D.5.4.1 Report on strategic guidelines for climate policies in Adriatic cities

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Interreg Italy-Croatia: AdriAdapt

AdriAdapt is a project funded under the European programme Interreg Italy-Croatia and its objective is the improvement of the capacity of the urban and coastal areas of the Adriatic area to respond to the effect of climate change at local level and the implementation of the resilience of the territory.

The project has developed a set of operational tools to help cities to increase knowledge of climate phenomena at European level, regional and local, and to be able to plan and develop climate adaptation plans and actions that contain concrete and integrated actions to combat climate change. The project aims to improve local climate change adaptation capacity in Adriatic region by creating an information platform that provides access to guidance, data and tools that will help local authorities to take adequate policy measures and develop plans to increase resilience in urban and coastal areas.

The project has four major actions. The first is the improvement of available climate-related knowledge and the production of dataset and projections for detailed information on climate-related impacts in the Adriatic pilot areas. These knowledges are very important for decision making process.

The second is the elaboration of a climate information system and a knowledge platform for the Adriatic region. The system and the platform include best practices, guidance documents, legal frameworks and climate and vulnerability studies.

The third is the test-integration of the knowledge platform in Croatian and Italian pilot cities and urban areas, where adaptation and resilience plans will be designed.

Th fourth is the dissemination phase of the information contained in knowledge platform. It has to be considered as a region-specific repository for climate policy and plans and it provides support and locally relevant data for follower cities.

The partnership of the project has been able to pool all skills and competences of relevant institutions in order to achieve the set of project results, having the capacity to create strong links to target groups addressed by the project.

This document is the deliverable *D.5.4.1 Report on strategic guidelines for climate policies in Adriatic cities* and set a methodological framework for the adaptation planning process.

1 Introduction

It is widely recognized that climate change will further stress ecosystems, negatively affect the conservation of natural areas, worsen human living conditions, limit social system resilience and the ability of cities to cope with climate extremes. Actions taken till now are not enough in order to cope with the effects of climate change. A real sustainable transformation of society is needed with scaled-up and integrated adaptation measures. Transformative climate action is also urgent, as climate change is already affecting many aspects of natural systems and human communities. Whatever stage a city or a region is at, the impacts of today's climate extremes and future climate changes do not wait. Better prepared cities and regions will increase the safety of their citizens and the resilience of their territory, assets and ecosystems. Improved resilience and strengthened adaptation capacity will reduce the costs and damages of climate change impacts, which are expected to rapidly increase if not actions are taken.

Climate change requires a substantial change to city and land planning and calls for both mitigation and adaptation actions. Local and regional communities are expected to participate to the reduction of climate-altering emissions and the enhancement of carbon sequestration (mitigation), thus contributing to a much wider global process. In parallel, they should make progress on the adaptation route that tends to be based on local needs. Climate change mitigation and adaptation are different sides of the same coin (that of climate action) and should be seen as complementary processes to be incorporated and integrated into multiple policies, strategies, plans and programmes adopted at different levels and for different sector and cross-sector purposes.

Adaptation to climate change is influenced by several economic, social, legal, technological, and environmental factors and needs a new form of governance which is heavily based on coordination between local, regional, national and international levels (known as vertical coordination) and coordination between different sectors (known as horizontal coordination). Due to its intrinsic cross-cutting nature, climate change adaptation that is not based on multi-sectoral and multi-level approaches is doomed to fail. Developing an adaptation plan and deciding on concrete adaptation solutions is not easy and it requires the coordinated contribution of several actors. From this perspective, the desired new form of governance for climate action should extend beyond governing institutions and bring together any stakeholders that act as key players in local and regional societies and economies.

Adaptation measures tend to be mostly implemented at the local level, with some solutions having a regional dimension, and more rarely, a national one. The OECD (OECD, 2009) identifies three reasons to focus on local adaptation:

- Climate change impacts take place at a local level and affect local livelihoods, but they also affect economic, health and social aspects, through localized phenomena in response to local geographical, environmental, economic, social and political factors.
- Vulnerability and adaptability are typical of every local context, depending on the interaction of many socio-ecological factors and processes. Thus, the ability to reduce exposure and recover from impacts or to exploit the opportunities offered by climate change impacts can be locally developed.
- Adaptation is best observed and measured at the local level, often requiring individual decisions; local approach allows better monitoring and evaluation of the efficiency or effectiveness of adaptation.

The local level is therefore expected to play a great role in transforming society into a more resilient and better adapted system. However, it is clearly at this level where obstacles to adaptation might hinder the process, including in particular limited financial capacity, a lack of technical and scientific knowledge, a lack of skills and tools, limited integration with the upper level, etc. Customized technical support, including the best use of scientific knowledge and tools, is key for local authorities, and is expected to help them within different phases of adaption planning, such as: visioning, the creation of climate change projections, vulnerability assessments, identification and comparison of adaptation options, the structuring of the information gathering for an actual plan and the development of monitoring and evaluation systems for local adaptation.

These guidelines and the entire AdriAdapt project start from these considerations, aiming to provide science for policies, practical knowledge and tools for the Adriatic local and regional communities wanting to improve their adaptation capacity.

AdriAdapt is a project funded under the European Interreg Italy-Croatia programme. It aims to improve the capacity of urban and coastal communities in the Adriatic region to respond to the effects of climate change in terms of improved resilience and adaptation capacity. The project has developed a set of operational tools to help local communities to increase their knowledge of climate hazards and related vulnerabilities, and to improve their capacity when it comes to planning adaptation actions. Specifically, the AdriAdapt includes four major actions:

1. improvement of available climate-related knowledge and the production of climate change projections in the Adriatic region and the pilot project areas (Vodice, *Šibenik*, Cervia, Union of Municipalities Valle del Savio, Udine);

2. development of an adaptation knowledge platform for Adriatic towns and cities, including climate information, examples of adaption measures, good practices, guidance documents and a simplified description of the integrated adaptation planning tool illustrated in these guidelines (see chapter 2);

3. testing of the contents on the knowledge platform in Croatian and Italian pilot project areas, where adaptation and resilience strategies and/or plans have been designed as part of the project;

4. wide dissemination of AdriAdapt results and, particularly, the knowledge contained on the platform.

The guidelines for local adaptation to climate change in the Adriatic region are one of the final documents of AdriAdapt and represent an important legacy of this project. They condense the results of a wider process of collection and systematization of technical and scientific knowledge, local needs, and good practices. From this perspective, the guidelines capitalize on the results of several AdriAdapt activities and, in particular, the outcome of pilot project actions implemented by local partners. The guidelines focus on climate change adaptation and the strengthened resilience of Adriatic local and regional (sub-national) coastal communities. They refer to those that aim to encourage the most vulnerable coastal regions to continue their resilience building process, both in the Adriatic and in the more general Mediterranean area. Main target users of the guidelines are practioners working within departments or divisions of local and regional administration dealing with climate change hazards and the corresponding adaptations.

The document is structured in three parts. This first part is introductory and frames the context of the guidelines within the overall AdriAdapt project. The second part forms the core of the guidelines and illustrates the Integrated Adaptation Planning Tool, a stepwise approach to adaptation, which is described more synthetically in its online version available on the AdriAdapt platform. The stepwise methodology includes tables, figures and boxes detailing some of the knowledge aspects whilst also reflecting on the experience developed by the AdriAdapt pilot projects. The third part of the guidelines focuses on some key factors which are required in order to ensure successful local adaptation in the Adriatic region, i.e. factors which can be decisive in driving the process and that, if lacking, can seriously hinder adaptation.

2 A stepwise approach: Integrated Adaptation Planning Tool

This chapter describes the stepwise approach developed by the AdriAdapt project to guide and support local and sub-national authorities on their path towards climate change adaptation. This approach is structured into 5 steps which are rarely implemented sequentially. Indeed, these steps are mutually interrelated and overlap, often implying the parallelized implementation of several aspects. The stepwise approach is completed by stakeholder engagement; given its relevance for the whole process this activity overlaps all five steps.

Like most policy processes, climate change adaptation is also based on a progressive and adaptive approach. Monitoring and reviewing the work carried out (as foreseen by step 5) is essential to highlighting the strengths and weaknesses of the process and to assess whether the evolution of the system is as desired. Therefore, if necessary the process may be restarted and the adaptation strategy or plan reviewed. Adaptation planning is not linear but rather it requires the adoption of a circular process leading to continuous improvement.

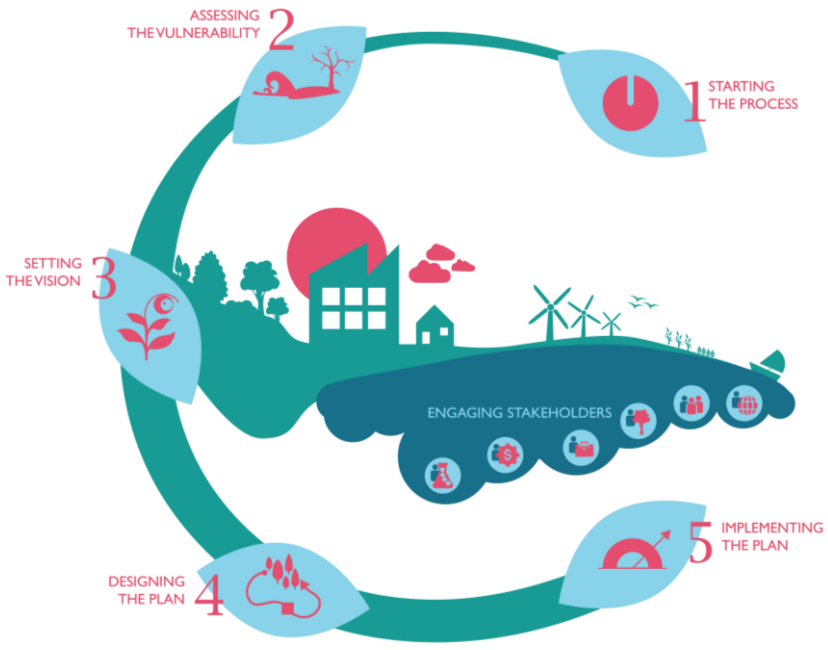


Figure 1. The AdriAdapt Integrated Adaptation Planning Tool

Integrated planning is a core ingredient of adaptation. A city or a region may initially focus on a specific adaptation measure to start with, but an overall integrated adaptation plan is essential in order to deal with the complex nature of climate change and its effects. A sector-based approach can improve adaptation for a specific issues but it may increase climate change risks in other sectors or areas. In addition, an integrated approach to adaptation can make it possible to reach maximum benefits with minimum costs, taking into account the resilience to climate change (adaptation), the reduction of the contribution of a city or a region to the problem (mitigation), and a wide range of additional benefits (e.g. protection of citizens' health, recreational opportunities, preservation of natural habitats and biodiversity, etc.). From this perspective, adaptation is expected to contribute to the overall transition of the society to sustainability.

2.1 *Step 1.* Establishing the ground for adaptation and starting the process

Adaptation is a long-term process, which does however require immediate action to be taken. Although it is often depicted as a stepwise approach, different activities are rarely implemented sequentially. Indeed, the process is often recursive and characterised by activities running in parallel. Such a long-term and complex process requires proper and timely preparation. Enough time and resources should be secured to establish the grounds for the adaptation process.

2.1.1 Obtaining high-level support and setting the governance

High-level, long-term political support for adaptation is a prerequisite for the successful design and implementation of adaptation actions. Obtaining and securing this support is essential from the outset of the process and could possibly be formalised in a policy document or by joining a structured adaptation initiative (e.g. Covenant of Mayors for Climate & Energy). Political support can be triggered by top-down and bottom-up approaches. Top-down drivers typically include legal and political requirements or recommendations issued at the national or sub-national level. The pre-existence of a climate change adaptation strategy can foster the development of an action plan, although it is not a necessary condition. Legal obligations can also arise from sector policies aiming at strengthening the climate proofing of a given sector, and therefore identifying actions to be included in an overarching adaptation plan. Bottom-up approaches typically refer to initiatives promoted by civil society or the private sectors aiming at placing climate action high in the political agenda. Top-down and bottom-up approaches are not necessarily alternatives. Actually, local administrators can collaborate with, and even initiate, civil society initiatives (e.g. campaigns for

raising awareness, communication campaigns, sharing good practices, the development of common knowledge on climate risks and opportunities, the gathering of information on available adaptation funding opportunities, etc.) so as to trigger top-down policy driven actions.

Political support must be reflected by transparent and inclusive governance for climate action. This phase is expected to identify public authorities and other private stakeholders that are to be involved. Uncertainty about climate change adaptation requires a strong knowledge base. Getting scientists and researchers on board is therefore essential. This could possibly be achieved by creating a science-policy interface supporting the entire adaptation process. Once actors are identified, their respective roles should be clarified, responding to the following questions:

- Who drafts the plan;
- Who expresses opinions and evaluates the plan;
- Who approves the plan;
- Who implements the plan;
- Who monitors the plan's implementation.

The definition of a core team (not necessarily made up of only representatives of the public authorities) within the overall governance scheme can highly improve the coordinated management of the adaptation process. Depending on the local context (its size, goals, and resources), this could require establishing a new team, strengthening an existing working group or mainstreaming adaptation to an existing department.

Box 1 – Integrated governance for climate action: the case of Emilia Romagna

In 2018 the Regional Council approved the Mitigation and Adaptation Strategy for Emilia-Romagna (Resolution n.187/2018), which constitutes a common framework for mitigation and adaptation for the regional economic sectors and local administrations. The Strategy identifies measures and actions to cope with current climate variability and future climate changes in all the valuable sectors of the region, including: inland waters and 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.).

The Regional Strategy encourages local administrations to take action by developing their own local climate change plans. Up to now, the eight provinces of the Emilia-Romagna region and the respective cities plus several other local administrations have developed their own climate adaptation plan.

The Mitigation and Adaptation Strategy has been developed and coordinated by the Territory and Environment General Direction of the Emilia-Romagna Region. Many different departments and regional institutions are involved in the regional management of the climate change issues. The Regional Environmental Protection Agency (ARPA ER) is the managing authority of the Observatory of Scenarios on Climate Change (Osservatorio Regionale degli scenari di cambiamento climatico). Another pillar of the general regional strategy is the Organizational Supervision on Climate Change (Presidio Organizzativo Cambiamento Climatico) managed by the regional 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 regional area. 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

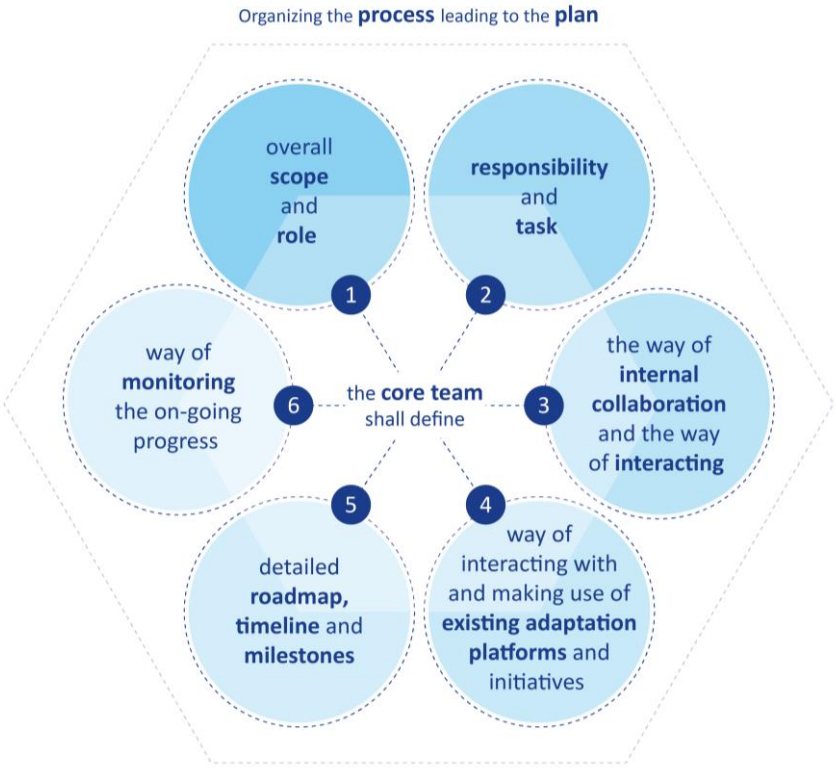
2.1.2 Organizing the process leading to the plan

Based on the received mandate, the core team should transparently define:

- the overall scope and role (e.g. steering the process, coordinating all stakeholders that are to be involved, communicating adaptation, communicating progress in the plan's creation, preparing policy and technical briefs, acting as contact point for adaptation, etc.);
- the responsibility and task of its members;
- the method for internal collaboration and the method for interacting with the other actors involved in the adaptation process (including stakeholder consultation);

- the method for interacting with and making use of existing adaptation platforms and initiatives at the national and international level;
- the detailed roadmap of activities leading to the plan creation, including timing and milestones;
- the method for monitoring the on-going progress of the plan's development and actions to put in place in the event of a deviation.

