and future climate changes in all the important sectors of the region, including: water resources, air quality, urban areas, land use, coastal areas, transport, forests, biodiversity and ecosystems, agriculture, production industry, energy system, tourism, health, fishing and aquaculture, and cultural heritage. For each sector, the Strategy identifies adaptation and mitigation actions for the short-term (by 2020) and for the medium-term (beyond 2020), as well as strategic guidelines. The actions suggested are detailed and classified according to the type of measure (e.g., structural and technological, social, institutional, etc.). As an example, for the production sector, medium-term actions foreseen by the regional Strategy aim to make the local area and businesses secure to the occurring climate hazards. Suggested actions include planning new production sites in areas not vulnerable to climate impacts (such as river and coastal flooding), promoting energy consumption from renewable sources, reducing water consumption and waste production, etc. The strategy (adopted in 2018) is continuously reviewed and updated in line with the latest knowledge on climate change projections and impacts and the identification of actions needed to address these climate challenges. The adaptation process promoted in the Emilia-Romagna region could count on strong political support.

2.1.2 Good Practices

In the Emilia-Romagna region, very important regional policy actions have been taken in 2020, which have implications for all subsequent initiatives in the region. The region's authorities, together with economic stakeholders, trade unions and trade associations, signed the **Pact for Work and Climate**, focusing on labour and the environment (with 2030 as its horizon). They jointly agreed that present complex challenges can only be addressed via a participatory and joint response by all sections of society. The Pact is among the cross-cutting pillars that are required to generate new sustainable development. It aims at "*generating quality jobs, combating inequality and taking Emilia-Romagna through environmental transition".* Key stakeholders in the region are aware of climate change and

its challenges, including climate risks affecting key social systems. A sense of urgency is becoming more apparent, and public support and advocacy is growing in the face of high uncertainty about climate change risks.

> *"The second challenge is the climate emergency which makes environmental transition a major issue that can no longer be postponed." (Pact for Work and Climate)*

The Pact refers to environmental transformation (one of the 4 strategic objectives) and just transition. It was emphasised that the fight against climate change and inequality is inextricably linked, as it is the most vulnerable groups that bear the highest costs of global warming and are most at risk of paying for the effects of the transition. CCA measures are part of this vision. The Pact and the subsequent agreements that will be signed are the instrument to define the strategic objectives towards which to direct the resources available for the regional territory (EU, national and regional funds, private investments) and to share the urgent and structural interventions needed to get the economy and society moving again, with a focus on climate and adaptation objectives.

The continuity of this systemic thinking can also be seen in another important document for the development of the region, adopted in 2021 - **2030 Agenda Strategy for Sustainable Development of the Emilia-Romagna Region.** The document also emphasises that the region is working to accelerate adaptation to the impacts of climate change, adopting a systematic approach to all future standardisation, planning and programming activities and encompassing all sectoral policies. The document also highlights the need to develop a culture of responsible consumption and production, and a culture of "climate risk" in the design of public works (sizing and innovation) and among stakeholders.

As regards innovation strategy, the main priorities of **RIS3** are defined according to the major challenges: sustainability, climate and natural resources, digitalization, social inclusion, wellbeing and quality of life, safety, through the identification of priority cross-sectoral thematic areas. The S3 Strategy has identified 15 Priority Areas and 8 Strategic Specialisation Areas: Agrifood, Building and Construction, Mechatronics and Motoring, Health and Wellness Industries, Cultural and Creative Industries, Innovation in Services, Digital and Logistics, Energy and Sustainable Development, Tourism. In addition, there are two new areas with high growth potential: the Aerospace Economy and Critical Infrastructures. Although the issue of CCA does not appear explicitly in this strategy, sustainable transition is an important area that runs throughout the document. RIS3 assigns research and innovation a driving role in the transition towards fairer and more sustainable production and consumption models, taking the same challenge-based approach that is indispensable for addressing the challenges of change and responding to society's new needs, both on the economic and on the environmental and social fronts.

2.1.3 Recommendations

The authorities and key stakeholders in the Emilia-Romagna region are aware of climate change and its challenges, including climate risks affecting key social systems. A sense of urgency is becoming more apparent, especially in view of the floods of May 2023, and public support and advocacy is growing. A transformative approach to sustainability themes can be identified, evident in successive initiatives in the region, with environmental transformation as a major issue. However, there is still a need to focus more on processes and pathways towards system change.

Possible solutions:

- There still needs to focus on processes and pathways to system change, above all the creation of a strong monitoring system, which has not yet been achieved.
- Transformational adaptations (defined as major changes in system components) should be based more on an innovation system.
- What is still needed is a "climate risk culture", and the change in the way of thinking, especially among companies.

2.2 Articulating portfolios

Box 2. Summary on portfolios

The strategy plans detailed and classified according to the type of measure activities, with policy portfolio only implicitly articulated. However, a great deal of CCA activity is being undertaken in the Emilia Romagna region. Substantial domestic resources are used primarily for water management (against floods) and land use. The most relevant drivers that foster local climate action are: forward-looking administrators supported by a motivated staff, the engagement in climate networks, and involvement in European projects. The private sector is also involved, mainly through public-private partnership (although these are project-based rather than system-based activities). Moreover, the new EcosistER project co-financed by the National Recovery and Resilience Plan, will bring over 100 million euro in resources to the region to support the green transition of the regional economic and social system. The project goal is to strengthen territorial innovation ecosystems. Appropriate sources or incentives are therefore available to fund innovative initiatives leading to CCA transformation. In addition, the Emilia-Romagna region and also various entities from the region are engaged in CCA activities internationally. Climate policy networks and transnational cooperation projects support an exchange of good practices and increase the capacity of regional/local governments on climate change issues (e.g. cross-border projects with Croatia on adaptation strategies in the Adriatic coastal areas and Po River Delta).

2.2.1 Current Status

In Italy, the national level has not yet established the legislative obligation for regions, provinces, and cities to adopt adaptation plans. However, most of the adaptation issues mainly fall within regional competences (e.g., floods and hydrogeological risks). The role of local authorities can be decisive in the fight against climate change. Administrations can play this role by guiding current local policies in strategic sectors such as mobility, energy, spatial planning. They can also play the role of privileged interlocutors for local businesses engaged in emission reduction actions. The action being developed by the sub-national levels is voluntary and determined by a complex set of interrelated causes. The most relevant drivers that foster local climate action are: forward-looking administrators supported by a motivated staff, the engagement in climate networks, and involvement in European projects. As the regions do not enjoy financial autonomy, and transfers from the state have gradually decreased in the last years, regional policies are mostly implemented with EU structural funds. The funds for the elaboration of the regional strategy and for the climate plans initiative were provided through regional laws. In particular, the regional decree D.G.R. 370/2010 allocated a total of 414.750€ to the eight Emilia-Romagna provinces. In some cases, the process of elaboration of local adaptation strategy

and/or plans has benefitted from collaboration with research institutions in the context of EU funded projects.

With the **Regional Strategic Document for the unitary planning of European development policies 2021-2027 (RSD)**, approved by the legislative assembly in June 2021, the Emilia-Romagna Region outlined the strategic framework within which to address all the European and national resources that the region will benefit from, with the aim of relaunching the development of the regional territory in a sustainable way. The RSD is therefore the regional planning tool for European development policies that ensures the "translation" of the strategic objectives that can be pursued through the European funds into specific objectives of the regional operational programmes. **ERDF Regional Operational Programme (ROP)**, also thanks to the thematic concentration thresholds indicated by regulations, is a decisive tool to implement the development objectives outlined in full consistency by regional unitary planning, the Pact for Work and Climate and the 2030 Agenda Strategy for Sustainable Development. Among the 4 priorities of the programme are: "Research, innovation, competitiveness", and "Sustainability, decarbonisation, biodiversity, resilience". Under this second priority, actions are planned for climate change adaptation, disaster risk prevention and resilience, considering ecosystem-based approaches, as well as nature protection and conservation, biodiversity and green infrastructure, including the one in urban areas. Separate measures for adaptation appear in the regional programme 2021-2027 for the first time and were not present in previous editions of the programme. In turn, under the priority dedicated to innovation, actions are planned in the area of sustainable growth and business competitiveness.

An additional source of investment in a strategic plan for maintenance, protection and adaptation of existing towns and infrastructure, prevention of hydrogeological instability and coastal protection is to be provided by **Next Generation EU** resources. In the Italian Recovery and Resilience Plan, green policies constitute more than one third (37%). An important project that has already received support and is implemented in the Emilia Romagna region between 2022 and 2025 is the **EcosistER** (Ecosistema Territoriale di Innovazione dell'Emilia-Romagna) **- Ecosystem for Sustainable Transition in Emilia-Romagna** project. The main goal is to create and strengthen territorial innovation ecosystems. The project brings over 100 million euro in resources to the region to support the green transition of the regional economic and social system. In particular, EcosistER will cover advanced and sustainable materials, green manufacturing, systems and components for the conversion and use of energy from renewable sources, intelligent mobility, housing and energy solutions for a carbon-free society, circular economy and blue economy, data analysis and supercomputing to foster the green transition.

On the national level, there is also **CAP Strategic Plan** implemented, that contributes to climate action and the protection of natural resources and the preservation of biodiversity. This includes protecting farmers from adverse climatic events, reducing the impact of agriculture on the environment, tackling labour exploitation and improving the quality of life in rural areas.

