

CREATE

Adaptation Handbook

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1. Introduction

Climate change is affecting all areas of the Mediterranean Sea including countries located in the Adriatic basin. Many climate-related hazards have been under the investigation of experts from the scientific sectors and it is recognized how the effects are affecting all citizens, entailing actions from politicians and decision-makers located not only in the coastal areas but also in the hinterland.

During the last decades, the European Union has financed many initiatives aiming at contrasting the effects of climate change and beginning adaptation processes in the areas of interest. Starting from the programming period 2000-2006, essential for the functioning of the EU Structural Funds and managing many regional and European programs, and finishing with the last one just concluded 2014-2020, several projects focused on starting suitable adaptation processes to enhance the adaptation capacity of coastal and hinterland areas, and many pilot sites have been the object of these interventions supported by studies and become reliable for being replicated in other contexts. In this perspective, the scope of the Project CREATE, and of this document in particular, is to collect the most relevant adaptation case studies describing the adaptation processes implemented in areas overlooking the Adriatic basin.

This document aims at collecting helpful information about adaptation case studies supporting politicians, experts, and decision-makers in transferring planning frameworks and processes in their contexts of operation, with particular focus to the Adriatic basin.

In 2021 the European Commission has adopted a new strategy at the European level for the adaptation to climate change. This strategy aims to enhance the resilience capacity of the European Union by 2050 and is composed of 4 principles and objectives:

1. Make adaptation smarter
2. Be faster
3. Be systemic
4. Step up into the international actions on adaptation to climate change

In the strategy, adaptation is recognized as a key-component of the long-term response to climate change. EU committed itself to reaching climate neutrality by 2050 with the ambitious objective to reduce emissions by 2030 by at least 55% compared to 1990. By 2050 EU aims to become climate-resilient and further reach climate neutrality following the lines drafted by the Paris Agreement and the European Climate Law. Besides, the European Member States commit themselves to enhancing their adaptive capacity, strengthening resilience, and reducing vulnerability to climate change. Other European initiatives referring to the Green Deal such as the Biodiversity Strategy, the Renovation Wave, Farm to Fork Strategy, the Circular Economy and Zero Pollution Action Plans, Forest Strategy, Soil Strategy, the Smart and Sustainable Mobility Strategy, and Renewed Sustainable Finance Strategy, are strictly connected to the necessity of undertaking the adaptation path.

A solid knowledge base is required to understand how the impacts of climate change propagate in different systems and economic sectors and undertake effective actions. To this aim, the European Commission is putting a lot of effort into climate knowledge by feeding with updated information on the Climate-ADAPT platform, a helpful source for decision-makers and already a reference tool and a progressively expanding knowledge resource. Climate-ADAPT helps in a deeper understanding of climate-related risks and links at the transnational, national, and subnational levels.

With the newest Adaptation Strategy, the European Commission pushes for acting now and aims to put the foundation to build a more resilient society by increasing knowledge, improving adaptation strategies and plans, promoting local resilience and boost the adoption of adaptation solutions. This will lead to an intensification and broadening of the support to local authorities in developing adaptation strategies. Adaptation is crucial for a global response to climate change and an EU Adaptation Strategy endorses the strategy for a climate-resilient Union reaching all sectors that can give an active participation.

The current status and recent trends of the coastal environments in the Adriatic Sea basin have been characterized in detail by CHANGE WE CARE, one of the cluster projects of CREATE. Quantitative and multidisciplinary information is available in the CHANGE WE CARE Deliverable 3.5.2, retrievable [here](#), and in the linked resources.

From the multi-decadal analyses conducted within CHANGE WE CARE emerged that the Adriatic basin is facing a negative trend in precipitation, with decrease consequences in the freshwater load from the mainland. Hydraulic regimes are affected also by hydropower harvesting and soil protection, and this resulted also in a different modulation of freshwater and sediment discharging. Recent trends exhibited also a dryer precipitation regime that, together with the adoption of water management policies, resulted in a decrease of riverine freshwater load in the order of 30% compared with the 20th century statistics.

This has further led to the accumulation of nutrients and contaminants in the mainland, with possible implication in loss of biodiversity in the basin coastal zone.

Besides, the multi-decadal sea level observations show an acceleration in rise rates throughout all the Adriatic coasts with increased frequency of flood events affecting mostly low-lying coastal plains and cities.

Furthermore, the warming of surface layers, the increase in salinity (due to the decrease of freshwater supply) and the decrease of dissolved oxygen in deep Adriatic layers, are showing the tendency to increase the stratification along the water column. The combination of these processes weakens the Adriatic thermohaline circulation leading to severe consequences in the biogeochemical cycles.

Hydrological, biogeochemical, and meteocean processes of the Adriatic basin are strictly interconnected, and knowing potential variations allows the implementation of adequate

adaptation policies. Creating a solid bridge between the assessment of present conditions and future climate change projections permits to reach solid adaptation knowledge.