The level of human and technical resources needed for adaptation is a critical factor that must be carefully estimated, based on the process ambitions and goals. The availability of these resources depends on the characteristics of the local context (e.g. whether experts are already assigned to roles dealing with climate change or sustainability in general), and it is also heavily influenced by the availability of financial resources. This step of the process should secure the funds required for the plan design from the outset. All possible sources of funding should be explored at this stage, including national, European and international ones (see section 2.4.4 and chapter 3). Within the context of restricted budgets, resource needs can be reduced through various actions, e.g.: building upon other initiatives already in place, mainstreaming adaptation into other (planning) processes, participating in support networks and initiatives, cooperating with the private sectors, or collaborating with universities.



Box 2 - Building strategy and governance in the Union of Municipalities Valle del Savio

The Union of Municipalities Valle del Savio is made up of 5 Municipalities of which Cesena is the head. For the development of the project, it was therefore necessary to build an effective governance that primarily involved the political level, and more specifically, the Councillor of the Municipality of Cesena for the Environment, European projects and climate, and the Councillor for European projects and territorial planning of the Union. In this way, it was possible to build a process from the outset that took into account both the territorial needs linked to the mountainous part of the pilot area and the urban territory of Cesena. In order to build a strategy and an effective vision regarding adaptation, it was also considered important to involve other areas of the administration in order to primarily build a widespread culture on adaptation and its various technical and strategic declinations. Therefore, an interdisciplinary working group composed of representatives of different municipal departments was established.

2.1.3 Planning stakeholder engagement

Adaptation is a cross-cutting, cross-sectoral and multi-level process and it is important for a wide, diversified range of stakeholders. From the outset, it is important to map the actors that are to be involved and understand what their interests, responsibilities and positions regarding climate change issues are. This initial activity should lead to a well-designed stakeholder engagement process in order to gain the most from their participation. Simultaneously, a communication strategy supporting stakeholders' engagement and activities for raising awareness should be developed, identifying communication objectives, target groups, communication means, methods and timings. Stakeholder involvement is a transversal concept that is often mentioned in the various steps of the methodology and is also discussed in depth in chapter 3.

2.1.4 Identifying the strategic goals of the adaptation process

Adaptation is aimed at improving the response capacity and the resilience of a territory and its community to the present and future effects of climate change. Within this overall scope, different adaptation goals can be identified, ranging from the design of measures aiming to solve specific climate-related problems to the systematic transformation of the territory and its communities into a new resilient and sustainable system. The strategic adaptation goals must be identified and agreed upon by the stakeholders at the very beginning of the process, as they orientate the steps that follow, and particularly, the formulation of the future vision (step 3). They need to be coherent with existing overarching goals like those set by regional or national adaptation strategies and plans or policy documents at all levels (from local to international), including those addressing the wider context of sustainability (specifically the way the 2030 Sustainable Development Goals are considered and implemented at the local level; see Table 1 and Box 3). Therefore, at this stage it is important to map all parallel cross-cutting and sector processes as well as related strategic and planning documents which can contribute to, and even orientate, adaptation. This exercise is also fundamental to then enable the mainstreaming of adaptation actions into these other processes (see section 2.5.2).

Table 1.Sustainable Development Goals (2030 Agenda) and main links to climate change actions (Paris Agreement) (adapted from SEI, 2019)

	SDG - Sustainable Development Goals	Link to climate action
	End poverty in all its forms everywhere	
	End hunger, achieve food security and improved nutrition and promote sustainable agriculture	Ensure sustainable and climate smart agricultural system to limit average temperature increase
	Ensure healthy lives and promote well-being for all at all ages	
	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	
	Achieve gender equality and empower all women and girls	
	Ensure availability and sustainable management of water and sanitation for all	Increase water-use efficiency and water ecosystem management as an element of adaptation
	Ensure access to affordable, reliable, sustainable, and modern energy for all	Improve energy efficiency and increase the sharing of sustainable energy to reduce greenhouse gas emissions
	Promote sustained, inclusive, and sustainable economic growth, full and productive employment and decent work for all	
	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	Resource efficiency, promotion of the green industry, revisiting building codes and standards for a transition to carbon neutrality
	Reduce inequality within and among countries	
	Make cities and human settlements inclusive, safe, resilient and sustainable	Integrated urban planning, sustainable transport and communities for a sustainable urbanization process
	Ensure sustainable consumption and production patterns	Changing consumption habits, encourage circular economy, improve waste management are key to fighting climate change
	Take urgent action to combat climate change and its impacts	All the 5 targets are involved in climate change action (see Box 3)

	SDG - Sustainable Development Goals	Link to climate action
	Conserve and sustainably use the oceans, seas and marine resources for sustainable development	
	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	Fundamental role of ecosystems, forest management and land use in climate change mitigation and adaptation.
	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	
	Strengthen the means of implementation and revitalize the global partnership for sustainable development	Activities relate to financial resource mobilization, capacity building, research and technology cooperation can directly influence climate change actions

Box 3 – Sustainable Development Goal 13

The Sustainable Development Goal n. 13 focuses on climate action. It is structured in 5 targets:

- 13.1 Strengthen resilience and adaptive capacity to climate-related disasters;
- 13.2 Integrate climate change measures into national policies, strategies and planning;
- 13.3 Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning;
- 13.a Implement then UN Framework Convention on Climate Change;
- 13.b Promote mechanisms to raise capacity for planning and management.

The first target (13.1) is the one more closely related to operative adaptation actions, while the others are mostly focused on governance strengthening and education improvement. Three categories of indicators are proposed for monitoring target 13.1: deaths and injuries from natural disasters, national disaster risk management, local disaster risk management. Maps and graphs are available on-line and provide a worldwide overview of these indicators and related trends over the last 60 years.

Adaptation provides multiple benefits beyond those directly linked to improved resilience and reduced vulnerability to climate change. The expected additional benefits should be made clear to help to define the overall goals of the adaptation process. A non-exhaustive list of the multiple

benefits of adaptation (in particular when green and societal adaptation measures are considered) include:

- Improvement of skills and creation of job opportunities;
- Strengthened integrated approach to complex challenges;
- Improved empowerment of civil society in the co-definition of solutions to complex challenges;
- Carbon sequestration, energy saving and the contribution to climate change mitigation;
- Reduced biodiversity loss and improved habitat conservation and requalification;
- Conservation and requalification of landscape and aesthetic values;
- New opportunities for recreational activities and tourism;
- Improved human health and well-being in general;
- Increased property value;
- Water conservation and improved water quality;
- Reduction in the air pollution;
- Improved soil fertility and reduced soil erosion;
- Food security, sustainable agriculture, and forestry.

2.2 *Step 2*. Assessing climate change vulnerability and risks

Climate change will have a multitude of impacts on the Adriatic communities. Not only extreme events (e.g. heatwaves, extreme precipitation, flooding, wildfires) are becoming more intense in magnitude and frequency, but as low-onset changes (e.g. increase in temperatures, change in precipitation patterns, rises in sea-level) are also taking place, which will mostly bring unfavourable climate conditions with consequent damages and losses. Understanding the present and future vulnerabilities for climate hazards is essential to designing responses and actions aimed at strengthening society's resilience and adaptation capacity.

This step explains how to carry out an assessment of risks posed by the existing and projected climate hazards, taking into account the specific reasons for vulnerability in a given location or sector. Based on the risk and vulnerability assessment, this step highlights that a community is not isolated from its surrounding regions. Climate change hazards that do not have a direct impact on a certain territory can still have severe repercussions on areas providing essential services for that territory. Equally, climate impacts that take place in a given community can affect its surrounding areas. Thus, the vulnerability and risk assessment calls for an integrated approach and requires looking at the interfaces with neighbouring areas.

2.2.1 Identifying and assessing current and future climate hazards

No assessment can cover all climate hazards in equal detail. A selection and prioritization of those relevant for the considered local context can help to focus the assessment efforts and match the overarching adaptation goals set in step 1.

Once identified, the relevant climate hazards need to be analysed in terms of past trends, current status, and expected future changes. Information about past local extreme weather events, such as heavy precipitation causing flooding, heatwaves or wildfires may be collected and maintained by regional or national civil protection or disaster management authorities, meteorological services and environmental agencies.. Long series of climate variables can be used to reconstruct past trends and therefore analyse the variability of the climate system on a local or sub-national scale (critical information in order to correctly assess expected future changes).

Although the direction of the global climate change is unquestionable, the extent and details of the change are not completely certain, particularly locally. Climate scenarios help to describe possible future climate conditions with differences depending on different rates of increase in global greenhouse gas emissions. Such climate scenarios are developed by taking into account global conditions and can be "translated" or downscaled to the specific local or regional contexts.

The analysis of the current and future climate hazards relevant for the local context is an activity which requires a high level of scientific expertise. Usually, this is not available in the administrations in charge of adaptation. Collaboration with universities and research centres, as well as synergies with climate analysis initiatives taken at a larger scale (e.g. climate change scenarios and projections developed for a Regional or National Adaptation Strategy or Plan) can help in this regard.

Scenarios do not provide climate predictions, rather they represent possible evolutions of the climate system. Therefore, regardless of who deals with their evaluation, it is of paramount importance that climate change scenarios are provided with the additional information required to understand them and use them appropriately, i.e:

- the spatial scale of the projections, as different climate models use different spatial resolutions;
- the baseline period, from which the change is modelled (analysis of past data series if of crucial importance in this regard);
- the projection timeline, usually expressed as a period (e.g. 2081-2100 or 2020 – 2052);
- the underpinning greenhouse gases emissions or assumptions related to other variables influencing the behaviour of the climate system (e.g. land use changes);
- how the projected change is represented. Climate change projections tend to state the probability of something happening in the future or outline a range of possible outcomes in terms of future temperatures, rainfall, or rise in the sea level. This is because the future climate will be affected by the level of greenhouse gas emissions and other socio-economic developments. Climate projections are also derived from various models (mathematical representations of the climate developed on regional or global scales), which are constantly improved but still cannot predict the future with absolute certainty. Uncertainties related to the modelled projects need to be adequately communicated.

2.2.2 Selecting the priority impacts of climate change

Once the relevant climate change hazards have been identified, it is advisable to focus the vulnerability and risk assessment that follows on their major direct and indirect impacts.

Priority impacts are those expected to significantly affect the considered territory as a whole (e.g. a flood impacting settlements and affecting their residents, services and infrastructure) or several of its natural and artificial elements and human activities (e.g. agriculture, forestry, biodiversity,

buildings and infrastructure, energy systems, transport, tourism, marine habitats, fisheries and other marine activities, water management, etc.). As for the previous sub-step, the collaboration with universities and research centres, as well as the wider discussion with all stakeholders, can support the prioritization exercise.

The present and projected impacts of climate change affect the territory as a whole, but some urban sectors are likely to be more affected due to their higher vulnerability or lower capacity to adapt. The ability of a given sector to adapt to and cope with climate change impacts is a matter of wealth, technology, information, skills, infrastructure, institutions, equity, empowerment, and the ability to share risk.

Identifying vulnerable sectors is important for prioritizing and focusing the adaptation efforts. This list is context specific; possible sectors to be considered include: industry, disaster risk management, health, social well-being and climate justice, urban planning, buildings and infrastructure, energy, transport, water management, environmental protection, biodiversity, education, tourism, marine and fisheries, coastal defences, finance and insurance, information and communication technologies, etc.

For some of the sectors, a municipality might have direct competencies, for others it might be only indirectly involved. Therefore, it is advisable to engage a wider range of sectoral stakeholders in the assessments of sectoral vulnerabilities. It is important, however, to take an interdisciplinary approach, looking at cross-sectoral impacts and spill-over effects across the sectors.

The evidence from the analyses of the AdriAdapt pilot projects showed that the impacts in the study areas are partly attributable to the progressive and complex waterproofing of soils, partly to the development of complex urban systems that tend to compromise the ecological balance of the territory, creating settlement environments in which the effects of climate change can take on different and sometimes severe connotations. The analysis also suggests that the use and consumption of the territory heavily affect the thermal behaviour of the urban environment and its ability to provide for the sustainable management of rain overflows. Locally, other specific climate change related hazards and impacts take on particular importance. AdriAdapt identified the following as major climate risks for the Adriatic coastal communities:

- Urban heat islands;
- Urban flooding;
- Wildfires;
- Droughts;
- Landslides;

- Rise in the sea-level and the corresponding effect on coastal flooding and coastal erosion;
- Saltwater intrusion.

Table 2 shows the location of the impact by geographical and administrative areas.

Table 2 Geographical contextualization of the AdriAdapt pilot project's impacts

Impact	Udine	Cervia	Cesena (Union of Municipalities Valle del Savio)	Union of Municipalities Valle del Savio	Vodice	Šibenik
Urban heat islands	•	•	•		•	
Urban flooding/runoff	•	•	•		•	•
Wildfires				•		
Droughts				•		
Landslides				•		
Rise in the sea level		•				
Salt intrusion		•				

2.2.3 Assessing the vulnerability and risks to climate change

For each relevant climate change impact, vulnerability and risks should be evaluated to provide the information required in order to identify long-term adaptive response actions.

Within the context of the climate change, according to the IPCC, vulnerability can be defined as the degree to which a territory, its community and activities are unable to cope with the adverse effects of the climate change, including climate variability and extremes. The assessment of the vulnerability of a system therefore requires the study of its exposure and sensitivity to a given climate change hazard and of its already acquired adaptation capacity. The combined assessment of the vulnerability, the magnitude of the climate hazard and the value of the most exposed receptors provides an estimation of the climate risk associated with the considered hazards and territory. The risk assessment should therefore consider aspects related to:

- the climate hazard (current and projected climate conditions);
- the characteristics of the geographic location (e.g. elevation, degree of soil permeability, land coverage, etc.);
- the affected sectors (e.g. human health, infrastructure, transport, energy, water management), affected assets and related values (e.g. critical infrastructure such as ports, roads, airports, schools, hospitals or highly vulnerable ecosystems and habitats, etc.) and most vulnerable groups (e.g. the elderly, homeless, students and children and those at risk of poverty, etc.).

Vulnerability assessments emphasize the evaluation of the exposure, the sensitivity and the adaptive capacity of a given system, asset or community and populations. Risk assessment focuses primarily on the projected changes in climatic conditions, the inventory of potentially impacted assets, the likelihood of the impact happening and the resulting consequences.