2.2.2 Good Practices

A number of projects, including EU-funded projects, have already been implemented in the region in the area of climate change adaptation. Some of these have resulted in the **development of local adaptation plans** or drafting of the SECAP (Sustainable Energy and Climate Action Plan). A good

example is Bologna, which, through its participation in the LIFE+ project BLUEAP[7] (Bologna Local Urban Adaptation Plan for a resilient city), has implemented its own Adaptation Plan in 2015. In 2018, the Municipality of Bologna signed the Covenant of Mayors for Energy and Climate, and in this new framework, the update of the adaptation plan merged into the drafting of the Action Plan for Energy and Climate containing: a new climate profile with the reworking of scenarios to 2050, a summary of adaptive capacity factors and vulnerability analysis. The BLUEAP project ended in 2015 and was followed by another LIFE project, RAINBO[8] (Innovative tools for planning and timely responding to floods in urban areas). It ran from 2016 to 2019, and focuses on the improvement of knowledge, methods and tools for the **assessment and forecast of the impacts of extreme precipitations and flash floods** for small and medium water courses in urban areas. To this purpose, a WebGIS modular platform for local administrations has been developed to provide information from observed data, forecasts and models before ("Planning support" mode) and during ("Event management" mode) extreme events of precipitation in vulnerable river basins. Another successful initiative implemented in Bologna that has contributed to a local CCA goal is the "agreement on green spaces in the city centre", developed as part of the LIFE+ GAIA[9] (Green Areas Inner-city Agreement) project (implemented in 2010-2013). This initiative shows how additional green spaces in the city can be funded and implemented to provide relief during heat waves. It was based on a **public-private partnership model that uses financial compensation for the carbon footprint of companies to purchase plants and maintain trees throughout the city**. This project was already underway before the adoption of adaptation plans (for both Italy and the Emilia-Romagna region), it was a way to develop a stand-alone climate plan and actions that could be financed without national or regional funds. The scheme has been replicated in a number of other Italian cities.

Among the more recent projects in the Emilia-Romagna region is LIFE ADA[10] (ADaptation in Agriculture), implemented in 2020-2023. It aims to increase the **resilience of the agricultural sector to the impacts of climate change through a public-private partnership** involving the public administration (Regions), insurers (UnipolSai), scientific institutes and producer organisations. Public-private partnership is a key element of the model. The project has the potential to involve the entire insurance sector, as the results could contribute to a substantial change in the way risks associated with climate change are managed in the agricultural sector, by defining an innovative model for incorporating societal needs (greater resilience to climate change) into insurance strategy.

Table 3. (Selected) EU-funded projects related to CCA in Emilia-Romagna

Project title	Source of funding	Main results and/or innovation	Duration
GAIA	LIFE+	Public-private partnership model that uses financial compensation for the carbon footprint of companies to purchase plants and maintain trees throughout the city.	2010-2013
BLUEAP	LIFE+	Local Adaptation Plan for Bologna	2014-2015

[7] https://www.blueap.eu/

[8] https://www.rainbolife.eu/en

[9] https://climate-adapt.eea.europa.eu/en/metadata/case-studies/gaia-green-area-inner-city-agreement-to-finance-tree-planting-in-bologna

[10] https://www.lifeada.eu/en/

IRIS	LIFE+	Adaptation plans for the clusters (group of businesses) involved. Promoting financial tools based on rewarding criteria for climate resilient enterprises.	2015-2019
RAINBO	LIFE+	WebGIS modular platform for local administrations to provide information from observed data, forecasts and models before and during extreme events of precipitation in vulnerable river basins.	2016-2019
CLARA	Horizon 2020	AirCloud Service, which it is an interface focused on local-scale dispersion modeling and health studies.	2017-2020
OPERANDUM	Horizon 2020	The tools and methods for the validation of Nature-Based Solutions in order to enhance resilience in European rural and natural territories by reducing hydro-meteorological risks	2018-2020
CHANGE WE CARE	INTERREG Italy - Croatia	Adaptation Plan/Design of Interventions/Pilot Interventions on Sacca di Goro in the Po River Delta.	2019-2021
LIFE ADA	LIFE+	Increasing the resilience of the agricultural sector to the impacts of climate change through a public-private partnership involving the public administration, insurers, scientific institutes and producer organisations.	2020-2023
AdriaCLIM	INTERREG Italy - Croatia	Management tools for adaptation strategies in the Adriatic coastal areas.	2020-2023
CityAdaP3	LIFE+	New models of cooperation between local authorities and businesses by stimulating the inclusion of climate change issues in Corporate Social Responsibility policies.	2020-2024
CLIMAX PO	LIFE+	Setting up an integrated governance approach (Multi level Governance Deal) for the whole Po River Basin.	2023-2032

Source: Author's elaboration.

Another LIFE project in the region using the public-private cooperation model is CityAdaP3[11] (Financing Cities Adaptation to Climate Change through Public-Private Partnerships and Corporate Social Responsibility), implemented in 2020-2024. It aims to develop adaptation actions to cope with climate change by promoting new models of **cooperation between local authorities and businesses** in a win-win logic and **by stimulating the inclusion of climate change issues in Corporate Social Responsibility policies**. As part of the project, the Municipality of Reggio Emilia (that has the new strategy on public green spaces, called "Natural Urban") experimented with a "**climate-friendly park**" model, aimed at optimising urban heat island mitigation. The four public parks involved, located in urban and peri-urban areas, were subjected to experimental urban forestation measures, All the actions are aimed at restoring a high degree of naturalness and biodiversity to the areas, also increasing the presence of spontaneous vegetation, to make the parks also more resilient to summer droughts and water shortages. Previously, in 2015-2019, another business-focused LIFE adaptation project was implemented in the region and coordinated by ART-ER:

[11] https://www.lifecityadap3.eu/

IRIS (Improve resiliency of industry sector)[12]. The project aimed to support **SMEs in becoming more resilient to climate change**, by mean of adaptation measures, carried out through a "cluster" approach".

Worth mentioning is a new project, also under the LIFE programme, which started in 2023 and is expected to last until 2032: CLIMAX PO[13] (CLIMate Adaptation for the PO river basin district). Its overall objective is to boost adaptation to climate change through **climate-smart water resources management** at the river basin district scale by implementing National Adaptation Strategy measures tailored-made on the local characteristics and climatic peculiarities present in the district. To this end, the project is setting up an integrated governance approach (**Multi level Governance Deal**) for the whole Po River Basin. In addition to the project budget itself, it plans to facilitate the coordinated use of complementary funding from the EAFRD, ERDF, INTERREG, CEF, NRRP and other national and regional funds, where appropriate.

Moreover, several cross-border cooperation projects have given rise to **urban and local partnerships**, as well as to **online participative platforms**, supporting the development of adaptation plans for the Adriatic coastal strip. For example, within the framework of the INTERREG Italy - Croatia CHANGE WE CARE[14] project (2019-2021), a document: "Adaptation Plan/Design of Interventions/Pilot Interventions on Sacca di Goro in the Po River Delta" was developed. It contains propaedeutic information on measures and intervention priorities for freshwater, wetland habitat preservation in the Sacca di Goro area in the Po Delta area in order to climate change adaptation. In turn, another project - AdriaCLIM[15] (2020-2023; EU Italy-Croatia Interreg) - developed management tools for adaptation strategies in the Adriatic coastal areas. It will address climate change threats by developing regional and local adaptation plans based on up-to-date meteorological and oceanographical information acquired through newly implemented observing and modelling systems for the Adriatic Sea.

Finally, it should be mentioned that entities from the Emilia-Romagna region are actively involved in **research projects in CCA-related areas**. To give some examples of such projects co-funded by Horizon 2020:

- CLARA[16] (2017-2020) – the aim was to develop a set of leading edge climate services building upon the newly developed Copernicus Climate Change Services near term forecasts and sectorial information systems (SIS). One of the outcomes of the project is the AirCloud Service, which it is an interface focused on local-scale dispersion modeling and health studies. Partners from E-R involved: ISPRA Regional Agency for the Prevention, the Environment and the Energy of Emilia Romagna (ARPAE), Emilia Romagna Region (RER), GECOsistema (srl);
- OPERANDUM[17] (2018-2022) - OPEn-air laboRAtories for Nature baseD solUtions to manage environmental risks. It deliveres the tools and methods for the validation of Nature-Based Solutions in order to enhance resilience in European rural and natural territories by reducing hydro-

[12] https://www.lifeiris.eu/en/project/.

[13] https://webgate.ec.europa.eu/life/publicWebsite/project/details/101069928

[14] https://programming14-20.italy-croatia.eu/web/changewecare

[15] https://programming14-20.italy-croatia.eu/web/adriaclim

[16] www.clara-project.eu

[17] https://www.operandum-project.eu/

meteorological risks. Partners from E-R involved: CMCC Agenzia Regionale Protezione Ambiente nella Regione Emilia-Romagna, Centro italiano ricerche aerospaziali RINA CONSULTING SPA Università di Bologna.

A great deal of CCA activity is being undertaken in the Emilia Romagna region. Attempts are also being made to create a database of such activities. The GELSO[18] (Gestione Locale Sostenibilità Ambientale - Local Environmental Sustainability Management) **database** has launched a thematic survey to investigate the **activities taking place at local level** on this issue, which is transversal in nature and crosses all the sectors of intervention into which the database is divided.

Climate policy networks and transnational cooperation projects can support an exchange of good practices in multilevel governance and increase the capacity of local governments on climate change issues. The Emilia-Romagna region and also various entities from the region are engaged in CCA activities internationally. The Municipality of Bologna, which is the largest municipality in the Emilia Romagna Region, has always been at the forefront in terms of CCA in Italy. It joined the Covenant of Mayors already in 2008.