Data and projections should converge in the development of adaptation measures. In recent years the European Member States have encouraged the development of national and local strategies following this path, addressing awareness-raising, coordination, and communication of climate change and how to contrast its effects. Adaptation plans include risk reduction, environmental protection, spatial planning, and water resources management. They must be effective, efficient, and coherent with various levels of governance. Although every plan should be tailor-made according to the local characteristics, adaptation cases should be replicable in other similar contexts or can be adapted according to the new condition.

For this reason, representativeness and replicability throughout the Adriatic basin have been key criteria in the identification of the implemented adaptation measures contained in this handbook. The cases here outlined have been found as innovative, efficient in putting effort into capacity building, capable of enhancing the monitoring ability of coastal systems, and producing tools to facilitate the response of coastal communities to marine- and climate-related risks.

The progress of CREATE has permitted to encounter many experiences implemented in our area of interest dealing with the need for adaptation to climate change and its effects or setting the ground for this process. Some of the cases resulted particularly innovative, replicable, and worth being considered as a source of inspiration for planners and decision makers throughout the Adriatic basin. The case studies gathered in this Adaptation Handbook follow the categorization put in place by the Joint Action Plan (JAP), a fundamental plan developed during the 2014-2020 programming period outlining the main actions to be implemented at the Adriatic Sea level for climate change adaptation and mitigation. The main objective of the JAP is to accelerate climate action and ecological transformations in Italy and Croatia and the Mediterranean regions, contributing to the development of a favorable environment. The JAP identifies a number of priority topics to consider for achieving a climate resilient society. These categories want to be a starting point for the development of ideas, projects and tools that allow an integrated and sustainable development of the Adriatic basin.

TOPICS: RESILIENCE & SAFETY

- governance / integrated coastal planning	ADRIADAPT
- adaptation / mitigation capacity building	ADRIADAPT / RESPONSE
- green infrastructure / spatial planning /GIS	CHANGE WE CARE
- wetlands	CREW
- marine biodiversity	ECOSS
- saltwater intrusion	MoST
- plastic pollution in the Adriatic	Net4mPlastic
- microbial contamination of Adriatic	WATERCARE
- multi-hazard risk management	PMO-GATE
-meteo-marine monitoring and modeling systems	AdriaClim
- flood/hazard risk maps and data / EWS	SaferPLACES

Some of the cases reported in the Adaptation Handbook and categorized under the JAP priorities do not address only one topic, but are transverse and cover more than one issue, being able to respond to multiple needs.

1. The measures

PMO Gate - Assess vulnerabilities against disasters

BRIEF DESCRIPTION AND CHALLENGES

PMO Gate aims to increase safety and resilience to disasters due to natural hazards. More specifically, the objective of the initiative is to contribute to people's safety and preserve, at the same time, the cultural heritage and EU's social and economic tissue. The main challenge taken into consideration by PMO Gate is the steady incrementation of precipitation rate and its intensity during the last decade, translating in heavy events characterized by frequent sea floods and strong winds. These events impact old cities and threaten cultural urban centers not able to face these kinds of phenomena. The coastal area of the town of Kaštela is specifically studied and considered by this project, being characterized by over 15 km of coastline in direct contact with people's living spaces. The city of Kaštela is strongly affected by meteorological events putting in great danger in an unpredictable way the community facing heavy rains and threatening properties and lives.

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Multi-hazard risk management



Adaptation measures applied

Beyond the many areas taken into consideration by the project, in Kaštel Kambelovac PMO Gate puts in place methodologies to assess the vulnerability of buildings against natural disasters (e.g. earthquakes and floods caused by rising sea level) were developed with the possibility to replicate the same evaluation of other Adriatic coastal cities. To reach this objective, maps of critical zones were developed and are stored in a new GIS environment, together with an early warning system serving citizens in being aware of emergency services in the process of sea level rise.

Rain gardens and other NBS systems to reduce pluvial floods

BRIEF DESCRIPTION AND CHALLENGES

The city of Pula is characterized by a low amount of annual precipitation and problems with the drainage of stormwater. During the last years, it was documented that rain lasting for 20 minutes is able to cause floods inconvenience; unfortunately, the application of usual drainage systems is not sufficient for the present situation and also for the predicted ones. Besides, the development of adequate infrastructural systems for the reception and drainage of rainwater is proceeding slower compared to the expansion of the city; these constraints lead to the impossibility to manage correctly the amount of water and the incapacity to correctly retain and purify it. To face and overcome these problems, Natura Based Solutions (NBSs) have been planned and applied, permitting to undertake a process of adaption to climate change. The works implemented permitted the reduction of the flood zones in the city, starting from Vladimira Nazor Street, furthermore, another drainage system has been introduced in another part of the city.