A great variety of methods are available to assess vulnerability and risks to the climate change. These can be roughly categorized as top-down and bottom-up approaches. Top-down assessments are usually based on data and use mapping and other quantitative tools to assess socio-economic and environmental data. For example, they can provide the damage estimations that are anticipated for the entire territory or parts of it. Bottom-up assessments generally rely on local knowledge and are qualitative in nature. They often involve local stakeholders. A combination of the two approaches is recommended, whenever possible.

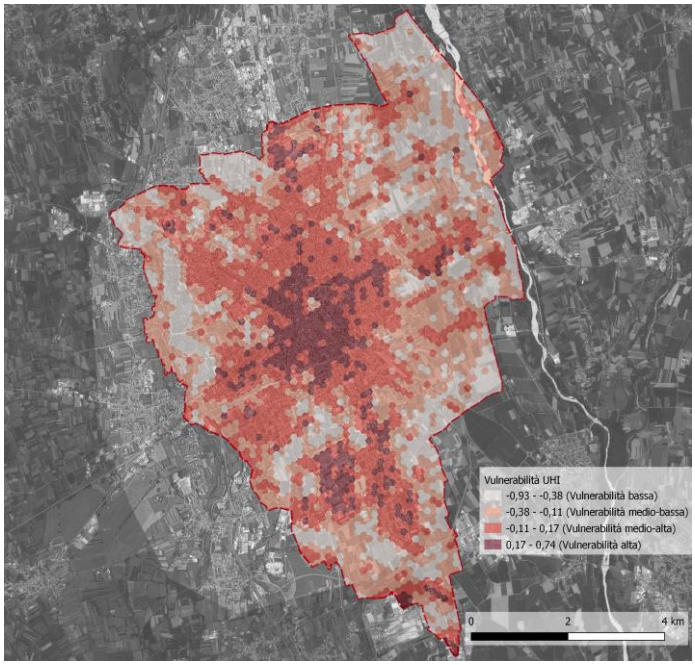
Some examples of the general principles of the AdriAdapt territorial vulnerability assessment techniques are shown in the boxes below.

Box 4 –The vulnerability assessment for an urban heat island in the municipality of Udine

One of the results of a vulnerability assessment for the Municipality of Udine is shown in the figure below. An urban heat island impact assessment has been performed by processing multispectral images in

order to assess the extent and intensity of the urban heat island (Stewaed & Oke 2014). The impact analysis by UHI has used five different interlinked work phases:

- the identification of the descriptors (variables) useful to spatially recognize the consequences of CC in terms of heat waves;
- the selection of multispectral satellite images with a parallel assessment of temperatures during periods of intense heat;
- the elaboration and analysis of the satellite scenes, considering the incidence of vegetation and thermal parameters able to describe the structure of the morphological relations of the territory;
- the spatial and alphanumeric extraction of information from municipal administrations (basic cartographic themes and general thematic cartography);
- the vulnerability assessment of morphological structures, urbanized environments and natural systems.



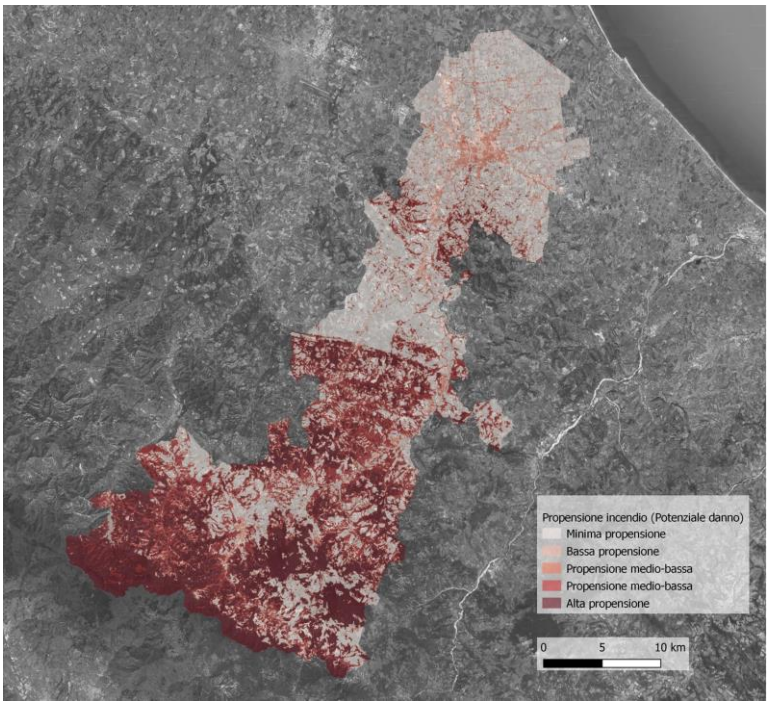
This process can spatially contextualize the vulnerability towards heat waves in relation to different types of aggregation (both natural and anthropic): building characteristics, urban green areas, wetlands, rural spaces etc..

The choice of a specific risk or vulnerability assessment methodology should be guided by:

- the human and financial resources at hand;
- data availability;
- existing knowledge;
- the required and possible level of stakeholder involvement;
- the preferred type of outputs for further adaptation action planning.

Box 5 – Unione Valle Savio: simulation of potential damage for areas with high fire sensitivity

Drought and propensity to fire in the territory depend on several factors, including: tree typology, morphological conditions, climate conditions, and climate change and ecosystem complexity. The analysis of these impacts may rely on a vulnerability assessment based on the study of satellite images and, in particular, the elaboration of the Vegetation Health Index - VHI (Bento et al. 2018; Cunha et al. 2019; Tripathi et al. 2013). In the investigation of the phenomenon of drought and the propensity to fire of environmental and territorial contexts, Unione Valle del Savio has used 3 different interlinked work phases:



1. the definition of a synthetic index capable of restoring moderate, severe or extreme water and thermal stress (VHI) conditions;
2. the monitoring of environmental and ecosystem responses influenced by intense and prolonged extreme events through the elaboration of a drought index conducted on different time scales;
3. the definition of 'potential damage' capable of recognising a spatial relationship between the phenomenon of drought, forest typology and morphologies.

The spatialization of the VHI can also help to identify different gradients of dry stress that can express the potential propensity of a forest to be ruined by fire.

The cartographic representation of the damage makes it possible to identify the urban areas most exposed to a potential fire hazard and gives a comprehensive information framework on vegetative stress.

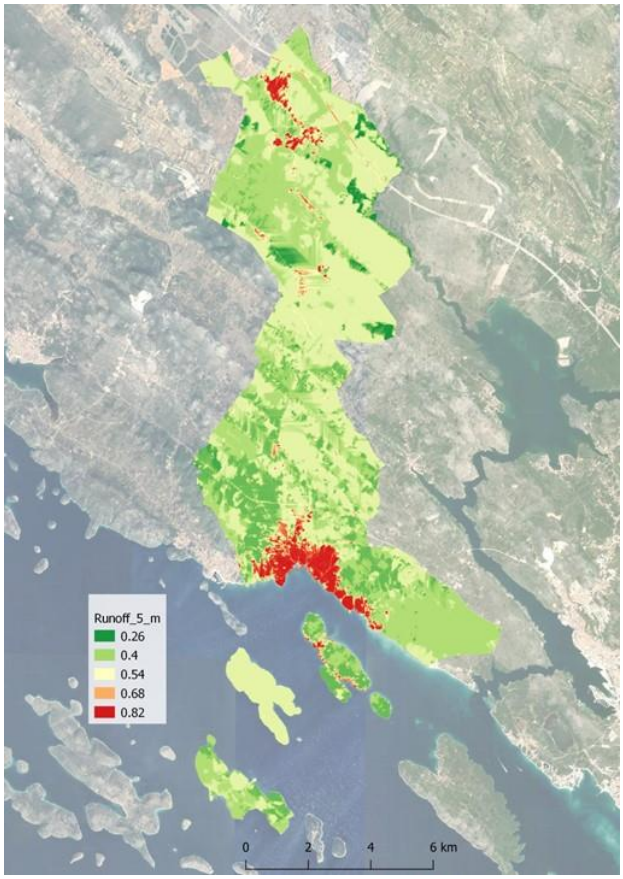
Regardless of the method applied, the assessment should take the following elements into consideration as a minimum:

- Trends of various climate variables (e.g. average and extreme temperature, number of days with extreme heat, intensive rainfall events, snow cover), ideally based on a range of different climate scenarios;
- Expected (direct and indirect) impacts (threats and opportunities) by identifying the most relevant hazards as well as the areas of a city or a rural community that are at most risk

(e.g. high total population, high rate of vulnerable populations, high concentration of economic activities and economic values, high concentration of vulnerable ecosystems and habitats);

- Timescale, such as short, medium (e.g. 2050s) or long-term (e.g. end of the century);
- An indication on the level of confidence (e.g. high, medium, low) for each of the assessed impacts, with a view to facilitating the decision-making process given the degree of uncertainty attached to the results.

Box 6 – The Vodice vulnerability assessment



In recent years, the town of Vodice has experienced frequent and intense urban flooding. This problem, especially in the coastal zones, has been recognized as the most impactful climate hazard in Vodice and it has top priority in the adaptation process.

The estimation of the levels of the hydraulic performances of a territory can be entrusted to appropriate models of simulation of the dynamics ='inflows-outflows' (Maragno et al. 2020). These models make elaborating a Vulnerability Hydraulic Index possible, based on a logic association between land uses (in terms of rainwater absorption capacity) and soil morphologies (slopes, depressions, elevations of soil and hollows).

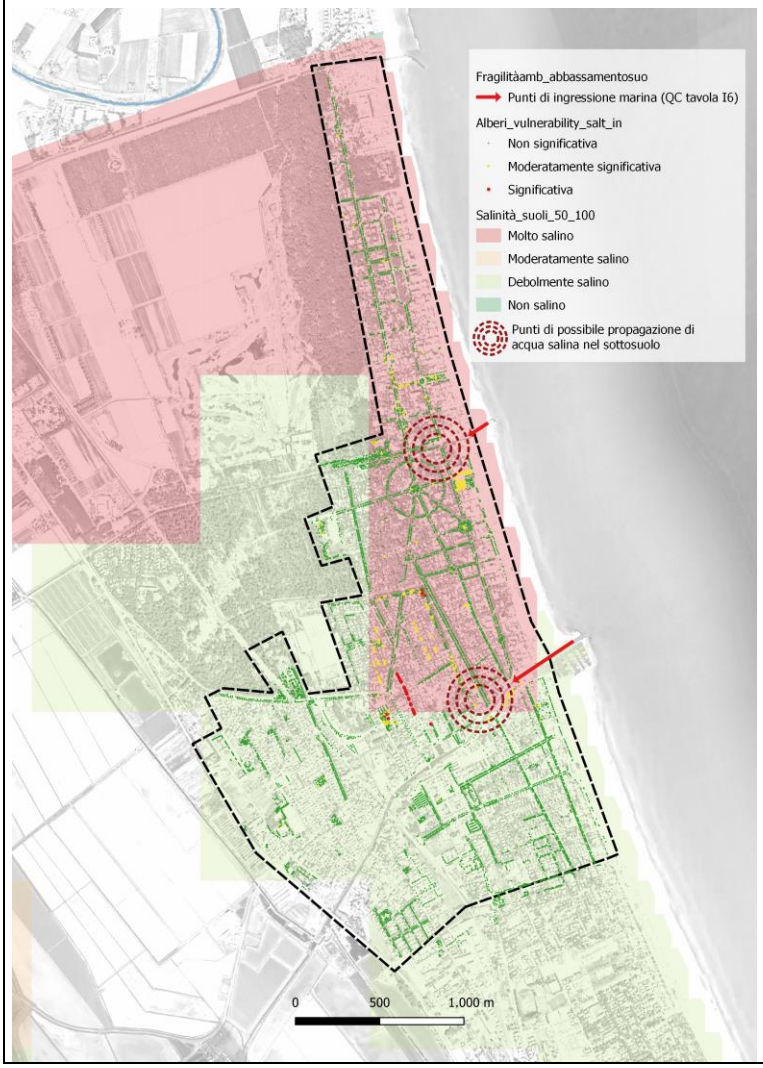
The recognition of spatial responses at different gradients of hydraulic criticality involve three phases:

- The use of spatial land cover data to construct a geographical surface database;
- The simulations of the hydrodynamic response of soils based on the study of the spatial correlation among soil morphology, artificial (sensitivity) and natural (adaptive capacity) morphological factors;
- surface outflow model results weighted on the estimation of the specific saturation volume of soils.

This enables us to return a cartographic index able to fix the thresholds of the hydraulic criticality calculated and weighted on the morphology of the territory, and on the hydraulic response of the land uses in terms of the capacity of absorption of meteoric waters.

Box 7 – Salt intrusion vulnerability on the Cervia shore

Starting from the current and future climate hazard identification and assessment carried out by the SECAP, within the framework of the Covenant of Mayors, one of the major climate hazards for Cervia territory is considered the saltwater intrusion.



The pilot project analysed vulnerability to salt intrusion though the spatial analysis of plant resilience to soil salinity. The vulnerability analysis involved three phases:

- the identification of the first altimetric references (or critical altitudes) that geographically localize the areas heavily affected by the event according to its intensity;
- the elaboration of the digital terrain model to identify the areas more vulnerable to marine flooding scenarios;
- the management of dune areas erosion considering the coastal regression.

This kind of evaluation can therefore exploit (in a completely experimental way) the qualitative behaviour of resistance of the arboreal species where there is saline content in the subsoil, which is partly attributable to the effect of salt intrusion'. The survey can be used as a basis for more detailed studies on the quality of the arboreal heritage and its level of resilience with a view to adapting to climate change.

2.2.4 Transferring the results to the visioning and planning steps

Identifying the main adaptation issues (e.g. which sector or which climate impact should be addressed first) is based on the analysis of the immediacy and severity of impacts, as well as on the opportunities to leverage existing disaster risk reduction strategies or the current resource and infrastructure management arrangements and plans. There are various methods available for prioritizing the main adaptation concerns. In general, the main issues to be considered in prioritizing which climate impacts to address include:

- already occurring climate-related impacts, with particular concern for those expected to become more severe in the future;
- the likelihood and severity of impacts over the near, medium and long term;
- whether the management of a climate risk is within the mandate of the municipality or the engaged stakeholders, and thus can be addressed through existing administrative arrangements;
- serious risks that might affect the territory irreversibly (e.g. the rise in the sea level);
- climate risks that can be approached with existing mechanisms that, despite not being labelled as an adaptation process, can be quickly aligned to climate action needs (e.g. spatial and urban planning, the implementation of the EU Floods Directive, biodiversity and habitat preservation with positive effects on ecosystem services, urban requalification using nature-based solutions etc). These mechanisms can provide useful entry points for actions also relating to climate change adaption.

It is of great importance that the results of the analysis on climate change risks and vulnerability are smoothly transferred to the visioning (step 3) and the planning phases (step 4) of the adaptation process. In this regard, the data and information must be condensed in order to be promptly and suitably used for the identification, design and implementation of adaptation measures. This sub-step implies the adoption of a simple approach for the communication of the step 2 results to a wide audience, whilst also highlighting the related assumptions and uncertainty.

2.3 *Step 3*. Setting the vision for adaptation

Climate change adaptation is a **long-term process** and requires the integration of different governance levels and sectors, as well as other planning and management processes. Adaptation to climate change has to be part of an **overarching and wider vision for the territory and its community**, beyond the pure scope of the adaptation itself.