Emilia-Romagna participates in the following **international initiatives**:

- Under2 Memorandum of Understanding (Under2 MOU): It is a network of subnational governments committed to reaching net zero emissions by 2050 - or earlier. By signing the agreement the Region commits to an 80% reduction of its emissions by 2050. This engagement supports knowledge transfer, integration, and strengthening of regional policies on mitigation and adaptation;
- Covenant Territorial Coordinators of the Covenant of Mayors for Climate and Energy (Covenant of Mayors): Regions, Province and Metropolitan areas can provide support to signatories of the CoM by conducting a CO2 emission inventory and/or a climate risk assessment, as well as in preparing and implementing their adaptation plans or SECAPs;
- Mission on Adaptation to Climate Change Charter: supporting EU regions, cities and local authorities in their efforts to build resilience against the impacts of climate change;
- EU Mission for 100 climate-neutral and smart cities by 2030 (Cities Mission): Bologna and Parma are among the nine cities from Italy that have joined the mission.

Participation in such initiatives can result not only in an exchange of experience, but also in joint actions. For example, Bologna and Parma, which joined the Cities Mission, are working together with other Italian cities; they want to implement a project in which they want to launch the objective of carbon neutrality as a priority to be achieved also for other cities in the Emilia Romagna region.

2.2.3 Recommendations

There are some domestic and EU instruments to support the implementation of regional and local development strategies, including in the area of climate change adaptation. Substantial domestic resources are used primarily for water management (against floods) and land use. A number of projects, including EU-funded projects, have already been implemented in the region in the area of

[18] https://gelso.sinanet.isprambiente.it/

climate change adaptation and innovation. However, it seems that these activities are fragmented and regionally uncoordinated, and adaptation and innovation are rarely combined.

Possible solutions:

- There is a need for greater valorisation of innovative CCA solutions in project selection systems under "Sustainability, decarbonisation, biodiversity, resilience" priority of the ERDF Regional Operational Programme 2021-2027, and – on the other side – promoting CCA in the selection process under "Research, innovation, competitiveness" priority.
- It would be valuable to take the good practices and solutions developed by the various projects and mainstream them into CCA policy.
- There is a need for more systemic action involving instruments of a different nature working in synergy, maximising co-benefits.
- It would be beneficial to define better synergies between funding sources.
- More funding is also needed for adaptation measures, so far more has been invested in mitigation.

2.3 Cross domain synergies

Box 3. Summary on domain synergies

In Italy, including the Emilia Romagna region, efforts are being made to strengthen cross-sectoral approach, coordination of policies, and the mainstreaming of climate change issues (not exclusively adaptation) into different sectoral areas. As far as CCA activities in Emilia-Romagna are concerned, the region is now adopting a clearly integrated approach based both on direct intervention (public funding, management of environmental institutions) and on sustaining bottom-up initiatives and cooperation between different actors. Also RIS3 includes the definition of priorities with a strong multidisciplinary and cross-sectoral dimension, including cross-sectoral thematic areas, few of which are related to sustainable transformation. There is a progressive integration of CCA within the RIS3. Interdisciplinary research in the field of climate change is also being undertaken, an example would be the Euro-Mediterranean Center on Climate Change (on the national level), efforts within universities and EcosistER project.

2.3.1 Current Status

While adaptation planning and implementation at the national level is primarily the responsibility of the Ministry of the Environment and Energy Security (Ministero dell'Ambiente e della Sicurezza Energetica – MASE), joint efforts also occur with other national authorities, including: ISPRA (Institute for Environmental Protection and Research) and National Agency for Meteorology and Climatology (ItaliaMeteo). Cross-sectoral cooperation also takes place within MASE, through interdepartmental working groups. In addition, the newly founded (in 2021) Ministry for Ecological Transition is going to gather some of the key responsibilities that normally pertain to the Ministry of Economic Development; specifically, it is going to accrue all activities revolving around energy policies, transport emissions, alternative energy resources, sustainable development policies, circular economy and related policies. In addition, the Ministry is going to deal with more classic environmental responsibilities such as waste management, water resources management and environment defense.

The **cross-sectoral approach and coordination of policies**, integrating them with digitalisation and energy transformation is to be ensured through the recent adoption of the Plan for Ecological Transition (drafted by the Ministry). The management of the Plan is to implement the integration and synergy of interventions and related funds dedicated to decarbonisation, sustainability and ecological transformation of all ministries involved, taking into account the lines already outlined in the Recovery and Resilience Plan, in view of the coherence of policy choices. Moreover, the specific objectives of the National Plan for Climate Change Adaptation (NAP, under development) are aimed at defining national governance for adaptation, mainstreaming adaptation into planning at all levels, defining sectoral and cross-sectoral means for implementing adaptation measures, improving, and systemizing the knowledge framework. One of the actions of the NAP aimed at administrative strengthening for adaptation, is focused on mainstreaming. The action aims at the identification of modalities, tools and competent actors for the introduction of climate change adaptation principles, measures and actions in the national, regional and local plans and programs. It will be implemented by the governance structure within six months of the approval of the NAP.

As for the policy landscape for CCA in the Emilia-Romagna, the region now takes a markedly **integrated approach based on both direct intervention** (public funding, management of environmental institutions), and sustaining **bottom-up initiatives and collaborations among different actors**. Such an integrated approach is pursued also by public policies implemented in other areas (e.g., tourism, welfare, employment), which consider potential synergies with CCA. This approach has been characterised recently by an increasingly tight relationship between CCA and other sectors, including the region's large, sophisticated manufacturing economy, and a progressive integration of CCA within the RIS3. The regional joint mitigation and adaptation strategy is also the result of a process that has actively involved many representatives, sectors affected by regional policies and regional system agencies through the establishment of an **inter-sectoral working group** with Council Resolution no. 570/2016. One of the main goals of the strategy was to create a "climate risk culture" among different department of the region, as climate change is seen as a transversal and integrated topic.

2.3.2 Good Practices

Over the last few years, during the development of the Emilia-Romagna Regional Strategy "2030 Agenda for Sustainable Development", the Regional Council has identified the need for a **cross-sectoral approach to implementing the SDGs** at the regional level, in line with the **multidimensional integrated approach** envisaged by the United Nations, with the aim of promoting the achievement and full dissemination of the 2030 Goals through regional policies and the territorial governance system, as well as building an innovative and transparent system to monitor progress for each goal. The document was developed by an interdisciplinary technical working group within the Region, made up of more than 40 representatives of the general directorates, called upon to contribute to the definition of the document, and an operational steering group made up of experts from the competent structures for methodological support. It was a cross-cutting work, functional to generating the integration of the key dimensions of sustainability in all policies that is indispensable to achieve the objectives. And while this work was not focused on the CCA, this example demonstrates the general approach in the region to ensuring synergies of action in the region's policies.

Some kind of synergy of action at regional level is also to be ensured through the **Regional Economic and Financial Document** of the Emilia-Romagna region. It is approved by the council by 30 June each year, starting with the Mandate Programme and the Labour and the Work and Climate Pact, and sets out the strategic objectives that the regional government intends to achieve during its term of

office, specifying the results expected for each objective in each year of the three-year period, coinciding with the time span of the budget forecast, and at the end of the legislature.

The cross-sectoral approach is also embedded in the **regional innovation strategy** of Emilia-Romagna. RIS3 includes the definition of priorities with a strong **multidisciplinary and transversal dimension** with respect to sectors. The strategy sees innovation and research as a response to societal challenges, not just as a competitiveness factor. The strategy includes 15 **cross-sectoral thematic areas**, five of which are related to sustainable transition: clean, affordable and secure energy; circular economy; climate and natural resources (air, water and land); blue growth; innovation in materials.

Italy also has examples of **interdisciplinary research in the field of climate change**. One example is the Euro-Mediterranean Center on Climate Change (CMCC - Centro Euro-Mediterraneo sui Cambiamenti Climatici). It is organised in the form of a network distributed throughout the country with locations in different cities, including Bologna. The network connects universities and research institutes in a strongly interdisciplinary collaboration aimed at developing and promoting knowledge in the field of climate science. The scientific organization enhances the integration and collaboration among interdisciplinary skills needed to deal with climate sciences related topics. The CMCC collaborates with experienced scientists from different areas of study, and promotes collaboration between universities, national and international research bodies, local authorities and manufacturing sectors. CMCC provides analyses of climate impacts on different systems, such as agriculture, water resources, health, among others. Furthermore, it "promotes and carries out basic and applied scientific research and develops operational services with a high content of knowledge and technological innovation, in the various fields on which climate change has an impact"[19]. It also supports policymakers in setting and assessing costs, and developing science-driven adaptation and mitigation policies.

Moreover, the Region Emilia-Romagna has funded the Future Earth Research School with the aim to providing high-level scientific courses that help researchers understand and anticipate future global environmental challenges in the more general context of sustainability and climate change. The Future Earth Research School aims to become a reference point for excellence in research on sustainability by providing high-level scientific courses that give researchers the tools to understand and anticipate future global environmental challenges. The school offers a unique opportunity for up-and-coming researchers and international experts to collaborate and share experiences on different **multidisciplinary aspects of research**, building a fertile ground for innovation and new research pathways. The School is part of the triennial high-education projects in cultural, economic and technologic fields (Progetti Triennali di Alta Formazione in ambito culturale, economico e tecnologico) funded by the Emilia-Romagna Region (pursuant to Article 2 of the Regional Law n. 25/2018 and approved by deliberation n. 1251/2019 of the Regional Council).

Also worth mentioning is EcosistER project (2022-2025), which is the result of great teamwork that has brought together the entire network of regional universities and is organised according to the Hub&Spoke model. The aim is to support the green transition of the regional economic and social system. The project intends to support the ecological transition of the regional economic and social system through a **process that transversally involves all sectors, technologies and skills**,

[19] https://www.cmcc.it/about/cmcc-foundation-2

combining digital transition and sustainability with work and people's wellbeing and environmental protection, in line with the objectives of the Covenant for Work and the Climate, and integrating with regional, national and European programmes. The budget is split 75% for research (applied research) and 25% for business.

2.3.3 Recommendations

In the Emilia Romagna region efforts are being made to strengthen cross-sectoral approach, coordination of policies, and the mainstreaming of climate change issues (not exclusively adaptation) into different sectoral areas. Also RIS3 includes the definition of priorities with a strong multidisciplinary and cross-sectoral dimension, including cross-sectoral thematic areas, few of which are related to sustainable transformation. However, there is a need to strengthen synergies at the level of organisational structures.

Possible solutions:

- There is a need to approach CCA issues more interdepartmentally, for example by using the already existed interdisciplinary teams and working groups, and such activities should be more systemic.
- The management of CCA should not take place in a specific sectoral department, but at the highest level of management, e.g. at the level of the regional presidency, as it is a transversal topic and not a sectoral one - which was also highlighted by the interviewee.
- This implies the need for an institutional leader in the CCA.

2.4 Increased breadth and depth of stakeholder involvement

Box 4. Summary on stakeholder involvement

In the Emilia-Romagna Region there is a long history and practise in stakeholder involvement. The inclusion of existing structures and networks can be identified as one of the key aspects to increase and multiply participation in the CCA process in the region. Stakeholders' contribution was fundamental in the elaboration of the CCA strategy and is important also in the monitoring phase of the strategy implementation, in particular through the Regional Climate Change Forum. The participatory process is based on different actions: meetings and workshops, a web-based platform to exchange knowledge and facilitate the discussion on key issues, and educational and communication initiatives addressing citizens. Further initiatives in the region, most notably the Pact for Work and Climate, are also based on high-quality relations between institutions and economic and social stakeholders. The Emilia-Romagna region also benefits from a strong regional ecosystem dedicated to innovation, which also allows business to be involved in support of various objectives, including climate change. In addition, stakeholder engagement is also marked in rural areas, facilitated by participation in the LEADER initiative as well as the **Multi-Actor Platform.** The wide variety of actors shows a good integration and a high level of participation in the CCA process. However a supervising management structure seems to be missing.

2.4.1 Current Status

The **inclusion of existing structures and networks** can be identified as one of the key aspects to increase and multiply participation in the CAA process in the Emilia-Romagna region. The region already benefits from strong networks between public agencies and non-governmental sectors, including companies, local utilities and universities. The path of democratic participation and shared planning are a confirmation and a "relaunching" of the method started in 2015 with the signing of the Jobs Pact (a forerunner of the 2020 Pact for Work and Climate).

Stakeholders' contribution was fundamental in the elaboration of the "Climate change mitigation and adaptation strategy for the Emilia-Romagna Region", especially for the identification of the main vulnerabilities to climate change for each addressed sector and for the definition of related actions to be undertaken. The stakeholders have been involved since the beginning of the process. The first phase engaged representatives of the scientific community in three seminars (July 2016) to build up a common and shared knowledge on climate change topic. In the second phase, which led to the definition of the strategy, regional stakeholders (local administrations, sector specific businesses and NGOs) were engaged to both share with them the scientific knowledge underpinning the adaptation process and to define a common ground of the measures to undertake. The participation of the stakeholders is particularly encouraged also in the monitoring phase of the strategy implementation, in particular through the **Regional Climate Change Forum**, to better inform and educate the community on climate change issues and encourage the dialogue among the different parties. The Regional Forum, established following the regional joint strategy of mitigation and adaptation, promotes permanent dialogue with local authorities, citizens and productive sectors by providing a forum to discuss policies and update choices. The Forum has also the objective of improving citizens' awareness on the importance of climate change mitigation and adaptation. The participatory process is based on different actions: meetings and workshops, a web-based platform to exchange knowledge and facilitate the discussion on key issues, and educational and communication initiatives addressing citizens and students. In 2021 the Forum started a survey activity among enterprises to detect their knowledge of the climate issue, as well as training and awareness-raising meetings on mitigation and adaptation management tools for SMEs.
Also at the local level, municipalities have involved citizens in the development of mitigation and adaptation plans. Almost all mitigation and adaptation plans have established participatory processes, which have involved citizens and key stakeholders both during the development of the plans and the implementation phase.

2.4.2 Good Practices

The Emilia Romagna Region has signed the **Pact for Work and the Climate** together with local authorities, trade unions, businesses, schools, universities, environmental associations, the third sector and voluntary sector, professions, chambers of commerce and banks. The Pact is based on quality relationships between institutions and economic and social stakeholders, mutual recognition of the role each of these play in society, sharing strategic objectives and the consequent accountability. It is made up of diverse demands, visions and sensibilities resulting from a democratic participation and shared planning process. Participation is a cross-sectoral process built in the Pact. The pact also stresses the importance of business commitment to the "environmental transition".

> *"If we are to achieve our transition objectives, it is fundamentally important to get companies involved, starting with local authorities' basic services providers - in which public participation and control are strategic - and develop all possible synergies*

between public-private investment cycles, supporting a management style which ensures services of universal value, through constant investment in networks and plants." (Pact for Work and Climate)

More recently, the "2030 Agenda Strategy for Sustainable Development of the Emilia-Romagna Region" was drafted through **interaction and collaboration among the various bodies** and is incorporated in their strategic instruments. It was prepared with the support of ASviS (Italian Alliance for Sustainable Development) and the involvement of Art-ER, the Regional Agency for Prevention, the Environment and Energy (ARPAE), of regional universities through Emilia-Lab, a network of universities in Emilia-Romagna. In order to guarantee the maximum participation of the region both in the strategy drafting phase and in its implementation, the Emilia-Romagna region has established the "**Forum for the 2030 Agenda Regional Strategy for Sustainable Development**" based on the integrated evolution of already established or ongoing regional participatory experiences. The Forum is also instrumental in ensuring synergies with the Emilia-Romagna Sustainable Coordination (ERSC) and with Agenda 2.0 for Sustainable Development of the metropolitan city of Bologna. The aim is to optimise initiatives, resources and tools with respect to the sustainability goals, as also required by the national framework supporting the construction of metropolitan agendas. This network, which will be expanded over time, characterised by the involvement of other administrations, the economic and social partnership, businesses and civil society, takes place in an articulated and flexible but integrated framework through tools and discussions, with a view to the continuous refinement of forms of cooperation for sustainable development.

In 2008, the Regional Council of Emilia-Romagna created the Osservatorio Partecipazione (**Participation Observatory**), an organism with the mission to stimulate participation and improve its quality. Participants are: municipalities and the government of the region implementing citizen participation projects. The Observatory also collects practices and processes of citizen participation implemented at the level of the State and civil society organisations. Moreover, since 2018, it collects all participatory processes carried out in all Italian regions. The Observatory was set up, first of all, to allow an effective analysis of the Emilia-Romagna participatory phenomenon, in order to adopt specific actions to encourage and improve the quality of the participatory approach by all public bodies in the territory. For this reason, the Participation Observatory has immediately taken the form of a common space of interaction and exchange between the various actors involved in participatory processes, to enhance the knowledge of citizens and the commitment of groups, organizations and representatives throughout society. It is also intended to provide local authorities with a knowledge base that can be used as a tool to improve their administrative actions, particularly participatory proposals.

Several **European projects** (Interreg, Life, H2020, etc.) have helped over the years to activate **local adaptation partnerships** made up of researchers, experts, professionals involved in drafting risk analyses, addresses to raise awareness among citizens and stakeholders, as well as making available data and decision-support tools that can be used by public administrations to plan their services. One of the examples, where business was particularly involved, is GAIA project. It consisted of a public-private partnership from the start. Each of the partners involved brought in their own expertise. The Institute of Biometeorology of the National Research Council (IBIMET) supported on the development of scientific guidelines. Impronta Etica, a non-profit organisation that aims to promote sustainability and Corporate Social Responsibility (CSR), helped to develop the partnership model. Unindustria Bologna, an association of entrepreneurs in Bologna, focused on the involvement of enterprises. Finally, Cittalia, a local branch of the National association of Italian cities and municipalities focused on research activities, provided support in the communication and dissemination needs. The project

also included the set-up of a body that controls the partnership model and procedures for the selection and planting of green areas. The GAIA Management Group, which consists of the G. Marconi Airport of Bologna, the Coop Adriatica, Enel, Gruppo Hera, Gruppo Unipol, La Perla, Manutencoop and M. Casale Bauer, was created to function as a first promoter at the start of the project. A further 11 businesses joined the project during the experimental phase. They are GD, Interporto, Bologna Fiere, Granarolo, Mec-Track, Cadiai, STS, BRT S.p.A., Indica Srl, Piccoli Motori srl and PS Mobile srl.