The term "vision" refers to a desirable state in the future. Visioning is a process of creating a vision in a structured and reproducible way, as a possible answer to scenarios and forecasting (possible future states).

The **vision statement** defines the broad priorities. The objectives that arise from the vision statement can be complex, consisting of high-level goals and groups of sub-goals. Some objectives might be predetermined in existing sub-national, national and international plans and policies, such as global and European directives and programmes or regional and national plans and strategies. A clear statement for a climate-proof vision is needed since the adaptation to climate change is a high-level global objective. The vision is established in this step of the methodology, and it is carried over to the plans, policies and actions (both local and national).

The objective of this step is to engage and involve stakeholders in the **shared vision for the plan area**. The vision sets the **direction** for plans and their implementation and should be complimented by a set of goals. The key tasks for setting the vision are:

1. stakeholder mapping;
2. the identification of the prospects for reaching an agreement among stakeholders;
3. establishing the direction towards creating the vision.

Establishing the direction or preparing the vision defines the **desired future state of the territory** in terms of its fundamental strategic pillars. The vision describes the future condition of the area, in a **long-term 10-to-20 year plan**, and it should be clear, compelling and aligned with the existing policies and the aspirations of communities and stakeholders. The vision and the objectives are derived from the **agreed priorities**, which are based on shared and joint principles, such as resiliency, productivity, diversity (social, cultural, or ecological), health and safety.

The objectives of the vision describe the **governance, environmental and socio-economic priorities** and how the implementation of the vision can be measured and achieved. **The objectives are the measure of the vision** and for this reason they should be measurable, realistic and time targeted.

2.3.1 Contributing to the sustainable development of the society

A climate change adaptation strategy or plan is primarily expected to **increase the resilience and reduce the vulnerability** of a given territory or community to climate change impacts. However, this objective must be pursued ensuring the **long-term sustainable development of the society**. Therefore, it must be ensured that choices made for the sake of adaptation will not compromise aspects of sustainability (e.g. environment, social and economic well-being and intergenerational equity). At the same time, investments made for adapting a community and making it more resilient should **maximise synergies and co-benefits** (e.g. increasing or protecting biodiversity and habitat conservation, reducing air pollution, improving health conditions, creating new job opportunities, improving the quality of life).

The sustainable development of society means **creating better perspectives** for inhabitants and communities, and improving several aspects of the socioeconomic territorial framework:

- investing in self-sufficiency policies in terms of resources (energy, water, waste, sewage, food), building more renewable energy production, and improving sewage and water management systems;
- ensuring education, healthcare and sport;

- ensuring job stability and opportunities;
- improving transport and connectivity within the urban areas and between urban and rural areas, especially in a very differentiated context such as that of the Adriatic region;
- reducing waste and enhancing circular economies, by recycling and reusing waste;
- improving the efficiency of the livestock system and reducing the importation of food products by creating a network of agricultural cooperatives.

Sustainable development faces climate change in all these aspects and the vision must respond to these challenges. In order to achieve this, the adaptation vision should foster a **long-term transformative approach**, radically changing the conditions which cause major vulnerabilities. For example, for coastal communities, the adoption of a transformative approach requires the early exploration of long-term effects of the rise in the sea level and the change in the intensity and frequency of extreme storm surges, making time for solutions which might require a longer

implementation term. Such solutions should consider to what extent the actual protection of coastal sites is feasible or becomes too expensive, suggesting a shift towards a managed retreat of infrastructures and human activities more prone to a rise in sea level and climate change impacts.

At this stage of step 3, **links between adaptation and the sustainable development goals** in general should be clarified and brought to the attention of those involved in the strategy or plan elaboration and implementation. **Links to mitigation objectives and measures** aiming to reduce greenhouse gas emissions should be also highlighted. All of the vision's priorities should be connected to sustainable development and to other existing strategy goals to underline their **coherency**.

Box 8 –Cervia's approach in sustainable development

As part of the AdriAdapt project, Cervia choose to implement one of the SECAP's (Sustainable Energy and Climate Action Plan) actions, the ADAPT08, focused on adaptation and concerning the protection of the coast. The goals carried out in the pilot project are focused on and contribute to the sustainable development of the society: the protection of the coast ensures safety for the people and their economic activities. Furthermore, attention to risks, soil protection and raising urban quality are the main goals of the municipality's urban planning instruments (General Urban Plan - PUG, SQUEA and SECAP). All these goals come from the regional law pursuing the objectives of zero soil consumption, urban regeneration and seismic retrofit, the sustainability of the intervention and accretion of NBS to enlarge ecosystem services in the cities.

The whole set of instrument and planning tools, from a local to a regional scale, are coherent and synergic in trying to achieve the same goal, i.e building a resilient territory through sustainably developing society

2.3.2 The moments of the vision creation process

A vision can be defined as an optimal desired future, illustrating what we would like to achieve with the management of a territory and its community in the medium or long-term. A vision forces to think in a long-term perspective. If a broader and long-term sustainable vision already exists, the adaptation process is driven by the existing vision. It must be ensured that the adaptation goals do not contrast with the broader vision. This step of the process can formulate recommendations to improve coherence among the different processes and ensure that the vision can be achieved under changing climate conditions (climate-proofed vision). In many cases a vision is not available, and it needs to be developed as part of the adaptation process. The initial

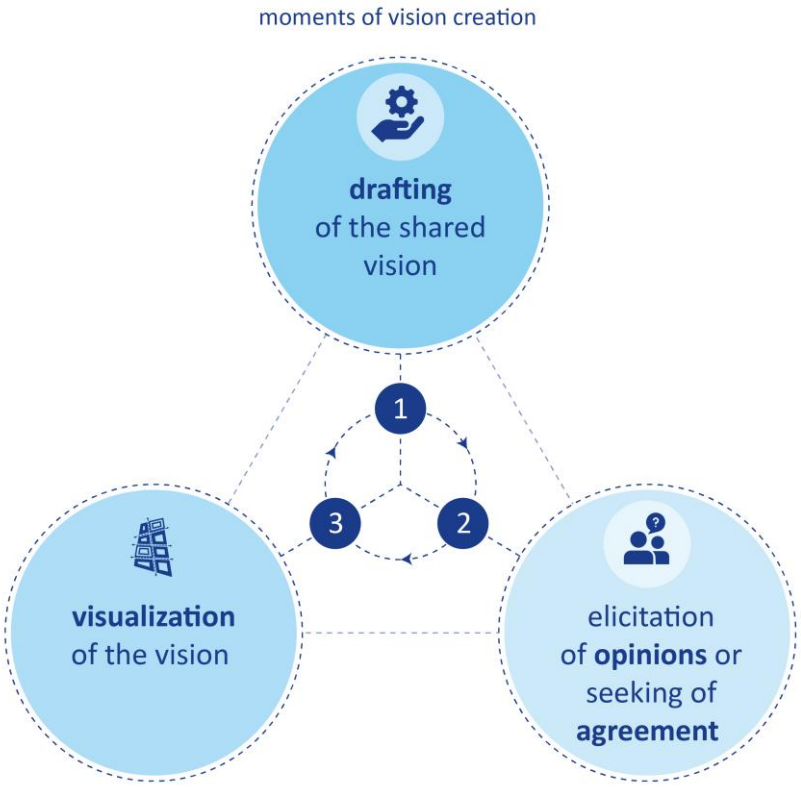
phase of the process leading to the vision is expected to **collect and systematise information** on relevant existing plans and policies and on those under development establishing the direction for the future. As seen in the previous step, all the assessments and analyses are important for the elaboration of a **general knowledge framework**. The scientific-technical base provides public administrations to work on objective data in order to create a territorial vision.

The creation of the vision consists of **three moments**: the first involves **drafting** the complete vision from individual elements and priorities; the second involves eliciting **opinions** or **seeking agreement** from participants (to ensure the correct reflection of the community's ideas and values); the third involves the **visualization of the vision** (spatial representation, mapping and photo/graphic representation). This last step is important for presenting and explaining the vision and it helps to communicate the feasibility of the vision.

During the **first moment**, a workshop is the suitable tool for drafting the vision starting by collecting statements, values, and priorities. This brings us to the discussion of shared values, the review of other city/territory examples, the drafting of the final vision. As presented in the next chapter, a collaborative/participatory process is a key-factor to building a shared and desirable future.

The **second moment** is necessary to build an agreement on a shared vision and to understand if the elements of the vision are representative of community and territory needs and aspirations. The agreement can be reached indirectly, through in-person surveys or online surveys, or directly through conferences or collaborations. Face-to-face interactions create legitimacy among the stakeholders and facilitates the implementation of efforts.

The **third moment** helps to visually represent the vision and its elements. Maps are very useful tools (with GIS technology or other graphic and photorealistic visualizations) for spatializing the vision and its relation to a territory and its communities/activities. Pictures and scenario images can also be used to figure out how the vision (territories, landscapes, cities, neighbourhoods) would look. The visualization of the vision is not only a matter of communication, but it also allows us to perceive spatial links and interferences, both physical and immaterial.



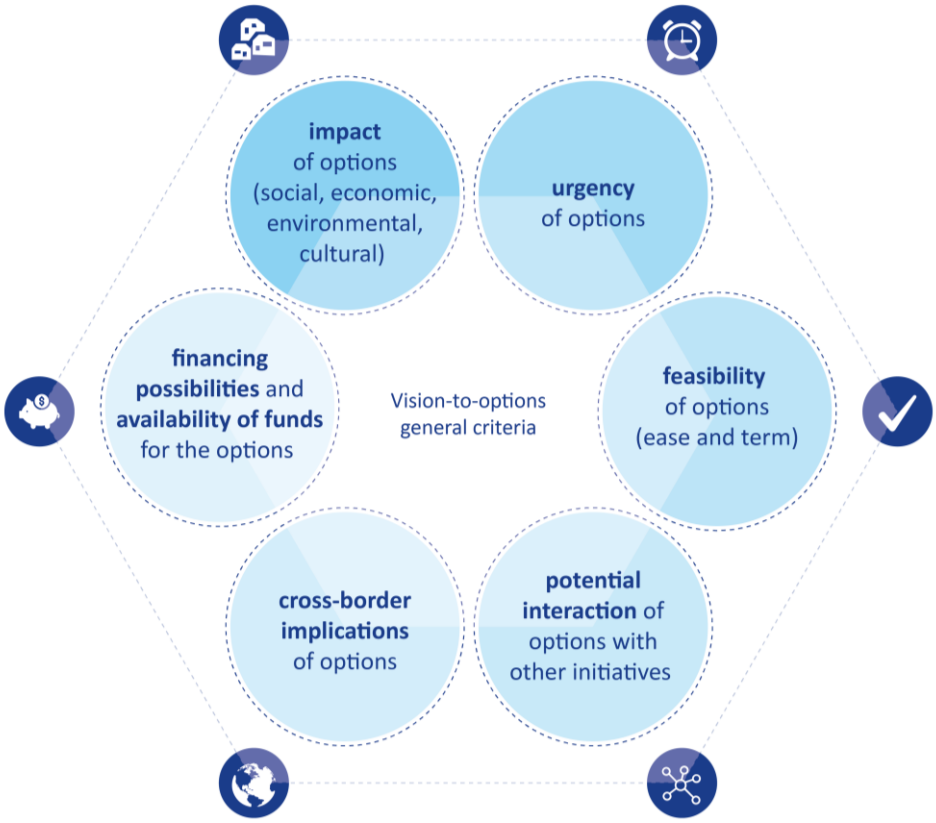
In the next steps (especially in *Step 4 - Assessing options and designing the adaptation plan*) the vision is developed through the assessment of adaptation options and plans. As part of the adaptation process to climate change, the priority setting phase assesses the main challenges and helps to identify the best options. Adaptation options follow a programme of priority actions based on local information regarding vulnerability and anticipated impacts. The vision, in general, and specifically the identification of priority options should be considered, assessed, and discussed with all stakeholders and implemented in a coordinated and integrated approach, using decision support tools, such as multi-criteria analysis, multi-objective analysis and the consultation of expert groups.

The transition from the vision to options should be done using the following general criteria that can be applied to select the adaptation priority options:

- the assessment of **the impact of options** on the following dimensions:

1. **social** (for example, social equity and cohesion);
2. **economic** (for example, a full cost-benefit analysis of options);
3. **environmental** (for example, environmental impact assessment, water quality, soil and biodiversity, positive or negative contributions to greenhouse gas emissions);
4. **cultural and heritage** (for example, building heritage impact assessment, cultural dimension impact assessment)

- the assessment of **the urgency** of facing the potential risks or existing risks. Adaptation options for imminent risks are a priority and must be implemented in the short term.
- the **feasibility** of the options, in terms of ease and speed of implementation.
- the potential **interaction of options with other initiatives** (already undertaken at local or regional levels), that may contribute to reducing vulnerability. Priority should be given to options that show synergy with other existing initiatives.
- the assessment of **cross-border implications**: in some cases, options may have negative consequences beyond regional borders. These options should be avoided.
- the **financing possibilities and availability of funds** to cover the implementation costs: existing funding, co-financing by the central government or community funding, private investment.



2.3.3 Co-creating the vision

The strategies of adaptation to sub-national level must be developed with a **participatory approach** in all their phases, from the drafting to the implementation, and in the construction of a shared vision for the territory and the community. Effective participation has **several advantages**: it helps to better identify the main impacts, vulnerabilities, and consequences at a local level; it enables scientific information on climate change to be better disseminated; it facilitates the integration of adaptation issues into sectoral policies and governance actions; it usually implies a greater understanding and acceptance of the adaptation strategy.

From the earliest stages, it is essential to **identify the stakeholders** to be involved in the process and define the tools to be used. A well-structured participation process must be carefully planned, and the most appropriate forms of participation must be chosen (such as round tables, seminars,

workshops, or presentations). **The workshops** are a particularly fruitful way of organising consultations and gathering the views and suggestions of individuals and groups outside the restricted group that is drafting the document. **Joint events** should be organised, involving government officials and researchers, in which communication between them should be promoted and improved.

Box 9 Setting the vision in Udine adaptation plan

The evaluation of a process for a community vision on the issue of climate adaptation must necessarily involve the stakeholders and the network with those who work and operate in the environmental and territorial planning fields. In Udine experience, was therefore important to involve, in addition to local administrations, environmental associations, research bodies and all those subjects that allow the creation of a more widespread network of skills. The collective vision must be carried out by teamwork between all the subjects operating in a territory with the aim of being inspiring and, if possible, replicable for other territories in such a way that a large-scale benefit can be obtained.

To develop an effective strategy, it is important that administrations have a clear understanding of the goal to be achieved and how to improve the area from a climate point of view. This requires a long-term vision that must go beyond the current political mandate so that future administrations can continue what has been started by ensuring the continuity of the technical part. Among the elements that have been fundamental in the Udine plan so we find a solid motivation and involvement of administrations and technical offices, as well as the creation of a network of collaborations between administrations, stakeholders and external entities.

Various **visioning approaches** (predictive, normative, exploratory, etc.) and tools are available ranging from those strongly relying on data and quantitative assessment (e.g. trend analysis and forecasting) to those of a more qualitative nature (e.g. scenario building, strategic roadmap). Regardless of the method used, the elaboration of a vision strongly relies on wide stakeholder involvement. Indeed, a vision is the result of a **co-creation process**. Considering the wide scope of the vision, stakeholder engagement cannot be confined to those strictly involved in the adaptation process but rather should be extended to a **wider arena** representing all the subjects dealing with planning and management. The robustness of a vision is increased by comparing different alternatives, assessing related trade-offs and benefits, and converging on the agreed option. The results of the co-creation process are the description of the **desired sustainable future (the vision)** as well as the identification of its geographic scope, timeframe, expected benefits and co-benefits and expected implications for the surrounding areas. To better inform the successive step of the process, it is recommended that the vision be translated into clear specific objectives for adaptation, in line with the strategic goals set in step 1.

People support what they help to create. Instead of selling an already-conceived-ready-to-implement project, co-creating a vision with stakeholders (that hold an interest) is very important in its ultimate success. A co-created vision is, **what do WE want to create?** The WE is central to co-creation. Combining technical and administrative priorities with the perceptions gathered from the stakeholders is important for rounding off the process.

2.4 *Step 4*. Assessing options and designing the adaptation plan

As already mentioned, climate change adaptation is a circular process, which often implies parallel activities and frequent interactions among the different steps. This is particularly true and relevant for the design of the adaptation plan, which strongly relies on science and stakeholder-based evidence developed in the previously described steps. Step 4 focuses on the identification of the portfolio of adaptation options which can be put in place to cope with the priority impacts of climate change identified in step 2, as well as on how and when these options should be implemented and by whom. **Adaptation options are concrete measures** aiming to reduce the vulnerability to major climate challenges and therefore strengthen the adaptation capacity of a given territory and community. More specifically adaption options can:

- Accept the impacts resulting from climate-related risks and act consequently (e.g. managing the retreat from the rise in the sea level or river flood-prone areas);
- Offset losses by sharing or spreading risks (e.g. through insurance schemes focused on climate hazards);
- Avoid or reduce exposure to climate risks (e.g. building new flood defences or changing location or activity).

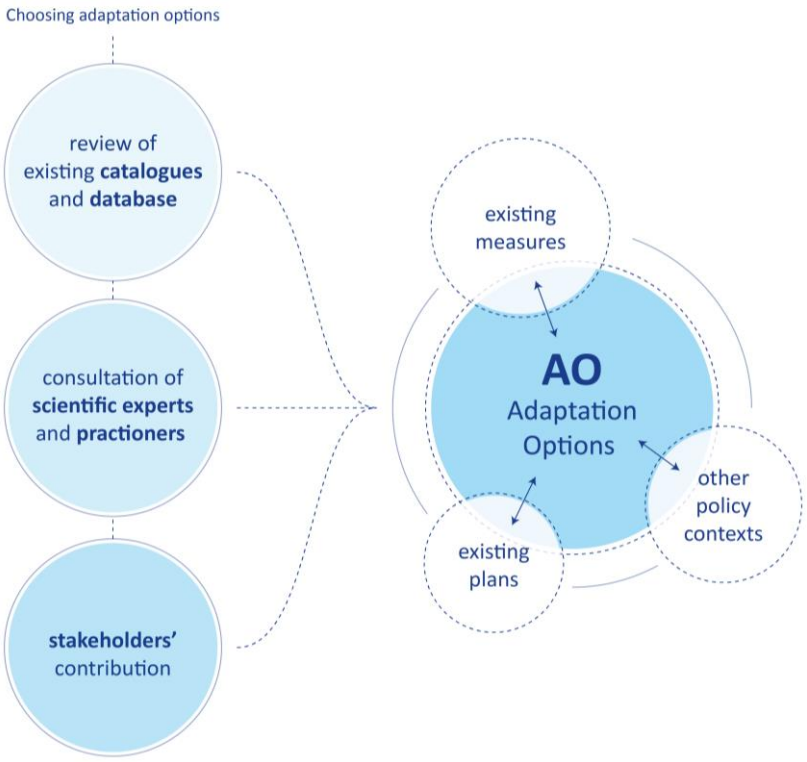
Adaptation options can also exploit new opportunities arising from the changed climate conditions and favour the transformative change of society towards more sustainable systems. They can range from measures aiming to build adaptive capacity and to establish governance and supportive mechanisms, to measures implemented on the ground to deal with cross-sector or sector-specific vulnerabilities.

It is often argued that adaptation is one side of the same coin of mitigation. Mitigation aims to limit global warming and related effects within agreed thresholds through actions reducing greenhouse gas emissions and enhancing the sinks that can accumulate and store these gases (so called “carbon sequestration”). Mitigation is also essential to limiting the financial, scientific and technological investment in adaptation, which of course is not unlimited. More generally speaking, it is important to consider that adaptation is a component of a wider approach looking for sustainability. Therefore, when designing an adaptation plan and identifying adaptation options, a wider context should be kept in mind, aiming at maximising the joint benefits of adaptation (including mitigating ones) and avoiding unsustainable solutions (maladaptation) which can increase the overall vulnerability to climate change and other human pressures of a considered system. Maladaptation can occur in different ways: reinforcing existing vulnerabilities, redistributing existing vulnerabilities thus providing benefits only for some of the society segments

or sectors, and creating new vulnerabilities. All these elements should be carefully assessed within the development of a plan and the identification of adaptation options.

2.4.1 Choosing the adaptation options

Developing a set of adaptation options can help in systematizing possible measures to reduce the vulnerability and increase the resilience of a given territory and community. Adaptation options can be selected from the review of existing catalogues and database, through the consultation of scientific experts and practitioners and through stakeholder contributions. From this perspective, the exchange of good practices and specific examples of implemented measures can help in developing a site-specific portfolio of adaptation options. Research and innovation can greatly contribute to developing new adaptation measures. However, it is also important to acknowledge that adaptation often implies strengthening and scaling up already existing measures, including those implemented within the context of other policies, thus requiring the adaptation to fit into existing norms and plans.



In recent years, several catalogues of adaptation options have been developed and can be used as inspiration for the construction of the local portfolio of measures. Climate-ADAPT was launched in 2012 with the intention of helping a wide range of users at the EU level, providing access and share data and information in support of better-informed decision-making on adaptation. The EU Adaptation Strategy recognises Climate-ADAPT as a key element for improving decision-making and emphasised its potential to act as the 'one-stop shop' for adaptation information in Europe. This platform contains a catalogue of adaptation options which can be browsed and selected according to different criteria, including addressed climate change impacts (droughts, extreme temperatures, flooding, rises in the sea level, storms, water scarcity) and approached sectors (agriculture, biodiversity, buildings, coastal areas, disaster risk reduction, ecosystem-based approaches, energy, financial, forestry, health, transport, urban and water management) regarding adaptation. The same platform also contains a wide collection of case studies, i.e. examples of the implementation of adaptation measures around Europe.

Table 3 illustrates some of the major international and European platforms which provide catalogues or databases of adaptation options and/or good practices (often called case studies) to their users.

Table 3. Major international and European platforms providing catalogues and databases with adaptation options and case studies.

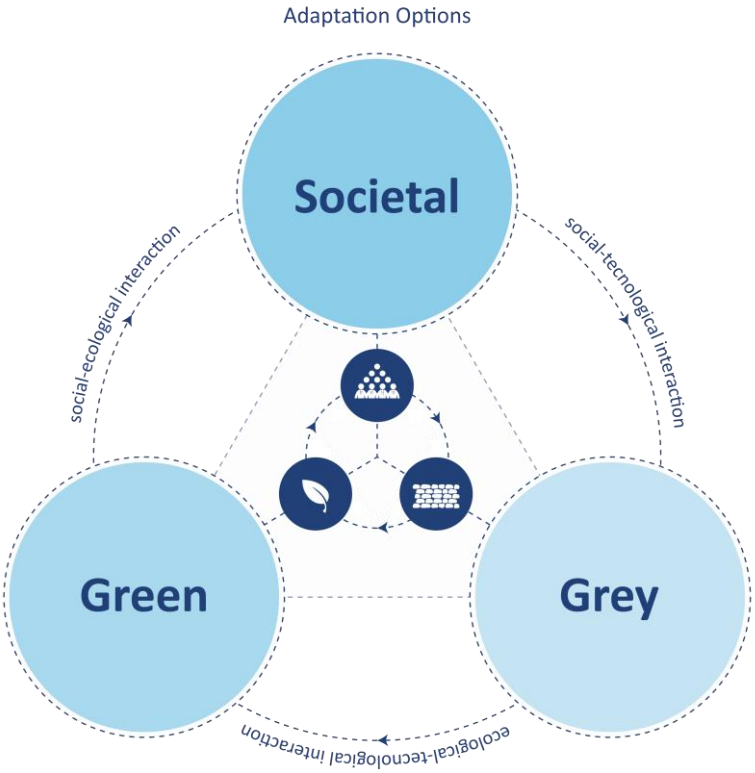
Platform	Relevant contents
OPPLA EU Repository of Nature Based Solutions (NBS). It is an open platform focused on NBS aimed at facilitating knowledge sharing.	OPPLA contains more than 300 worldwide case studies providing examples on NBS. Case studies cover several sectors, such as: water management, forestry, agriculture, urban areas, coastal areas, etc. Each case study is described in terms of objectives, implemented actions, potential impact and benefits, transferability of the results, lessons learned, financing and contacts.
weADAP Global collaborative platform facilitating learning and exchange on climate change adaptation and DRR among practitioners, researchers, and policymakers.	weADAPT provides the user with a map viewer for the selection and visualization of adaptation case studies around the world. Case studies (and all weADAPT database items) are organised around key themes, including NBS, synergies between adaptation and mitigation, transational climate impacts, community-based adaptation, gender and social equality, etc.
ThinkNature Multi-stakeholder communication platform supporting the promotion of NBS at a local, regional, EU and international level	The platform hosts the "Nature Based Solutions Knowledge Hub". Within the repository the user can find adaptation examples of: (i) NBS project sites and platforms; (ii) worldwide case studies which can be explored through a dedicated map, (iii) resources, a knowledge repository for online resources on NBS state-of-the-art practise.
NATURVATION 4-year project aimed at developing knowledge on NBS and on the way these measures can respond to urban sustainability challenges	NATURVATION has created the Urban Nature Atlas. This is a NBS database specifically targeted to cities. It includes 1000 examples of NBS interventions from across 100 European cities. Several of these examples deal with climate change adaptation through various urban settings (external building greens, grey infrastructures combined with green features, green indoor areas, green areas for water management, etc.)
UNFCCC Adaptation Knowledge Portal Online portal of the UNFCCC Knowledge-to-Action Hub for Climate Adaptation and Resilience, providing free and open access to adaptation knowledge resources	The Adaptation Knowledge Portal (AKP) provides access to a database of adaptation case studies, methods and tools, publications and technical documents, methodologies, and knowledge resources. Information in the database can be filtered by geographical area, adaptation element, adaptation sector and climate hazard.

Platform	Relevant contents
RESIN Climate resilient cities and Infrastructures Practice-based research project investigating climate resilience in European cities	RESIN developed Adaptation Options Library, a database of key adaptation measures in urban areas, addressing different climate risks (heatwaves; pluvial, fluvial and coastal floods; drought; etc.). The performance of these adaptation measures has been evaluated through an extensive review of scientific literature.
Urban green – Blue grids for resilient cities Website focused on key urban challenges, including climate change mitigation and adaptation, urban biodiversity, air quality improvement, etc.	The website proposes a series of more than two hundred sustainable and resilient urban measures and examples of their real implementations, mainly from the Netherlands. The measures are related to several themes: water, heat, biodiversity, urban agriculture, air quality, energy, and social and economic importance.
Nature Water Retention Measures (NWRM) Platform focused on green measures aimed at preserving or restoring natural water retention and conservation processes	The NWRM platform gathers information at EU level on NBS applied to the water sector. NWRM are multi-functional measures aiming to protect and manage water resources and address water-related challenges using natural means and processes. The platform contains a catalogue of 53 measures addressing four sectors (agriculture, nature, urban, forestry) and a large number of case studies mainly across Europe.
Nature Based Solutions Initiative Interdisciplinary programme of research, policy advice and education, aimed at enhancing understanding the potential of NBS to address multiple global challenges and support their implementation	The platform of the Nature Based Solutions Initiative includes a several case studies about how working with nature can help in better adapting to climate change, as well as improving ecosystem health and carbon storing. Case studies are organised around major categories: nature-based solutions for economic recovery, coastal nature-based solutions, lowland nature-based solutions, montane nature-based solutions, nature-based agriculture, blue and green infrastructure in urban environments.
PANORAMA Partnership initiative to document and promote examples of inspiring, replicable solutions across a range of conservation and sustainable development topics	PANORAMA developed a platform providing examples of ecosystem-based adaptation solutions, featuring 160 solutions worldwide, including dozen of examples in Europe. A subset of 134 solutions are specifically focused on climate change adaptation.
BASE “Bottom-up Climate Adaptation Strategies towards a Sustainable Europe” is a project aiming to support bottom-up actions for sustainable climate change adaptation in Europe	The project website includes case studies map with concrete examples of adaptation actions across Europe. The case studies are not only aimed at demonstrating how to approach sector specific issues of adaptation but also to examine interactions across multiple policy levels.

Platform	Relevant contents
EU Covenant of Mayors for climate and energy Initiative bringing together thousands of local governments voluntarily committed to implementing EU climate and energy objectives.	Within this initiative, as part of their progress, all Covenant signatories share their key actions as a source of inspiration for others. A Good Practices database lists more than 800 adaptation actions implemented in EU countries.

AdriAdapt has developed its own catalogue of adaptation options, included on the AdriAdapt platform. These adaptation options are specifically targeted to the Adriatic context, thus linking to the most relevant climate hazards and impacts (droughts, extreme temperatures and heatwaves, flooding, wildfires, heavy rain, change in sea conditions, rise in sea level, storms, water scarcity) as well as sectors (agriculture, biodiversity, buildings, coastal management, disaster risk reduction, energy, forestry, health, marine and fisheries, spatial planning, tourism, transport, urban, water management) of the region. The AdriAdapt platform also provides examples of the implementation of adaptation measures around the Mediterranean and specifically in the Adriatic region. The adaptation options are categorized into societal, green and grey ones:

- Societal options include policy, legal, social, management and financial measures that can modify human behaviour and styles of governance, contributing to improved adaptation capacity and sustainable development.
- Green options make use of natural or ecosystem-like processes to improve resilience and adaptation capacity and are characterized by a wide range of benefits extending beyond adaptation.
- Grey options refer to technological and engineering solutions to improve adaptation of the territory, infrastructures, and people.



The literature and practices provide another way of categorizing adaptation options. The approach developed by the IPCC is one of the most referenced; it clusters options into three main categories (structural and physical options, social options, and institutional options), further divided into sub-categories (see Table 4).