The Emilia-Romagna region also benefits from a **strong regional ecosystem dedicated to innovation**. The main stakeholders of the regional innovation ecosystem are:

- Universities - Emilia-Romagna is home to 4 regional universities and 2 Universities from other regions;
- ART-ER - Attrattività Ricerca Territorio (Attractiveness Research Territory) is the Emilia-Romagna Joint Stock Consortium created to promote the sustainable growth of the region through the development of innovation and knowledge, attractiveness and internationalisation of the territory; it coordinates the regional innovation ecosystem;
- Clust-ERs, a community of public and private actors (research centres, companies, training institutions) sharing ideas, skills, tools, resources to support the competitiveness of the most important production systems in Emilia-Romagna. The Clust-ERs are the subjects capable of multiplying innovation opportunities through a collaborative approach, as they focus their activity in R&D strategic sectors. The network of clusters is coordinated by ART-ER. One of the 11 clusters in operation is Energy and Sustainable development Clust-ER GREENTECH;
- High-Technology Network - composed of 82 Industrial research laboratories and 14 Innovation centres operating in the following fields: agri-food, construction, energy and environment, ICT and design, life science, mechanics and materials. The laboratories are hosted within the Technopoles: 10 infrastructures located throughout the territory that stem from an initiative of the Region in collaboration with ART-ER, universities, research centres and local authorities;
- Open Laboratories - spaces equipped with advanced technological solutions to start cooperation and collaboration projects involving citizens, the public administration, the third sector, the universities and, in general, all actors that play a significant role in the transformation of the information society in the urban environment;
- Sustainable Territorial Development Division - focus on the support of regional programming and planning, cooperation, and promotion of collaboration with economic and social players in order to promote the sustainable development of the Emilia-Romagna region.
- Digital Innovation Hub Emilia-Romagna - act as the coordinator of a set of territorial services, consultancy and competences made available by the regional innovation and digital ecosystem;
- BI-REX (Big Data Innovation & Research Excellence) - a public-private consortium consisting of 56 members (including the Universities that are present in the Emilia-Romagna region, research centres and companies of excellence) that was established in 2018 in Bologna as a Centre of Competence (CC) within the framework of the Industry 4.0 National Plan, with the mission to support companies in their innovation processes;
- MAK-ER Association - regional network that brings together fab labs and makerspaces in Emilia Romagna, integrating them into the ecosystem of regional innovation. It acts as a collector of training services, prototyping and adoption of digital technologies, distributed on a regional scale, to support businesses, the world of education and public administration.

The dedicated Open Innovation Platform EROI was set up to pursue this aim and to gather in one place all the services and opportunities available to the regional ecosystem.

It is also worth mentioning the **Multi-Actor Platform (MAP)** operating in the Emilia-Romagna region, coordinated by the University of Bologna. This platform operates at regional level, specifically

in the plain part (rural area) of the region. It is mostly focused on discussing innovative solutions that can sustain the competitiveness of the agriculture sector while enhancing environmental protection and increasing the sustainability of production. Specifically, the thematic focus of this cycle of MAP's activities is on land-use management in the context of climate change. It is one of 40 MAPs implemented across the EU under SHERPA project (2019-2023) funded by the Horizon 2020. The project aims to gather knowledge that contributes to the formulation of recommendations for future policies relevant to EU rural areas, by creating a science-society-policy interface. The region has previous extensive and successful implementation experiences in involving the local population, the private operators and the local authorities along with higher institutional levels under the **LEADER initiative**. In Emilia-Romagna region, local institutions are very active in the constitution of Local Action Groups (LAGs). The LAGs in this region are considered by the National Rural Network of Italy to be those with the most political and functional autonomy which gives LAGs an institutional prestige because they are considered as competent by the regional administration and by local stakeholders (Gargano, 2021).

2.4.3 Recommendations

The wide variety of actors shows a good integration and a high level of participation in the CCA process. However a supervising management structure seems to be missing. The Emilia-Romagna region benefits from a strong regional ecosystem dedicated to innovation**. Nonetheless,** it is more oriented towards mitigation (energy efficiency, innovative processes, better use of natural resources etc.), in the area of adaptation, there is still much to be done.

Possible solutions:

- It would be beneficial to transfer the good practices developed in relation to environmental transformation in general, to the CCA actions more specifically.
- There is a need for a greater orientation of the regional innovation ecosystem towards climate change adaptation concerns.
- A supervisory governance structure for participation in the CCA process would be valuable.
- It is important to involve business more strongly in CCA activities.

2.5 Multi-level governance

Box 5. Summary on multi-level governance

In Italy, a large part of the environmental and innovation policies are shared between regions and the state on the basis of principle of vertical subsidiarity. Regions play a key role as coordinators and service providers for smaller municipalities. As an example: in 2011 the Emilia-Romagna region launched the Climate Plans initiative, supporting local administrations to take action to cope with climate change, and in 2019-2020 established a fund offering grants to municipalities to facilitate the development of their SECAPs. The lower levels of government are acting with regard to climate issues on a voluntary basis, which has generated a rich and complex landscape of climate action dominated by a high level of heterogeneity across regions, provinces and cities. An important actor for multi-level governance is ANCI (National Association of Italian Municipalities), and ANCI Emilia Romagna in 2022 created the SBAM project (School of Bioclimatic Design for Adaptation and Mitigation) to help municipalities develop new skills concerning urban climate adaptation. Moreover, the Emilia-Romagna Region created a Regional Forum on Climate Change to improve vertical and horizontal integration among the different administrators and other stakeholders involved in the adaption process. As for innovation, the Emilia-Romagna region has a Joint Stock Consortium - ART-ER which plays a very important role in coordinating innovation activities in the region. The challenge for multi-level management comes with major extreme events, such as the recent flooding, in May 2023. Even if the region's budgetary power is strong, huge investments and state support are needed, and the cooperation between regions and the state are very complex especially in political terms.

2.5.1 Current Status

Italy is a country with an institutional architecture based on four government levels: national, regional, provincial and municipal. Policy responsibilities and competences are distributed between these governmental tiers on the basis of a federalization process that took place in the 1980s and the 1990s and empowered the regional level. After the constitutional reform of 2001, Italy is a quasi-federal system in which a number of competencies, including a large part of the environmental, and enterprise and innovation policies are shared between regions and the state on the basis of principle of vertical subsidiarity. As a result, regional-scale initiatives coexist with some programmes of national relevance that are managed by the Italian government. Therefore, regions have legislative power different from the national state and the capacity to enact laws that regulate the governmental action of provinces and municipalities. Among the competences shared between the state and the regions are energy and environmental issues, which result in the **regional level playing a pivotal role in the national climate policy**.

One of the objectives of the mitigation and adaptation strategy of Emilia Romagna was to establish a dialogue with the local administrations that have joined the CoM. Regions play a key role as **coordinators and service providers for smaller municipalities** that lack experience and/or personal and financial resources. Municipalities have the capacity to develop their climate strategies on mitigation and adaptation in full alignment with the state and regional guidelines and objectives. In this regard there are no binding regulations from higher government levels that require municipalities to implement local climate strategies and plans. As a consequence, the lower levels of government are acting with regard to climate issues on a voluntary basis, which has generated a rich

and complex landscape of climate action dominated by a high level of heterogeneity across regions, provinces and cities. The governments of various regions have developed specific approaches to provide financial and technical support to local municipalities implementing Sustainable Energy and Climate Action Plans (SECAPs).

2.5.2 Good Practices

Emilia Romagna region has a history of cooperative movements which are at the base of the so-called "Modello Emilia" (Emilia Model) a model of "endogenous development" and "local development" which reflects a strong multi-level governance system with devolution of planning and implementation activities to provinces according to the regional law no. 15/97 (Putnam et all, 1994). In Emilia-Romagna the Regional Adaptation Strategy encourages local administrations to take action by developing their own local climate change plans. In 2011, before the Strategy was adopted, the Emilia-Romagna region launched the Climate Plans initiative, supporting local administrations to take action to cope with climate change, both in terms of adaptation and mitigation, and more in general to pursue sustainable development objectives. The Climate Plans initiative includes a dedicated web-based platform (CLEXi)[20] helping administrations to monitor and report the implemented actions and the achieved results. Later on, for the 2019-2020 period, the region of Emilia Romagna established a fund of €1.2 million offering grants to over 30 municipalities to facilitate the development of their SECAPs. The region also provides technical assistance, including access to climate-related data through the Climate Regional Observatory enabling Covenant Signatories to access critical climate-related data and information at the municipal level. This support is invaluable for the development and monitoring of risk and vulnerability assessments within their strategies and plans.

All Italian regions and several local authorities participate in activities of the Ministry of the Environment to **strengthen administrative capacity in adaptation** through Line 5 of the CReIAMO PA Project[21], which was financed by Priority Axis 1 of the National Operational Programme (NOP) on Governance and Institutional Capacity 2014-2020. It is a part of an overall strategy to deal with critical environmental issues encountered in the implementation of public policy. This strategy identifies management systems and methods to eliminate fragmentation and loss of resources, by assigning competences to the regions. Groups of Regions (Po Valley, Alpine areas, Tyrrhenian and Adriatic) collaborate with local authorities to foster adaptation at the local scale. All the Italian regions and several municipalities have participated to the training activities carried out for strengthening their administrative capacity on adaptation. This was done through the establishment of networks between regional and local authorities on specific topics. In practice, activities mainly reduced to assistance in the development of adaptation plans provided by higher levels of government to local administrations. Worth mentioning is a new project, under the LIFE programme, which started in 2023 and is expected to last until 2032: CLIMAX PO, which is setting up an integrated governance approach (**Multi level Governance Deal**) for the whole Po River Basin.