Table 4. IPCC classification of adaptation options (IPCC, 2014)

Category	Sub-category	General features	Notes
Structural and physical	Engineered and built environment	Discrete, with clear outputs and outcomes, well defined in scope, space and time.	Expert driven, capital intensive, large scale highly complex
	Technological		Include Hard and soft technologies but also new and indigenous – locally made-technology
	Ecosystem based		More difficult to implement and assess because they require cooperation across institutions, sectors, communities, and stakeholders. One of the major barriers is the lack of comparable standards and methodologies
	Services		Focused on aspects related to societal nets, public health services, infrastructures associated with basic services (sanitation, water, public transport, etc.)
Social	Educational	Various adaptation options that target the specific vulnerability of disadvantaged groups, including targeting vulnerability reduction and social inequities - Community-based adaptation (CBA)	Focused on building social capital in order to improve social resilience (education, awareness raising, community meetings, etc.)
	Informational		Measures aimed at increasing informational strategies using both ICT and low- tech measures (brochures, direct contact, public announcements, etc.)
	Behavioural		Very influenced by government incentives that can spark behavioural change
Institutional	Economic	Key role of institutions and of the international agreements and donors	Taxes, subsidies, insurance arrangements, etc.
	Laws and regulations		Planning measures, building codes re-zoning, but also legal rights can determine better adaptive capacity
	Government policies and programmes		Action driven by central government

2.4.2 Assessing the adaptation options

Once a catalogue of potential adaptation options has been created, these need to be assessed in order to select the priority options. Priority adaptation options are the key measures to put in place to realize the strategic and specific objectives set in the previous steps 1 and 3. They must obviously be suited to the considered local context, reduce its vulnerability, and increase its adaptation to climate change, whilst also contributing to the wider scope of sustainability goals (thus avoiding unsustainable maladaptation pathways). The comparison and assessment of available adaptation options should be based on a transparent process. In addition to the criteria listed in section 2.3.2, the scientific literature and practices provide a wide range of possible issues to be considered, e.g.:

- Preference for no-regret measures, i.e. measures which are worthwhile whatever the extent of future climate change will be, also in consideration of their multi-benefits beyond climate change adaptation.
- Preference for low-regret measures, i.e. measures with relatively low costs and high benefits.
- Preference for nature-based solutions, green measures aimed at protecting, sustainably managing, and restoring natural or modified ecosystems, to improve adaptation and simultaneously provide human well-being and biodiversity benefits.
- Preference for adaptation measures also contributing to climate change mitigation. In any way, potential adaptation measures (e.g. cooling measures with a high demand of energy powered with non-renewable sources) contributing to enhance global warming and related climate change should not be considered at all. On the other hand, when planning for mitigation it is important to assess whether related measures negatively affect the adaptation process.
- Equal distribution of benefits of adaptation measures across society. Selected measures should ensure that adaptation provides benefits to the entire community, favours social inclusion and cohesion, and does not exacerbate social inequalities. Moreover, benefits of the adaptation options should be equally distributed among all the affected communities and sectors.
- Effectiveness and efficiency of the measure. Effective options reduce a particular vulnerability or number of vulnerabilities to a desired level. Efficient options are those whose benefits exceed costs and are more cost-effective than alternatives.

- Comparison of costs and benefits, preferring those options which can deliver multiple benefits for human well-being and natural ecosystems, beyond those strictly related to adaptation. Whenever possible, costs and benefits should be quantified; as an alternative, several qualitative assessment approaches can be implemented. The evaluation of cost and benefits of adaptation options can be measured using different approaches. The most commonly used ones are: cost-benefit analysis (CBA), cost-effectiveness analysis (CEA) and multi-criteria analysis (MCA) (Table 5).
- Robustness under a broad range of future potential impacts of climate change, flexibility for adaptive adjustments or reversibility.
- Minimisation of negative (economic, environmental, and social) impacts of adaptation measures and more in general of their trade-offs. The evaluation can also look at barriers to adaptation, privileging no or less affected measure.

Key evaluation issues should be translated into criteria for the comparison and prioritization of the adaptation options. As for the entire assessment process, it is important that criteria and related weights are shared and transparently defined by the actors involved, and suited to the specificities of the local context.

Table 5. Strengths and weakness of CBA, CEA and MCA methods (UNFCCC, 2011).

Method	Strengths	Weaknesses
Cost-Benefit Analysis (CBA) assesses benefits and costs of adaptation options in monetary terms. Outputs typically include net present values, internal rates of return or benefit-cost ratios	CBA can provide concrete quantitative justification for adaptation options rather than just relative qualitative information. It allows for a comparison between different aspects using a common metric	CBA focuses on efficiency, when other criteria may be important as well (e.g. feasibility or equity). It has difficulties with non-monetised costs and benefits and may need a subjective input into the choice of discount rate.
Cost-Effectiveness Analysis (CEA) identifies the least-cost option that can reach an identified target or risk reduction level or the most effective option within available resources.	CEA can assess and compare different adaptation options, using units other than monetary ones. Therefore, it can take into consideration effects that are difficult to evaluate in monetary terms.	CEA is unable to offer an absolute analysis or common metrics. The selection of thresholds or target risk levels is not always easy or objective
Multi-Criteria Analysis (MCA) assesses adaptation options against a number of criteria,	MCA can consider monetised and non-monetised costs and benefits together. It can also include both	Scoring and ranking of options in MCA is subjective which make

Method	Strengths	Weaknesses
which can be weighted differently, to arrive at an overall score.	quantitative and qualitative information. It allows considering a wide range of criteria, including for example equity in adaptation. It can accommodate stakeholder contribution and is therefore often used in engagement process.	MCA results not always easily comparable.

Finally, selected and prioritised adaptation options can be described in concise factsheets to be included in the climate change adaptation plan. The AdriAdapt catalogue of adaptation options provides an example template that can be used:

- Name; brief and clear name of the adaptation option
- Description; including scope, objectives, applicability, available techniques/methods, major (policy, legal, institutional) drivers encouraging the adoption of the initiative, factors that can be decisive for the successful implementation of the measure, and expected challenges or limiting factors which may hinder the process.
- Costs and benefits; this section should ideally provide information on typical costs for the design and implementation of the adaptation measure. Quantitative estimation can be derived from literature or cases of real implementation. In the event that quantitative information is not available, the qualitative evaluation of expected costs can be alternatively included. The section should also highlight adaptation benefits and other co-benefits of the consideration option.
- Implementation time and lifetime; typical time needed for the design and implementation of the adaptation measure and typical duration of the adaptation measures.
- Category of the adaptation option: AdriAdapt considered categories are societal, green and grey.
- Addressed sectors.
- Addressed climate impacts.
- Sources of more detailed information.

Box 10 – The adaptation option choice in the Vodice pilot project

In the Vodice pilot project, the choice of adaptation options has been made by a team of experts who explored all the available options before producing a list of adaptation measures which could be labelled as "Best Available Techniques" and "Best Environmental Practices" for the Vodice area and its major climate challenges. These options cover several sectors: urban flooding, urban heat waves, wildfires and droughts, coastal flooding. The assessment of these options according to their effectiveness and suitability to a specific context has been obtained quantitatively and qualitatively in the Vodice Plan, with a clear identification of suitable measures or, at least, with a narrowing to a set of a viable adaptation measures. The Vodice Plan strongly advocates the use of so- called Nature Based Solutions which promote measures that mimic the natural cycle (e.g. measures for urban storm water management such as bio retention ponds and rain trenches or measures for urban heat waves urban green canopy).
An adequate mix of these "green infrastructure" measures with traditional "grey" structural measures, combined with planning and societal measures will enhance the effectiveness of the whole process.

2.4.3 Elaborating the plan

Once climate change risks and vulnerabilities have been assessed (step 2), a vision for the desired future has been designed (step 3) and the specific objectives and policies have been identified (steps 1 and 3), individual adaptation measures can be agreed upon (step 4) and a framework for the implementation of adaptation can be developed in the form of a plan. An adaptation plan is expected to set out what needs to be done to convert prioritized adaptation options into actions. A plan can be guided by an adaptation strategy previously developed (at the local, sub-national or even national level), outlining the direction of the actions and the expected outcomes. However, this is not always the case, and the strategic adaptation objectives can also be developed contextually with the plan.

The expected contents of the adaptation plan should be agreed upon by all the experts contributing to its development. An adaptation plan is not just a list of preferred adaptation measures, but a more articulated document which may contain the following information:

- A summary of major climate change challenges addressed by the plan. Usually, there is no need to include a detailed description of all climate hazards and related impacts within the plan, but to focus on the key information which guides the users in understanding plan's choices. Detailed information about present and future climatological aspects and the results of impact assessments can be included in the technical documents attached to the plan.
- The vision and the objectives of the adaptation process. These can be developed throughout the process of the plan elaboration (step 3) or be part of a previously available adaptation strategy. In any case, they must be included in the plan as they are aimed at orienting all of the plan's choices.
- Details of each selected adaptation option. The summary factsheets resulting from the assessment, selection and prioritization of adaptation options should be further detailed, including, if needed, their feasibility or preliminary design.

- Clear quantification of costs and identification (possibly based on quantitative evaluation) of adaptation benefits and the trade-off of the selected adaptation measures.
- Roles and responsibilities for the implementation of the adaptation options and the cross-cutting components of the plan (overall coordination, monitoring and reviewing of the plan, linking to other processes, etc.). The identification of who does what is essential to bridge the plan development to its real implementation.
- Links with other strategic and planning documents. Climate change adaptation cannot be developed in isolation, but as argued in other parts of these guidelines it is part of a wider approach to sustainability. As described in more detail in step 5, the implementation of adaptation options often implies the mainstream integration into existing policy documents and plans, which do not necessarily deal with climate change in a direct way. Therefore, it is advisable to develop a section within the adaptation plan outlining the key sectors and related policies and plans for the integration of adaptation aspects.
- Timeline for the implementation of the adaptation measures, setting a clear roadmap that can be easily monitored. An adaptation plan can be organized into adaptation pathways, where the implementation of a group of adaptation measures consists of a sequence of actions towards pre-defined adaptation goals. Due to the high uncertainty of the future, it is envisaged that the plan includes several adaptation pathways, thus enabling a shift from one to another.
- Overall costs of the plan implementation. These costs are given by calculating the single adaptation measure costs, but they also include the human resources needed to coordinate the plan's implementation, review, and monitoring.
- Available funding schemes. A lack of adequate economic resources is one of the major barriers to the implementation of the planned adaptation measures. Available options for funding the plan should therefore be clearly stated (see section 2.4.4 and chapter 3). These can include both funds specifically allocated for the plan implementation or links to funding mechanisms of other plans and programmes, also relevant for adaptation.
- Monitoring, reporting and evaluation (MRE) system (see step 5).

The use of visual elements (such as maps, infographics, conceptual diagrams, visual storylines, etc.) is highly recommended to support the plan's communication and interrupt the monotony of the text content.

Box 11 - The Italian climate change strategy and plan

The Italian National Climate Change Adaptation Strategy (SNAC) was approved and adopted in 2015, after a process of public consultation. The strategy is based on a previous project coordinated by the Italian Ministry for the Environment, Land and Sea Protection (today Ministry of Ecological Transition) that led to the publication of three documents, about: (1) the scientific knowledge status on impacts, vulnerability and adaptation in Italy; (2) the analysis of the legislation framework at the national and EU level and (3) the elements for a national strategy, identifying strategic objectives and actions. The main objective of the Italian SNAC is to develop a national vision regarding the possible actions to be taken to deal with climate change by contrasting and adapting to its impacts.

Following the SNAC, the elaboration of the National Plan for Adaptation to Climate Change (PNACC) started in 2016, including a prolonged phase (2017-2018) of content sharing and co-definition with local, regional and national, administrations and institutions, as well as research organizations and other stakeholders (MATTM, 2018). In June 2020, the structured consultation of the PNACC began as part of the Strategic Environmental Assessment (SEA) process (MATTM, 2020). The SEA preliminary environmental report of the PNACC was published in November 2020 and the consultation phase was concluded in April 2021.

Compared to the Strategy, the Plan is configured as a more operational tool aimed at helping at all institutional levels (local, regional and national) in defining their adaptation pathways. This general objective is articulated in three specific objectives: (1) limiting the vulnerability of natural, social, and economic systems to the impacts of climate change, (2) increasing their adaptation capacity, improving the exploitation of any opportunities and (3) facilitating the coordination of actions at different levels. The PNACC focuses on eighteen sectors: water resources, marine environments, inland and transitional waters, coastal zones, hydrogeological instability, desertification, soil degradation and droughts, terrestrial ecosystems, forest ecosystems, agriculture and food production, sea fishing, aquaculture, tourism, urban settlements, transport, industry, cultural heritage, energy, and health. For each sector, specific objectives are identified together with their related adaptation actions (more than 350 in total). A prevalence of non-structural measures (societal) emerges from the analysis of the proposed actions, followed by actions based on an ecosystem approach (green) and then by infrastructural and technological measures (grey).

Box 12 - The Croatian climate change strategy and plan

The Croatian Climate Change Adaptation Strategy was adopted on the 7th of April 2020. This Strategy is a fundamental document which establishes a framework for implementing all climate change adaptation measures in the Republic of Croatia. Specifically, the strategy aims to:

- reduce the vulnerability of social and natural systems to the negative effects of climate change;
- gather relevant institutional, political, economic and social stakeholders in order to create strong support for joint actions when implementing adaptation measures;
- integrate the adaptation process, including the implementation of measures, into existing and new policies, programmes, plans and other strategic activities carried out at local and national levels of governance;
- implement and promote scientific research in all vulnerable sectors in order to significantly reduce the degree of uncertainty associated with the effects of climate change;
- raising the level of awareness of the importance of climate change and the inevitability of the adaptation process amongst decision-makers and society in general

The Croatian Strategy (MZOE, 2017) lays out a vision and guidelines for developing adaptation to climate change by 2040 with a view to 2070. It proposes a total of 81 measures, the largest number being represented by non-structural ones (administrative, political, legislative, planning actions). The draft Action Plan includes an in-depth analysis of the measures outlined in the strategy, providing further details about implementation methods, responsible authorities, estimated costs, monitoring indicators and the coordination of measures under implementation. Both the strategy and the action plan address 8 key sectors (water and sea resources management, agriculture, forestry, fishery, biodiversity, energy, tourism and health) and 2 cross-sectoral thematic areas (spatial planning and coastal area management, and risk management) that have been identified as the most vulnerable to climate impacts.

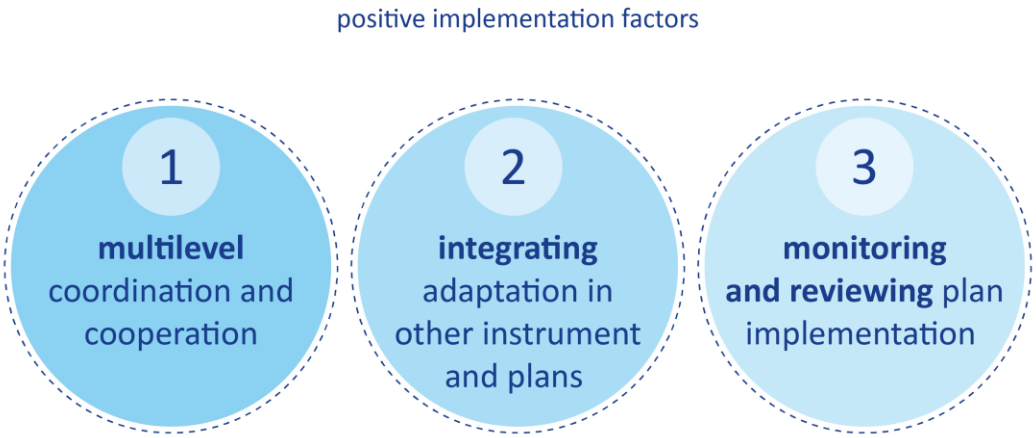
2.4.4 Funding

Several adaptation measures can be implemented through other cross-sector or sector-specific planning instruments or programmes (see step 5, and more specifically, section 2.5.2, about mainstreaming adaptation). For others, securing dedicated economic resources is essential. Economic resources are potentially available through several sources and instruments. However, limited funding is often mentioned as one of the major barriers for progressing towards adaptation, in particular for smaller communities and when adaptation requires a radical transformation of the territory. To overcome this barrier, it is advisable to secure the required economic resources for implementation early in the process and to diversify the portfolio of possible funds (see chapter 3 for possible sources of funds).