An important actor for multi-level governance is ANCI (Associazione Nazionale dei Comuni Italiani) - the **National Association of Italian Municipalities** (in which almost all Italian municipalities are members), which has long been actively involved in decentralised cooperation. It participates, through its own representatives, in every institutional office where decisions concerning the interests of local

[20] https://clexi.ervet.it/

[21] https://creiamopa.mite.gov.it/index.php/en/

authorities are taken and provides consultancy to municipalities. In addition, the region is home to ANCI Emilia Romagna, which brings together 310 of the 330 municipalities (figures for 2022[22]) and its internal company ANCICOM Srl, which provides services and carries out training and consultancy activities for local authorities. To respond to the need of local authorities to develop new skills concerning urban climate adaptation, the project **SBAM (the School of Bioclimatic Design for Adaptation and Mitigation)** was created by ANCI Emilia Romagna in 2022. SBAM is also an **outreach and training opportunity aimed at creating a network of competent professionals ready to implement adaptation strategies.** The topics are explored with an operational and participatory approach, based on the analysis of real case studies, ongoing pilot actions, as well as **regional, national, or international best practices,** site visits. A series of workshops were conceived to simulate the Nature Based Solutions (NBS) design approach. Municipalities in the Emilia-Romagna region with more than 60,000 inhabitants were able to participate in an experimental programme launched by the Ministry of the Environment to set up SBAM, using an innovative approach based on collective financing. There are other public representative bodies of local and regional authorities that can also participate in CCA planning: the State-Regions Conference (Conferenza Stato-Regioni); the Conference of the Regions and the Autonomous Provinces (Conferenza delle regioni e delle province autonome, CRPA), and the State-Cities and Local Autonomies (Conferenza stato-città e autonomie locali).

Moreover, the Emilia-Romagna Region created a **Regional Forum on Climate Change** to **improve vertical and horizontal integration among the different administrators and other stakeholders involved in the adaption process**. The Forum is used to exchange knowledge on climate change, coordinate the policies on adaptation and mitigation at local level as well as share the results achieved in mitigating and adapting to climate impacts. It is addressed to the regional stakeholders, such as local administrations, businesses, universities and research centres and organizations of the civil society. In this way, Emilia-Romagna Region intends to become a hub for linking and coordinating local initiatives in CCA.

The Emilia Romagna region recognises the need for coordination of efforts at different levels of government and for regional and local institutions to work together to achieve the region's development goals. This is why it was decided to set up a multi-level regional steering committee (**Steering Committee for the Governance and Strategic Control of Regional Planning**) with the local authorities. It was established by Regional Decree 602/2021, and has the task of promoting and verifying the full consistency between the regional planning of the 2021-2027 European funds and the objectives of the 2030 Regional Agenda for Sustainable Development. The objective is the involvement of municipalities in the process of the territorialisation of the development goals, in order to create a multi-level system of 2030 Agenda Strategy for Sustainable Development and strategies embedded in the programming cycle of the authorities.

As for enterprise and innovation, the Italian policy framework is relatively complex. Once that some policy competencies have been transferred to regional governments, the national government has somehow tried to redefine its role (Caloffi et Bellandi, 2017). The national type of intervention is basically selective and vertical, and the main focus is on supporting R&D and large-scale technology transfer projects. At regional level, the real driver of the regional innovation strategy is RIS3. The Emilia-Romagna region has a Joint Stock Consortium - ART-ER which plays a very important role in

[22] https://www.anci.emilia-romagna.it/chi-siamo/comuni-associati/ (30.09.2023)

coordinating innovation activities in the region. It **coordinates the regional innovation ecosystem** that includes the Emilia-Romagna High Technology Network, the **Technopoles**, the **business Incubators**, the **Clust-ERs** and **Startups** and also operates through the local S3 AREAS as meeting places set up to foster the relationship between young people and the most innovative employment networks.

2.5.3 Recommendations

There's a rich and complex landscape of climate action dominated by a high level of heterogeneity across regions, provinces and cities. Though many valuable initiatives at the local scale have been carried out in recent years, a stronger integration among regional and local plans still needs some efforts to be fully realised. The challenge for multi-level management comes with major extreme events, such as the recent flooding, in May 2023. Even if the region's budgetary power is strong, huge investments and state support are needed, and the cooperation between regions and the state are very complex especially in political terms.

Possible solutions:

- Climate planning needs to ensure vertical integration to support local governments and ensure collaboration at different levels.
- This integration needs to work in both directions: top-down, to ensure that national policy encourages sub-national governments to prepare plans and strategies (by regions) and turn them into action plans (by municipalities); and bottom-up, to ensure that the local scale can be a testing ground for national governments and can influence national action.
- There is a need for strong multi-level governance, cooperation and coordination, especially in the face of extreme events when government support is needed. Such cooperation between regions and the state should be strengthened, despite the complexity of political relations.

2.6 Room for experimentation

Box 6. Summary on experimentation

Emilia-Romagna is a region with a strong innovation ecosystem. Thus, there is also a space in the region for creativity and experimentation on potential innovative solutions, although it is not strictly dedicated to climate change adaptation. Initiatives that foster the exploration of new solutions include open laboratories and living laboratories, also operating in climate change area. There are also initiatives supporting start-up growth, eg. EmiliaRomagnaStartup, in-ER network, Start Cup Emilia-Romagna, and EROI - Emilia-Romagna Open Innovation.

2.6.1 Current Status

Emilia-Romagna is a region with a strong orientation towards investments in research, innovation, and sustainability. There are a wide range of initiatives in the region that can generate diverse changes (including those that are the result of an experimental approach), e.g. new technologies, new business practices, changed discourse, policy and institutional change, new citizen practices (Kivimaa et al., 2017). Thus, there is a **space for creativity in the region**, although it is not strictly dedicated to climate change adaptation. For example, in the Technopoles are hosted the Areas S3 which have the task of generating new opportunities for highly skilled young people to access professional paths related to innovation. Clust-ERs are associations of laboratories and firms aimed at developing joint strategic projects with a high regional impact in accordance with the regional specialization. Open Laboratories are spaces equipped with advanced technological solutions to start cooperation and collaboration projects involving citizens, the public administration, the third sector, the universities and, in general, all actors that play a significant role in the transformation of the information society in the urban environment. Another approach, proposed in the Emilia Romagna region's smart specialisation strategy, and offering a space for experimentation, are "**living laboratories**". Living labs are open-innovation ecosystems that integrate research and innovation processes in a real-life setting (research-in-action approach), in a logic of open–user innovation, through public-private partnerships. Co-design is very important in this approach.

2.6.2 Good Practices

There are also examples of **living laboratories and open laboratories in the area of climate change** that have been **set up as part of EU co-funded projects**. As an example, under I-CISK[23], Horizon 2020 project, a living lab on agriculture and domestic water resources have been implemented in Emilia-Romagna. It addresses the climate services needs of agriculture (irrigation), water governance (water allocation, withdrawals constrains), and environment (maintenance of aquatic life and the natural environment) sectors. I-CISK recognises that to achieve behavioural change, the active use of climate information in informing decision-making toward climate adaptation and mitigation requires that citizens, stakeholders and decision-makers are at the centre of the

[23] https://icisk.eu/about-icisk/

design, creation, implementation and evaluation of climate services. Another example is OPERANDUM project, aimed at establishing of novel open-air laboratories, an approach that uses the living-labs concepts for natural and rural areas to promote innovation and research development (innovative nature-based solutions). They allow gemming of new services/systems/products and business opportunities and fostering residents participation in the conceptualization and testing. One of such open air laboratories is in Po Valley, in Emilia-Romagna region.

As for the regional initiatives supporting knowledge-based **start-up growth**, it is worth mentioning EmiliaRomagnaStartup, a one-stop-shop offering information and support to regional start-ups, and the in-ER network, the community composed of regional incubators and accelerators providing facilities, services, tools and financing opportunities. There are also initiatives devoted to technology transfer and to the exploitation of the research results, such as the Start Cup Emilia-Romagna, the business idea competition organized in partnership with the regional Universities and research centres and EROI - Emilia-Romagna Open Innovation, a digital community open to people who want to innovate by collaborating in line with the open innovation principles.

2.6.3 Recommendations

There is a space in the region for creativity and experimentation on potential innovative solutions, although it is not strictly dedicated to climate change adaptation.

Possible solutions:

- It would be valuable to use existing solutions (e.g. open laboratories, living labs) to create space for innovation more focused on climate change adaptation.
- Failure-accepting solutions are needed in policy instruments and new types of risk-tolerant financing are necessary.
- There is a need to encourage public sector innovation and innovative procurement to create space for private sector experimentation in CCA.

2.7 Policy intelligence, learning and strategic capacity

Box 7. Summary on policy intelligence, learning and strategic capacity

In Italy, at the national level, there is a system for collection, elaboration, and dissemination of environmentally relevant climate data, as well as newly introduced National Platform on Adaptation to Climate Change. Also the regional and local initiatives gave the opportunity to strengthen the scientific knowledge about climate change. Emilia Romagna has established its own Climate Observatory in 2017. The Region has also established the Organizational Supervision on Climate Change. Solid regionalisation techniques of climate scenarios (based on statistical and dynamic approaches) have been validated in various previous projects and then used to support regional and local adaptation planning. Due to the complexity of climate change adaptation and its interdisciplinary nature, the learning process in the region is ongoing (especially with regard to monitoring processes). Valuable experience and lessons are gained through participation in international initiatives and projects.

2.7.1 Current Status

Since 2006, the **national system for collection, elaboration, and dissemination of environmentally relevant climate data** (SCIA)[24] has been realized by the National Institute for Environmental Protection and Research (ISPRA). It aims to establish (among all the relevant institutions dealing with meteorological networks and observations) a common procedure for calculating, updating and representing Italian climate data. In addition, the National System for Environmental Protection, set up a national Working Group on "Impacts, vulnerability and adaptation to climate change" with the objective to define a set of climate change impact indicators. The National Research Council - Institute of Atmospheric Sciences and Climate (CNR-ISAC) promotes and develops an integrated scientific understanding of the atmosphere, the ocean and their processes, through a multidisciplinary approach. Euro-Mediterranean Center on Climate Change (CMCC) aims to investigate and model Italian climate system and its interactions with society to provide reliable, rigorous, and timely scientific results as well as foresights and quantitative analysis, and develop science-driven climate change adaptation and mitigation policies. The National Adaptation Strategy establishes a National Observatory coordinated by the Sardinia Region and made up of the Regions and local representatives, for the identification of territorial and sectoral priorities, as well as for the subsequent monitoring of the effectiveness of the implemented adaptation actions.