2.5 *Step 5*. Implementing, monitoring, and evaluating the plan

An adaptation plan is usually perceived as the key instrument in order to transform, select, and prioritise adaptation options into practices. As highlighted in the previous step, in this regard it is important that the plan identifies a clear timeline for the implementation of each adaptation option, roles and responsibilities, range of costs and possible funding sources, links to other plans or programmes that can be used to implement that option. The approval or the endorsement of the adaptation plan is just the first essential step to moving towards implementation. Persisting and long-lasting implementation is a challenging process which can be affected by variable and uncertain obstacles. The identification of possible constrains and barriers to implementation, of related uncertainties and possible adaptive solutions is essential to bringing together the plan's design phase and implementation. Effective implementation often relies on:

- multilevel coordination and cooperation (see section 2.5.1)
- integrating the adaptation into other instrument and plans (mainstreaming; see section 2.5.2)
- monitoring and reviewing the plan's implementation (see sections 2.5.3 and 2.5.4).



2.5.1 Defining basis elements for the plan's implementation

Considering the cross sectoral nature of adaptation, the implementation of an adaptation plan requires suitable institutional set-ups and governance frameworks to ensure effective, coherent and continued implementation. Communication, coordination, and cooperation along horizontal and vertical levels of governance are needed to integrate adaptation into all of the relevant policy areas ("sectors") and at all scales. Governance is often depicted as the capacity of governing institutions to respond effectively to changing conditions and problems that may occur; however, it cannot be merely considered a government-led process. In order to achieve social unity in climate action, wider support from the different groups in human society is needed and should be included in the governance mechanism. Therefore, the governance for climate action requires for all the stakeholders who are major players of the adaptation process to be on board.

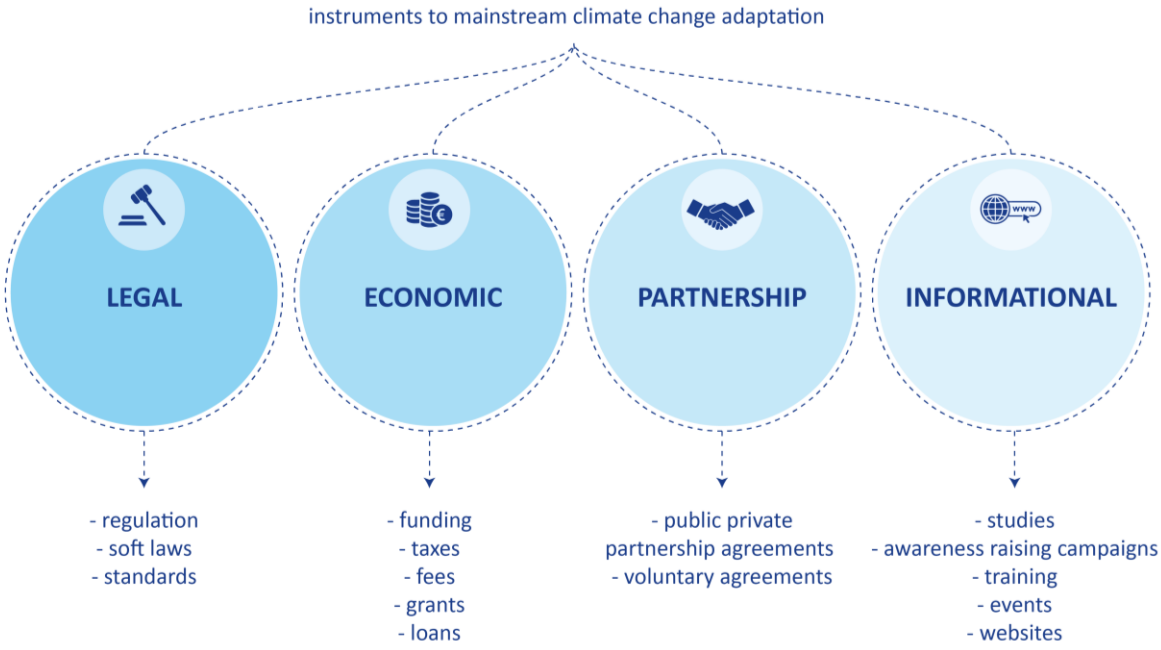
Crucial for implementation is the designation of a coordinating team of local and sub-national leaders, supported by scientists and representatives from the local business sectors and civil society. The establishment of this team (in the form of a committee, board, or any other option) is one of the first tasks to be carried out after the adoption of the plan. The team coordinating the implementation phase can be the same as those in charge of the coordination of the plan's design (see step 1 in section 2.1) or a different one. Such a team is called to steer the implementation process, interacting with a wider arena of subjects directly involved in the specific transformation of the desired adaptation measures into actions.

A clear policy-based mandate can empower the team coordinating the implementation phase, defining its objectives, establishing the decision-making process, and the rules for its functioning. Maintaining continuity in the process and in the core actors of the coordinating is also beneficial.

The governance framework can apply formal and informal approaches. Formalised processes can act as strong drivers for vertical and horizontal integration, as well as strengthening the role of the involved actors. However, they can also block or slow down the process. Informal approaches can lead to quicker agreements (which will then be formalised as a decision) and foster innovation. Flexibly combining formal and informal governance methods capitalizes on the strengths of both approaches. For example, institutionalized coordinating committees can be combined with working groups involving both officials and experts with the role of specifically boosting the actions needed for the implementation.

2.5.2 Mainstreaming the plan into other instruments that are in place or pending development

Adaptation cannot be pursued in isolation from the wider existing policy and planning framework, covering both cross-cutting (e.g. sustainable development strategies and plans, urban plans, integrated coastal zone management plans, marine spatial plans, etc.) and sector issues (e.g. building codes, water management plans, health protection plans, transport management plans, etc.). While some specific measures can be implemented as a direct consequence of the adaptation plan with specifically dedicated funds, several others need to be integrated (mainstreamed) into existing policy and planning instruments. Indeed, mainstreaming can raise the profile of the entire adaptation process, develop synergies, and reduce conflicts among policies, ensuring a more efficient use of resources and maximizing co-benefits.



Besides strategies and plans, a broad portfolio of instruments is available to mainstream climate change adaptation, including:

- legal instruments, such as laws, regulation, soft laws such as standards;
- economic instruments, such as funding, taxes, fees, grants, loans;

- partnerships instruments, such as public private partnership agreements, voluntary agreements;
- Informational instruments, such as studies, campaigns for raising awareness, training, events, websites, which can initiate collaborative initiatives aiming to transfer climate change adaptation into sector-based processes.

Bridging the gap between planning and implementation requires the identification of the existing policy and planning instruments which can integrate adaptation and the way they should be adjusted, if needed. This phase of the process is also useful to assess whether new instruments should be put in place to foster the implementation of the adaptation measures. The analysis of the existing and new instruments starts at the very beginning of the process (step 1). Based on the step 1 overview, step 5 activities should provide a clear, operational indication about how the planned adaptation options need to be implemented through other plans and programmes. Indeed, the interaction between an adaptation plan and other cross-cutting and sector-based plans and programmes is bidirectional. These plans and programmes must be climate-proofed, i.e. their specific measures (e.g. aiming to protect biodiversity, preserve quality and quantity of water resources or allocate marine space for human activities) must be valid and reliable under altered climatic conditions.

Box 13 – Mainstreaming in the Sibenik pilot project

An Adaptation Plan with specific focus on ICZM issues has been developed in the Sibenik pilot project, as coastal management is a highly vulnerable issue for Croatia. Several coastal towns and cities along the Croatian coast are in fact experiencing an increasing number of coastal flooding events and, at the same time, the construction trend on the narrow coastal strip is constantly on the rise. The link among these themes has been strengthened by establishing of a County Committee for ICZM, comprising representatives from 11 organizations in Sibenik-Knin County, which were also responsible for the implementation of the Adaptation Plan. Civil Protection has also included the Adaptation Plan's findings into its actions, while the Plan's contents will be used to draft the County's strategic documents. This integrated approach enhanced the Plan's mainstreaming into other instruments that are in place or pending development

In addition, a highly participative process has accompanied all the steps of the Plan's development with the result of spreading the feeling of ownership and contributing to the increase stakeholder's engagement and trust. The participative process also contributed to raising awareness of the threats of climate change and the need for adaptation and mitigation.

2.5.3 Monitoring the plan's implementation and the adaptation process

Monitoring and evaluation (M&E) are intrinsic components of any planning process. This is particularly relevant for adaptation, considering its long-term perspective and the great uncertainty characterising the evolution of the climate system and its related effects. Monitoring is essential to evaluating the progress of planned actions and for checking the actual outcomes of adaptation against objectives to ensure that an adaptation process is effective and sustainable over time. Clear objectives are therefore crucial for meaningful monitoring and evaluation. M&E is also needed to monitor spending related to adaptation and to efficiently communicate progressive results of the adaptation process.

M&E mechanisms often make use of indicators, i.e. a quantitative or qualitative variable that can be measured and described in response to a defined objective. Indicators can transform objectives into measurable variables. Three major categories of indicators can be considered within the adaptation process:

- Process indicators, aiming to assess how the plan is developed, if all the required steps are established and all the required stakeholders are involved.
- Performance or output indicators, aiming to assess if and how adaptation measures are implemented, according to the plan's objectives and its implementation roadmap.
- Impact indicators, aiming to assess the effects of the implemented adaptation measures, in terms of reduced vulnerability and increased resilience to climate change as well as the obtained co-benefits.

Performance and impact indicators can be related to various aspects of the overall climate change adaptation processes, referring to: drivers, stressors, exposure, sensitivity, hazard, impact, adaptive capacity, etc. (see Table 6 for examples of urban adaptation indicators). Different or partially different categories of indicators have been used; some examples are reported in Box 14.

Box 14- Examples of the categorization of indicators for climate change adaptation

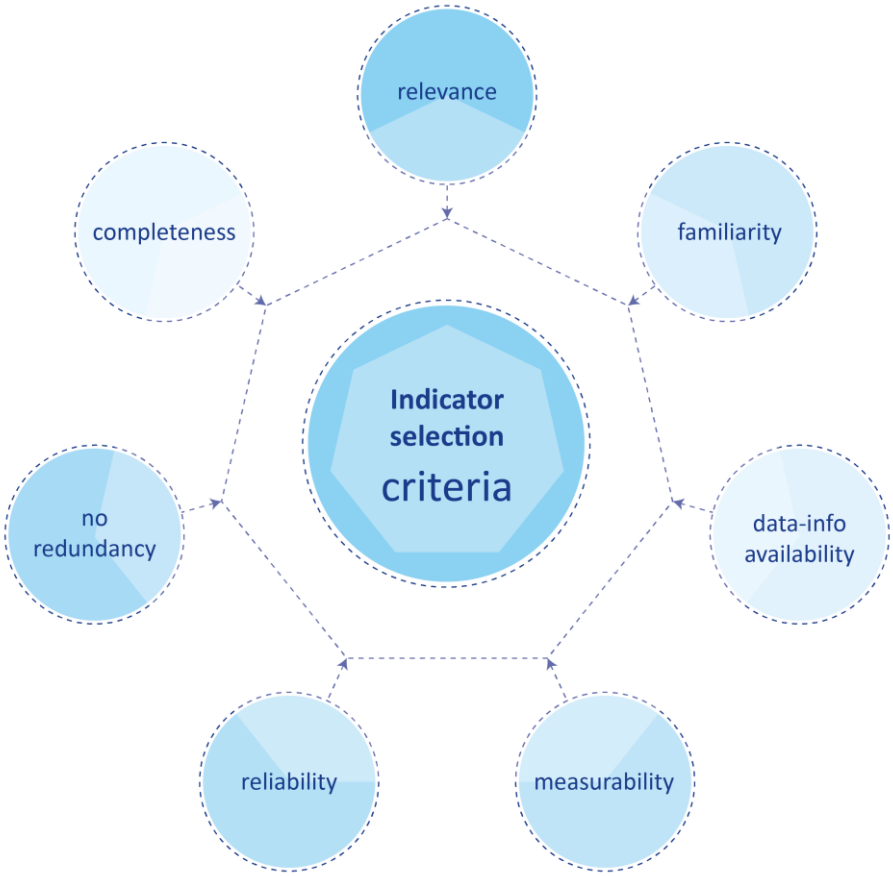
A 2018 ETC/CCA technical paper analyses the indicators developed by five European countries (Austria, Finland, Germany, Scotland and the United Kingdom) to monitor climate change adaptation at a national level. Based on an in-depth examination of the five countries' experience, the paper categorizes adaptation indicators into the following categories:

- Input indicators, providing a measure of resources, both human and financial, devoted to a particular adaptation activity, programme, or intervention.
- Process indicators, tracking progress in adaptation policy processes and actions.
- Output indicators; relating to the direct results of an adaptation policy or action, without assessing if these results actually lead to better adaptation outcomes.
- Outcome indicators; seeking to define an explicit outcome or result of an adaptation action. Outcome indicators may also assess the level of success of specific adaptation measures.

The Italian guidelines for the identification of climate change indicators (Linee Guida SNPA n12/2018) are equally based on process and performance categories. They also refer to the concept of "data availability" as a criterion for categorizing and prioritizing the selection of the indicators:

- Short term priority indicators: indicators based on accessible and freely available data; data production is based on an existing monitoring system;
- Medium term priority indicators: indicators are still under development but monitoring systems of related data exist;
- Long-term priority indicators: indicators for which a standardized procedure and monitoring system are not in place; such indicators are therefore still completely undeveloped.

Within the framework of disaster risk management and climate change adaptation, the Urban Adaptation Assessment project, developed the "Notre Dame Global Adaptation Index". The index is built on a set of indicators assessing the different climate risks (hazard, exposure, sensitivity, and adaptation capacity) and readiness (economic, governance and social readiness) components. Risks and readiness evaluation are then combined to evaluate impacts of climate hazards on lives and livelihoods.



The selection of indicators should be based on shared and transparent criteria. According to the RESIN project, these might include:

- Relevance; the indicator should have a strong link to the adaptation objectives set in the previous steps of the process;
- Familiarity; the indicator should be easy to communicate to and understand by the users;
- Data and information availability; Data or information for the indicators should be easily available and be gathered at reasonable costs;
- Measurability; the indicator should be capable of being measured, preferably as objectively as possible;

- Reliability; the indicators should have a limited degree of uncertainty. Factors that increase reliability are: good quality of the underlying data, clear and specific definition of the indicator and a transparent and direct calculation methodology;
- Non-redundancy; indicators part of the same M&E framework should not measure the same aspect;
- Completeness; the total set of indicators should consider all aspects that affect the adaptation goals.

Identified indicators can be organized onto a factsheet structured in a common template, e.g.: title, description, objective the indicator aims to evaluate, related target, methodology for the calculation or evaluation of the indicator, sources of data and information, value and temporary evolution of the indicator, links to other indicators and a conclusive message on the evaluation of the indicator within the framework of the overall adaptation process.

Table 6.Categories of indicators and related examples identified by the RESIN project (source: RESIN – Monitoring and Evaluation).