In October 2022, the **National Platform on Adaptation to Climate Change**[25] was implemented on the national level, promoted by the Ministry of the Environment and Energy Security and implemented by ISPRA. It is a portal aimed at informing and raising awareness on the issue of adaptation. The Platform makes available data and tools for supporting public administration in decision-making processes. Its objective is to facilitate the exchange of information between the central administration, local authorities and all stakeholders, starting with citizens, on the issue of adaptation to climate change, thus representing the main information tool in Italy on this topic.

2.7.2 Good Practices

At the regional level, Emilia Romagna has established its own **Climate Observatory** in 2017. It is located at ARPAE (the Regional Environmental Protection Agency) - HydroMeteoClima Service[26]. The Climate Observatory is responsible for the reconnaissance and documentation of ongoing climate change, the elaboration of future climate scenarios and their impacts, and scenario analyses of specific intervention options for integrated regional sectoral plans. The Observatory therefore updates data and provides indicators and elaborations concerning the regional climate, past, present and future, for sectoral and inter-sectoral planning. Prior to this, when the regional adaptation and mitigation strategy was being developed, ARPAE together with ERVET (now part of ART-ER) – a regional development agency of the Emilia-Romagna Region involved in the promotion of sustainability and in the environmental qualification of the region – actively contributed to the definition of the strategy by providing the needed scientific knowledge on climate change. Future climate projections are reported in the strategy were developed by the Hydrological, Meteorological

[24] http://www.scia.isprambiente.it

[25] https://climadat.isprambiente.it/

[26] https://simc.arpae.it

and Climatological Service of the Emilia-Romagna Environmental Protection Agency (Arpae-SIMC) through statistical downscaling technique applied to different Global Climate Models and different emission scenarios.

The Emilia-Romagna Region also established the **Organizational Supervision on Climate Change** (Presidio Organizzativo Cambiamento Climatico) managed by its Service on Impact Assessment and Sustainable Development Promotion (Servizio Valutazione Impatto e Promozione Sviluppo Sostenibile). This body monitors and evaluates the effectiveness of the regional adaptation and mitigation policies and guidelines as well as upgrades the strategy according to the new evidence on climate change in the region's area. However, at the moment there is no systematic monitoring on CCA, it is only monitoring of single actions. The proper monitoring system is to be established.

In order to expand the regional computing and storage infrastructure to support both scientific and industrial applications, a SUPER (Supercomputing Unified Platform) project was implemented in the region, funded by the Cohesion Policy (POR-FESR 2014-2020 Emilia Romagna). The SUPER federated integration of the infrastructure will allow to support future regional, national, EU and international projects. However, the research was unable to confirm the effects of these measures. The Emilia-Romagna region is also just embarking on a very ambitious twinning project to simulate public transport, air quality and climate policies (to make scenarios what to change, how different action impacts the air quality). Such simulations are made possible by the availability of large amounts of data.

Due to the complexity of climate change adaptation and its interdisciplinary nature, the learning process in the region is ongoing. Valuable experience and lessons are gained through **participation in international initiatives** (Mission on Adaptation to Climate Change Charter, Covenant of Mayors for Climate & Energy, Partnership for Regional Innovation) **and projects** (mainly under Interreg, Life, Horizon Europe), but these activities are rather fragmented and expertise is dispersed.

2.7.3 Recommendations

The regional and local initiatives gave the opportunity to strengthen the scientific knowledge about climate change, and the Climate Observatory serves its purpose. Solid regionalisation techniques of climate scenarios have been validated in various previous projects and then used to support regional and local adaptation planning. Due to the complexity of climate change adaptation and its interdisciplinary nature, the learning process in the region is ongoing, and is still needed, especially with regard to monitoring processes.

Possible solutions:

- There is a need for continuous learning, to better understand what opportunities new solutions, such as NBS, bring, and to know how to implement them.
- It is important to make further use of international networks for the exchange of knowledge and experience in CCA, and the knowledge gained by the regions' authorities through participation in international initiatives and projects should be more widely discounted.
- It would be beneficial to make good use of the new EcosistER project, as well as ARCADIA project (which has just received funding under Horizon Europe).

3 Conclusions and Recommendations

The Emilia-Romagna Region is a frontrunner when it comes to action on climate change, though the effort is more conspicuous in the area of mitigation than adaptation. The authorities and key stakeholders in the Emilia-Romagna region are aware of climate change and its challenges, including climate risks affecting key social systems. A sense of urgency is becoming more apparent, especially in view of the May 2023 floods and public support and advocacy for climate adaptation are growing. A transformative approach to sustainability themes can be identified, evident in successive initiatives in the region, with environmental transformation as a major issue. However, there still needs to be a focus on processes and pathways to system change, above all the creation of a strong monitoring system, which has not yet been achieved. Transformational adaptations should be defined as major changes in system components and should be based more on an innovation system. What is still needed is a "climate risk culture", and the change in the way of thinking, especially among companies. There is also a need for continuous learning in order to better understand what opportunities new solutions, such as NBS, may bring, and to know how to implement them. The management of CCA should not take place in a specific sectoral department (e.g. environment), but at the highest level of management, e.g. at the level of the regional presidency, as it is a transversal topic and not a sectoral one.

The wide variety of actors show a good integration and a high level of participation in the CCA process. Efforts are being made to strengthen cross-sectoral approach, coordination of policies, and the mainstreaming of climate change issues (not exclusively adaptation) into different sectoral areas. The inclusion of existing structures and networks can be identified as one of the key aspects to increase and multiply participation in the CCA process in the region. The most relevant drivers that foster local climate action are: forward-looking administrators supported by a motivated staff, the engagement in climate networks, and involvement in European projects. The lower levels of government are acting with regard to climate issues on a voluntary basis, which has generated a rich and complex landscape of climate action dominated by a high level of heterogeneity across regions, provinces and cities. Though many valuable initiatives at the local scale have been carried out in recent years, a stronger integration among regional and local plans still needs some efforts to be fully realised. Climate planning needs to ensure vertical integration to support local governments and ensure collaboration at different levels. This is fundamental to achieving the goals of territorial resilience and avoiding "policy gaps" between sub-national action plans and national policy frameworks. This integration needs to work in both directions: top-down, to ensure that national policy encourages sub-national governments to prepare plans and strategies (by regions) and turn them into action plans (by municipalities); and bottom-up, to ensure that the local scale can be a testing ground for national governments and can influence national action.

The challenge for multi-level management comes with major extreme events, such as the recent flooding in May 2023. Regions have the competences and political power, sometimes it is simple when the crisis is at municipality or regional level, but if the size is larger, the complexity is more important - there is a need for strong multi-level governance, cooperation and coordination. Even if the region's budgetary power is strong, huge investments and state support are needed, and the cooperation between regions and the state should be strengthened, despite the complexity of political relations. The challenge (evident during the recent floods) is to integrate and coordinate the different levels: the municipalities, which have power and responsibilities but limited budgets in the face of big events, the regions, which have to coordinate the municipalities, and the state. The difficulty to act in an integrated way must be overcome. More funding is also needed for adaptation measures as so far more has been invested in mitigation.

The Emilia-Romagna region benefits from a strong regional ecosystem dedicated to innovation**.** However, it is more oriented towards mitigation (energy efficiency, innovative processes, better use of natural resources etc.), in the area of adaptation, there is still much to be done. This is also the result of silo-thinking, the department dealing with the economy and innovation being more about efficiency. There is a space in the region for creativity and experimentation on potential innovative solutions, although it is not strictly dedicated to climate change adaptation. The regional and local initiatives gave the opportunity to strengthen the scientific knowledge about climate change, and the Climate Observatory serves its purpose. Solid regionalisation techniques of climate scenarios have been validated in various previous projects and then used to support regional and local adaptation planning. Due to the complexity of climate change adaptation and its interdisciplinary nature, the learning process in the region is ongoing, and is still needed, especially with regard to monitoring processes. It will be beneficial to make good use of the new EcosistER project, as well as ARCADIA project.

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AdriaClim (Climate change information, monitoring and management tools for adaptation strategies in Adriatic coastal areas) https://programming14-20.italy-croatia.eu/web/adriaclim

BLUEAP (Bologna Local Urban Adaptation Plan for a resilient city) https://www.blueap.eu/

CHANGE WE CARE (Climate cHallenges on coAstal and traNsitional chanGing arEas: WEaving a Cross-Adriatic REsponse) https://programming14-20.italy-croatia.eu/web/changewecare

CLARA (Climate forecast enabled knowledge services) www.clara-project.eu

CLIMAX PO (CLIMate Adaptation for the PO river basin district) https://webgate.ec.europa.eu/life/publicWebsite/project/details/101069928

CReIAMO PA (Competences and Networks for Environmental Integration and Improvement of the Public Administration Bodies) https://creiamopa.mite.gov.it/index.php/en/

EcosistER (Ecosystem for Sustainable Transition in Emilia-Romagna) https://ecosister.it/

GAIA (Green Areas Inner-city Agreement) https://climate-adapt.eea.europa.eu/en/metadata/case-studies/gaia-green-area-inner-city-agreement-to-finance-tree-planting-in-bologna

I-CISK – Human Centred Climate Services https://icisk.eu/about-icisk/

IRIS (Improve resiliency of industry sector) https://www.lifeiris.eu/en/project/

LIFE ADA (ADaptation in Agriculture) https://www.lifeada.eu/en/

LIFE CITYAdaP3 (Financing Cities Adaptation to Climate Change through Public-Private Partnerships and Corporate Social Responsibility) https://www.lifecityadap3.eu/

OPERANDUM (OPEn-air laboRAtories for Nature baseD solUtions to manage environmental risks) https://www.operandum-project.eu/

RAINBO (Innovative tools for planning and timely responding to floods in urban areas) https://www.rainbolife.eu/en

SHERPA (Sustainable Hub to Engage into Rural Policies with Actors) https://rural-interfaces.eu/

SUPER (Supercomputing Unified Platform - Emilia-Romagna) https://www.hpc.cineca.it/projects/super

Websites

Air Force Meteorological Service https://www.meteoam.it/it/home

ANCI, the National Association of Italian Municipalities https://www.anci.it/home/

ART-ER - Attrattività Ricerca Territorio https://en.art-er.it/

Climate Observatory - Regional environmental protection agency https://www.arpae.it/it/temi-ambientali/clima/cosa-fa-arpae-clima

Clust-ER https://www.art-er.it/clust-er-en/

ClimateADAPT page on climate adaptation activities in Poland: https://climate-adapt.eea.europa.eu/en/countries-regions/countries/italy

Coesione Italia (data on cohesion policy) https://opencoesione.gov.it/en/

Covenant of Mayors https://eu-mayors.ec.europa.eu

Emilia-Romagna Government: https://www.regione.emilia-romagna.it

Emilia-Romagna Region, Research and Innovation https://www.regione.emilia-romagna.it/en/research-and-innovation

ERDF Regional Programme https://fesr.regione.emilia-romagna.it/erdf

Euro-Mediterranean Center on climate change https://www.cmcc.it/

Future Earth Research School https://www.fersschool.it/the-school/

GELSO (Gestione Locale Sostenibilità Ambientale - Local Environmental Sustainability Management) https://gelso.sinanet.isprambiente.it/

I.Stat data http://dati.istat.it

National platform on climate change adaptation https://climadat.isprambiente.it/

National Research Council - Institute of Atmospheric Sciences and Climate (CNR-ISAC) https://www.isac.cnr.it/en

National System for collection, elaboration and dissemination of environmentally relevant climate data (SCIA) http://www.scia.isprambiente.it/wwwrootscia/Home_new.html

Under2 Coalition https://www.theclimategroup.org/states-and-regions-under2-coalition

List of abbreviations and definitions

Abbreviations	Definitions
ADA	ADaptation in Agriculture
AdriaCLIM	Management tools for adaptation strategies in the Adriatic coastal areas
ANCI	National Association of Italian Municipalities
ARCADIA	TrAnsformative climate ResilienCe by nAture-baseD solutions in the contInentAl bio-geographical region
ARPAE	Agency for Prevention, the Environment and Energy
ART-ER	Attractiveness Research Territory Emilia-Romagna
ASviS	Italian Alliance for Sustainable Development
BI-REX	Big Data Innovation & Research Excellence
BLUEAP	Bologna Local Urban Adaptation Plan for a resilient city
CC	Centre of Competence
CCA	Climate Change Adaptation
CEF	Connecting Europe Facility
CityAdaP3	Financing Cities Adaptation to Climate Change through Public-Private Partnerships and Corporate Social Responsibility
CLARA	Climate Forecasts Enabled Knowledge Services
CLIMAX PO	CLIMate Adaptation for the PO river basin district
CMCC	Regional Environmental Protection Agency in the Emilia-Romagna Region
CHANGE WE CARE	Adaptation Plan/Design of Interventions/Pilot Interventions on Sacca di Goro in the Po River Delta

Abbreviations	Definitions
CNR-ISAC	The National Research Council - Institute of Atmospheric Sciences and Climate
CoM	Convenant of Mayors
CReIAMO PA	Skills and networks for environmental integration and for the improvement of Public Administration organisations
CRPA	Conference of Regions and Autonomous Provinces
CSR	Corporate Social Responsibility
DG CLIMA	Directorate-General for Climate Action
DG RTD	Directorate-General for Research and Innovation
EAFRD	European Agricultural Fund for Rural Development
EcosistER	Ecosystem for Sustainable Transition in Emilia-Romagna project
E-R	Emilia Romagna
ERDF	European Regional Development Fund
EROI	Emilia-Romagna Open Innovation
ERSC	Emilia-Romagna Sustainable Coordination
ERVET	Emilia-Romagna Valorizzazione Economica Territorio SpA
EU	European Union
GAIA	Green Areas Inner-city Agreement
GELSO	Local Environmental Sustainability Management
HORIZON	European Union's key funding program for research and innovation
IBIMET	Institute of Biometeorology of the National Research Council
I-CISK	Human Centred Climate Services

Abbreviations	Definitions
INTERREG	European Territorial Cooperation Programme of the EU
IRIS	Improve Resiliency of Industry Sector
ISPRA	National Institute for Environmental Protection and Research
JRC	Joint Research Centre
LAG	Local Action Groups
LEADER	Liaison Entre Actions de Développement de l'Économie Rurale (Links between activities for the development of rural economy)
LIFE	EU funding instrument for the environment and climate action
MAP	Multi-Actor Platform
MASE	Ministry of Environment and Energy Security
MoU	Memorandum of Understanding
NAS	National Strategy for Adaptation to Climate Change
NBS	Nature Based Solutions
NOP	National Operational Programme
NRRP	National Recovery and Resilience Plan
NUTS	Nomenclature of territorial units for statistics
OPERANDUM	OPEn-air laboRAtories for Nature baseD solUtions to Manage environmental risks
PET	Plan for Ecological Transition
POR-FESR	Regional Operational Programme (ROP) – European Regional Development Fund (ERDF)
R&D	Research and Development

Abbreviations	Definitions
RER	Emilia Romagna Region
RINA	Italian Aerospace Research Centre
RIS3	Research and Innovation Smart Specialisation Strategy
ROP	Regional Operational Programme
RSD	Regional Strategic Document for the unitary planning of European development policies 2021-2027
SBAM	School of Bioclimatic Design for Adaptation and Mitigation
SCIA	National System for the Processing and Dissemination of Climate Data
SECAP	Sustainable Energy and Climate Action Plan
SME	Small and Medium-sized Enterprise
SUPER	Supercomputing Unified Platform
TI	Transformative Innovation
Under2 MOU	Network of subnational governments

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Annexes

Annex 1. List of interviews

Table 4. Interviewees and respective organisations

Date	Interviewee
Regione Emilia-Romagna / ART-ER	
11.10.2023	Patrizia Bianconi
University of Ferrara, SEEDS Inter University Research Centre CERCIS Research centre	
17.10.2023	Prof. Massimiliano Mazzanti

Annex 2. List of case studies

Case studies have been carried out to analyse to what extent and how enabling factors towards 'Transformative Climate Change Adaptation' strategies, as identified in the conceptual report (European Commission, 2024), are at play in reality, and what can be done to overcome barriers in various territorial contexts. The methodological framework described in the conceptual report essentially acts as a practical guide for undertaking cases studies on CCA strategies in different territories, in a uniform way. These case studies are listed below:

"Transformative innovation for better climate change adaptation" – Case studies

Country	Territory	URL (*)	DOI	JRC number
Belgium	Leuven	https://publications.jrc.ec.europa.eu/repository/handle/JRC137313	10.2760/58125	JRC137313
Finland	Espoo	https://publications.jrc.ec.europa.eu/repository/handle/JRC137316	10.2760/177322	JRC137316
Finland	Turku - Southwest Finland	https://publications.jrc.ec.europa.eu/repository/handle/JRC137315	10.2760/211155	JRC137315
France	Provence-Alpes-Côte d'Azur	https://publications.jrc.ec.europa.eu/repository/handle/JRC137314	10.2760/46893	JRC137314
Greece	Attica and North Aegean regions	https://publications.jrc.ec.europa.eu/repository/handle/JRC137322	10.2760/493562	JRC137322
Iceland		https://publications.jrc.ec.europa.eu/repository/handle/JRC137291	10.2760/305796	JRC137291
Italy	Emilia-Romagna	https://publications.jrc.ec.europa.eu/repository/handle/JRC137319	10.2760/790200	JRC137319
Netherlands	Northern Netherlands	https://publications.jrc.ec.europa.eu/repository/handle/JRC137312	10.2760/10862	JRC137312
Poland	Mazovia - Stare Babice	https://publications.jrc.ec.europa.eu/repository/handle/JRC137323	10.2760/58125	JRC137323
Portugal	Norte	https://publications.jrc.ec.europa.eu/repository/handle/JRC137321	10.2760/399394	JRC137321
Romania	Nord Vest - Cluj	https://publications.jrc.ec.europa.eu/repository/handle/JRC137317	10.2760/923916	JRC137317
Slovenia	Gorenjska	https://publications.jrc.ec.europa.eu/repository/handle/JRC137320	10.2760/502482	JRC137320
Spain	Andalucia - Granada	https://publications.jrc.ec.europa.eu/repository/handle/JRC137324	10.2760/104672	JRC137324.
Sweden	Blekinge and Värmland	https://publications.jrc.ec.europa.eu/repository/handle/JRC137318	10.2760/249067	JRC137318

(*) Links may give error message for those studies still under publication

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