Typology	Description	Examples	Unit
Drivers	Indicators that assess meteorological parameters that drive climate change	Frequency of heat/cold waves	N° heat/cold waves
		Consecutive dry days	N°
		Tropical nights: number of days with minimum temperature>20°C	N°
Stressors	Indicators that signify a change or trend unrelated to climate that can exacerbate the impact of climate hazards	% change in water consumption for agriculture/irrigation	%
		Population density (compared to national/regional average in year X in country/region X)	N°/hectares
		% of treated wastewater	%
Exposure	Indicators that measure the presence of people, livelihoods, environmental services, infrastructure, or economic, social,	% of areas at coasts or rivers	%
		Number of households affected by drought	N°

Typology	Description	Examples	Unit
	or cultural assets in places that could be adversely affected	Percentage of city land area located in a flood zone	%
Sensitivity	Indicators that target the degree to which a system or species is affected, either adversely or beneficially, by climate variability or change. Often addressing intrinsic properties of an object resulting in susceptibility to a risk source	Percentage of climate resilient trees	%
		% of (public/residential/tertiary) buildings retrofitted for adaptive resilience	%
		% green and blue surface area in the neighbourhood in relation to paved and built surface area	%
Hazard	Indicators that assess the potential occurrence of a natural or human-induced physical event or trend or their physical impact (i.e. flooding, heat stress, drought).	Urban Heat Island	°C UHI max
		Change in river flooding	unknown
		Change in coastal flooding	unknown
Impact	Indicators that address the (direct) effects on natural and human systems (lives, livelihoods, health, ecosystems, economies, services and infrastructure, etc.).	Reduced work productivity due to heat stress	euro
		Number of properties lost due to coastal erosion per year	N°
		Number of people injured, evacuated or relocated due to extreme weather events	N°

Alongside indicators, checklists and reporting templates are useful tools to evaluate the completeness and robustness of the adaptation process. For example, the reporting platform of MyCovenant (see also the offline version reporting template) provides several templates for the evaluation of the different components required for adaptation and mitigation (i.e. organised by: strategy, GHG emissions, risks and vulnerability, action plan, actions). The reporting platform also includes a list of illustrative indicators for adaptation and an adaptation scoreboard. The latter is a self-assessment checklist of the different steps and sub-steps of the adaptation process.

Regardless of the approach used, it is very important that the design of the M&E method identifies who is responsible for the different monitoring and assessment phases (who should collect the data, evaluate the available data and information, report and communicate the results of the M&E activities). Stakeholders should actively contribute to this phase as well, in terms of data and

information sharing and validation, the joint decision on the M&E method to be used, the contribution to the selection of the indicators, the wider dissemination of M&E results, etc. The design of the M&E approach should also be based on pragmatism, taking into consideration human and economic resources available as well as data availability.

2.5.4 Reviewing the plan

A good M&E scheme is expected to produce results useful to respond to a series of questions: Are we doing the right things? Are we doing things properly? How is implementation progressing? Is the monitoring framework effective? Ultimately, monitoring and evaluation results should be used to revise and adjust the adaptation plan. Monitoring and evaluation results can inform stakeholders and society overall about the progress in adaptation and encourage them to undertake further adaptation actions.

It is evident that M&E can serve different purposes and multiple users. The design of an M&E approach should therefore include a clear indication about how to use its results and how to tailor their communication to specific target groups (policy makers, practitioners, and experts, sector representatives, civil society associations and citizens, etc.). A wide variety of communication tools and formats can be considered, such as: technical reports, technical summaries, policy briefs, infographics and other visual products, periodic newsletters, sections of adaptation portals, alive communication events, press releases for media, initiatives for raising awareness, etc.

Climate change adaptation is a process of progressive adjustment to the current and future climate conditions and their availability. The adaptation plan is therefore a living and evolving document, which must reflect the progressive and dynamic nature of the whole process. Results of the monitoring phase are clearly meant to evaluate whether the plan is up to date or not, and if not, proceed to review it. The plan can be updated periodically considering a pre-defined schedule or can be reviewed occasionally, when important changes in the system occur (e.g. due to major interventions, a new sector or cross-cutting plans, the emergence of other challenges which are not specifically linked to climate change) or when new information become available (e.g. updated projections on climate change, a new assessment of climate change impacts, new solutions for more efficient adaptation, etc.). A mixed approach combining periodic and occasional update is recommended.

3 Key factors to ensure successful local adaptation in the Adriatic region

The five steps that make up the Integrated Adaptation Planning Tool mention several factors and components which are essential to ensuring successful local adaptation. It is stated, for example, that a clear and transparent political buy-in, together with strong support from all of the involved stakeholders, is essential to placing climate action high on the political agenda and to therefore boost the adaptation process. Equally, a robust scientific knowledge base plays a very important role throughout the entire process, requiring researchers and experts to be involved from the early stages. All in all, this calls for a new form of governance for climate action based on the involvement of all actors, a long-term commitment and view, transparent and inclusive processes and effective communication to society as a whole. Based on the broader discussion of the previous chapters, some of the key factors for a successful local adaptation process are noted here in detail. Their full availability can act as decisive drivers for adaptation while a lack or the limited availability of them can hinder the process.

It is widely recognised that climate change adaptation is a cross-cutting, multi-sector process. However, a lack of **integration** often acts a major barrier for adaptation. The concept of **vertical integration** highlights the importance of improving coherence among strategies and plans dealing with different spatial scales. Strategic choices taken at the national and sub-national levels orientate measures implemented locally, while on the other hand, different local actions must become part of a coherent picture contributing to common goals. Vertical integration implies coordination amongst the governmental institutions acting at the different levels. It must be developed hand in hand with **horizontal integration**, looking at the different sectors involved in the adaptation process through a common lens. Horizontal integration is essential for designing and implementing adaptation measures which are beneficial for more than just one sector (as well as creating synergies), not generating maladaptation for a specific sector and providing multiple benefits beyond adaptation. In fact, horizontal integration requires cooperation from different administration departments or divisions. However, as stated elsewhere in these guidelines, the involvement of governmental institutions alone is not enough in order to make progress towards a new form of governance for climate actions based on vertical and horizontal integration. The integration of disciplines is equally essential. Climate resilience and climate actions towards adaptation are complex challenges which require contributions from experts from different sectors and cross-sector disciplines. Lastly, the concept of integration is very much linked to that of the engagement of stakeholders. Given its cross-cutting nature, a wide range of stakeholders should be invited to contribute to the co-generation of the knowledge for adaptation and the co-definition of the key components of an adaptation plan (key vulnerabilities, vision and objectives, adaptation measures, monitoring tools and mechanisms, etc.).

Stakeholder engagement plays an important role in all the adaptation steps, as stated in various points in the previous chapter. Indeed, it should not be famed as a specific step but as a transversal activity throughout the entire adaptation process. Despite its cross-cutting nature, there is a clear need to channel the stakeholders' contribution, particularly to get the most benefits out of it and avoid engagement becoming unsustainable and unmanageable for those involved. The detailed design of the stakeholder engagement process is therefore an essential starting point which should look at:

- Why and when stakeholder engagement is important

  Involving stakeholders in all the steps and specific activities of the adaptation process is rather impossible. Major benefits can be obtained by identifying when stakeholder contributions are essential and mostly beneficial for the whole process. This decision is context specific, although we can expect it is particularly important for: sharing data and information on climate change hazards and risks, prioritizing climate change impacts, co-creating the vision behind adaptation and setting related objectives, sharing experiences on adaptation options, contributing to the selection of specific adaptation measures, and designing the monitoring and evaluation scheme of adaptation. Stakeholder engagement is also expected to continue in the implementation phase. Stakeholders can be active actors in the implementation of some of the planned measures (particularly for those focussing on specific sectors), contributing to monitoring the implementation of the adaptation plan and to disseminating the results of the adaptation process.

- Who should be involved

  Stakeholder mapping and analysis aims at identifying who should be involved in the adaptation process. This is useful in order to understand what the interests and positions of stakeholders are and their mutual relationships. The selection of the stakeholders should be based on transparent criteria and aim at ensuring a balance participation of different categories, including administrations in charge of adaptation at different levels (from local to national, if needed), different departments or divisions of the same organisation, sectoral authorities, academia and research institutions, NGOs, other interest groups and representatives of the business sectors. There is not an ideal number of people that should be involved; it is a good idea to balance out the demand in order to give a voice to all the different categories under the instruction of keeping this number small enough to increase the efficiency of the process and the commitment of people throughout its entire duration. Once stakeholders have been identified, the related level of involvement should be clarified, ranging from information, bi-directional communication, consultation, co-creation, co-decision, etc. This level will be different for the different

stakeholders and can even change over the course of the process. Defining roles and responsibility for each stakeholder from the beginning is essential to increasing the success of stakeholder engagement.

- Providing evidence of the use of stakeholder contribution

  Stakeholder contributions to the adaptation process can be laborious. Together with prioritization, this requires that stakeholders are regularly informed about the use of the contributions they provide. Such actions can improve trust and create a sense of ownership during the process. Indeed, adaptation should be seen as a co-designed pathway and the resulting strategy or plan should be presented as a co-developed outcome of all the involved stakeholders. Different methods and instruments can be used to document the discussion, such as minutes from the meetings, handouts, posters or infographics summarizing the key results obtained, dedicated web-sites, etc. It is also important to define the required level of formalization of stakeholder inputs. When stakeholder participation deals with knowledge and experience sharing, in general formalization is not necessary. However, when participants are expected to bring their strategic interests to the table and express related objectives, a higher degree of formalization might be required. The decision about the level of formalization is case specific. In some contexts, informal processes may be preferred to avoid blocked positions and avoid active participation being discouraged.

Not all interested parties can actively participate in the process leading to an adaptation strategy or plan. Stakeholder engagement should be backed by **communication activities and those raising awareness**, which are essential to ensure more widespread public support for the process, to further strengthen public participation and to increase consciousness about climate change's challenges and a possible solution. A robust plan for communication and raising awareness is needed to convey major findings of the adaptation process to society as a whole. Elements to be considered include the following:

- clarifying the terminology; the meaning of terms as vulnerability, risk, mitigation, adaptation may not be obvious to everyone.
- shaping the conveyed messages in a user-oriented way (in terms of language, contents and format) considering that different target audiences need different approaches
- together with results, communicating about related assumptions and uncertainty (e.g. on future climate change scenarios and projections)
- focusing on examples and good practices, rather than on methodological and theoretical aspects

- making the best use of a mix of communication approaches (direct involvement, mass-media, internet, social media) and means (short text, graphic information, video, audio, narrated stories at meetings, etc.) to maximize the number of people you want to reach.

An inclusive (with various and different stakeholders) and integrated approach to climate change adaptation also recognises the importance of **cross-border** and **transboundary cooperation**. The first refers to the cooperation of two or more spatial entities sharing a common border, whether they are municipalities, regions/counties of even countries. Cross-border cooperation is firstly aimed at improving coherence and synergies among confining adaptation strategies and plans. Trans border cooperation refers to the common management of a shared region or sub-region as in the case of the Adriatic Sea. This form of cooperation is highly useful for the development and exchange of region-specific knowledge, tools and good practices. However, it should also contribute to the resolution of common climate change problems (e.g. flooding in transnational river basins or storm surges affecting coastal areas of more than one country belonging to the same sea basin or sub-sea basin) and to the implementation of common solutions (e.g. conducting a regional scale climate risk assessment, developing a regional climate action strategy, implementing a common NBS approach to climate change adaptation, etc.). The common resolution of regional problems is, however, a long process, requiring time, dedicated resources and a long-term vision on a regional scale.

EUSAIR is the macro-regional strategy for the Adriatic and Ionian region adopted by the European Commission and endorsed by the European Council in 2014, to work together on areas of common interest for the benefit of countries and the whole region. EUSAIR considers climate change adaptation (and mitigation) as a horizontal topic cross-cutting all the four pillars of the strategy: blue growth, connecting the region, environmental quality, and sustainable tourism. At the Mediterranean level, the ICZM Protocol to the Barcelona Convention provides a common framework for the Contracting Parties to promote and implement ICZM. This Protocol includes actions which are also directly linked to climate change adaptation along the coastal system. Particularly important is article 8, the so-called ‘setback article’ which invites countries to establish in coastal zones, behind the highest winter waterline, a zone where construction is not allowed (UNEP/MAP/PAP, 2008). Moreover, the ‘Regional Climate Change Adaptation Framework for the Mediterranean Marine and Coastal Areas’ (UNEP/MAP, 2016) provides a common regional strategic approach to increasing climate resilience and adaptation capacity in the Mediterranean. The document focuses on four strategic policy areas: (1) creating the necessary institutional and policy frameworks for adaptation policies, (2) development of best practices, (3) improving and enhancing access to relevant finance mechanisms, and (4) improving the scientific knowledge base for informed decision-making.

Finally, early and detailed identification of funding sources is really essential to feeding the entire process and making sure the resources required during both the design and the implementation phases are available. Funding opportunities and mechanisms include:

- EU funding programmes, such as LIFE and Horizon Europe (see Box 15 about the Horizon Europe Mission for Adaptation) which can contribute to financially support adaptation at the sub-national and local level.
- The European structural and investment funds (ESIF) which can be used to mainstream adaptation in different contexts. The ESIF includes:
    - The European Regional Development Fund (ERDF) (particularly through the INTERREG program), promoting balanced development in the different regions of the EU.
    - The European Social Fund (ESF), supporting employment-related projects throughout Europe and investing in Europe's human capital.
    - The Cohesion Fund (CF), funding transport and environment projects in countries where the gross national income per inhabitant is less than 90% of the EU average.
    - The European Agricultural Fund for Rural Development (EAFRD), focusing on resolving the particular challenges facing the EU's rural areas.
    - The European Maritime and Fisheries fund (EMFF), supporting the fisheries sector in adopting sustainable fishing practices and coastal communities in diversifying their economies, improving quality of life along European coasts.
- The Recovery and Resilience Facility, the EU financial instrument aiming at mitigating the economic and social impact of the coronavirus pandemic and making European economies and societies more sustainable, resilient and better prepared for the green and digital transitions.
- National and sub-national funding programmes, driven by an adaptation process or sector-based funding streams also supporting increased resilience, or more in general, the sector's green transition.
- Initiatives promoted by the private sector (including those of donor organisations), also leveraged by the increase in public funding dedicated to climate action and sustainability in general.

- Loans from financial institutions, such as the European Investment Bank, which is working to gradually increase the share of its finance allocated to climate action and environmental initiatives.
- Crowdfunding, households' own funds (i.e. private initiatives aiming to improve resilience) and sectoral funding mechanisms (in which available funds may not necessarily be labelled as "adaptation" but can contribute to it).

Box 15 - The mission on "Adaptation to Climate Change, including Societal Transformation"

EU missions are commitments to solve some of the greatest challenges facing our world like fighting cancer, adapting to climate change, protecting our oceans, living in greener cities, and ensuring soil health and food. They are an integral part of the Horizon Europe framework programme beginning in 2021.

The mission on "Adaptation to Climate Change, including Societal Transformation" will test integrated solutions that contribute achieving the 2050 vision of a climate-resilient Europe, with an emphasis on citizen engagement. More specifically, the mission will support 200 European communities and regions in co-creating a vision, innovation pathways, and developing solutions for transformative adaptation. It will also scale up actionable solutions triggering societal transformations through 100 deep demonstrations of resilience across a number of European communities and regions.

Acronyms

EU European Union

CBA Cost-Benefit Analysis

CEA Cost Effectiveness Analysis

CC Climate Change

CF Cohesion Fund

COP Conference of Parties

EMFF European Maritime and Fisheries Fund

EAFRD European Agricultural Fund for Rural Development

ERDF European Regional Development Fund

ESIF European structural and investment funds

ESF European Social Fund

EUSAIR EU Strategy for the Adriatic and Ionian Region

ICZM Integrated Coastal Zone Management

IPCC Intergovernmental Panel on Climate Change

MCA Multi criteria Analysis

M&E Monitoring and evaluation

MSP Maritime Spatial Planning

NBS Nature Based Solutions

NGO Non-Governmental Organization

NWRM Nature Water Retention Measures

OECD Organization for Economic Cooperation and Development

PUG General Urban Plan

PNACC National Plan for Adaptation to Climate Change

SECAP Sustainable Energy and Climate Action Plan

SDG Sustainable Development Goals

SEA Strategic Environmental Assessment

SEI Stockholm Environment Institute

SNAC National Strategy for Climate Change Adaptation (Italian)

SQUEA Strategy for Urban Quality and Ecological Environmental

UHI Urban Heat Island

UN United Nations

UNFCCC United Nations Framework Convention on Climate Change

VHI Vegetation Health Index

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