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Green infrastructure, spatial planning, GIS



Picture courtesy of Tatjana Uzelac



Picture courtesy of Tatjana Uzelac

Adaptation measures applied

ANBS is found as a suitable system in the most heavily loaded central part of the city, becoming an ideal solution in other parts of the city too. The solutions implemented by exploiting their power of drainage are the following: grassed depressions, infiltration ditches, retention and detention pools, rain gardens, and artificial wetlands. In wet lagoons and extended ones, water is discharged from the highway drainage pipeline system, retained, and then released into the existing mixed drainage system. From streets, water is discharged into rain gardens, infiltration ditches along the roads, and other green areas partially converted into parks. Furthermore, three lagoons were constructed to retain water for at least 24 hours in order to reduce the load on the existing drainage system. The same helped to decrease the annual pollution that was affecting the city. This proves the presence of additional benefits besides those related to climatic influences: like increasing biodiversity, reduction of pollution, reduction of maintenance costs, the addition of further socializing places, etc.

LIFE SEC ADAPT – The common methodology for drafting of the climate change adaptation at municipal level

BRIEF DESCRIPTION AND CHALLENGES

LIFE SEC ADAPT aims to increase climate resilience and facilitate the transition to a low-carbon economy in the European urban area. Among its objective, the adoption and upgrade of the model of the Sustainable Energy Communities – SEC to support the improvement of climate governance and the development of a virtuous climate change adaptation process is found as primary.

Indeed, to pursue this objective is essential to facilitate the adoption of climate adaptation and mitigation policies and actions at a cross-border level, by drawing a joint policy recommendation paper, to implement territorial-coherent strategies. Developing a common methodology is necessary to increase the capacity for climate change adaptation planning in cities. This permits to understand what steps should be taken and how to perform those steps. LIFE SEC ADAPT's objective is to guide the municipality in developing an adaptation strategy with the related plan. Approaches to adaptation are several, very complex, interrelated, often overlapping, and therefore difficult to disentangle one from another. The Plan gives to the user a comprehensive insight into the complexity of adaptation planning. It presents several numbers of cases where strategies and plans were prepared.

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Green infrastructure, spatial planning, GIS

Adaptation measures applied

The common methodology is composed by 4 phases: definition of a political vision, identification of potential adaptation options, prioritization and selection of best options, drafting and adopting the municipal climate adaptation strategy and plan. Considering that governance is often the critical step allowing the transposition of adaptation to municipal and local levels, it is fundamental to create an enabling institutional and organization framework for the process to succeed. Furthermore, a review of the available knowledge is necessary to establish a baseline situation, having in mind the legal basis, the scientific research and the activities implemented so far. The process to the urban climate change adaptation, after the preparatory activities for getting starts, should encompass the following steps: vulnerability and risk assessment, definition of the Vision Statement on adaptation, identification of the adaptation options, drafting and adoption of the Strategy, drafting and adoption of the plan.

SECAP – Heat recovery from wastewater in the Municipality of Kranj

BRIEF DESCRIPTION AND CHALLENGES

A feasibility study was conducted in SECAP project to understand if it is possible the recovery heat power deriving from the wastewater system of the Municipality of Kranj (Slovenia). One of the biggest challenges of our century is energy efficiency because traditional sources cannot be any more thought of as a permanent solution. In this study is conducted the identification of the potential places where a heat recovery system can be implemented, allowing the calculation of the heat potential and finding technological solutions. The study conducted has the overall objective to: confirm the possibility of exploiting the energy for heating and cooling, identifying potential sites in the Kranj wastewater system and identifying possible technological solutions with a suitable financial analysis of the investment.

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Green infrastructure, spatial planning, GIS

Adaptation measures applied

The feasibility study follows the necessity to improve energy efficiency by exploiting the municipal wastewater management system that is going to be revised after several real estate projects that will take place between 2025 and 2030. Input temperature, volume, water quality, technical conditions of the wastewater system and the distance between heat recovery and buildings together with citizens' needs are variables considered in the study. In the area of Kranj, the analyses conducted exposed several technological options to exploit the wastewater temperature averaging between 10°C and 15°C. Furthermore, risks are identified to: the functioning of the wastewater system, the functioning of the treatment system, the functioning of the heat recovery, and legal and property risks. Beyond the guidelines reported to determine the suitability of a site and the typology of technology to be implemented, two sites are identified for the implementation of the temperature exploitation system: the Planina site near the future Iskrice apartment building and the Kranj OČN site, both projects foreseen in the near future.

Veneto Adapt in Medio Brenta – improving environments to resist flooding

BRIEF DESCRIPTION AND CHALLENGES

Three areas in Cadoneghe, Vigodarzere, and Curtarolo are partially degraded from the environmental point of view and subjected to floods even when no intense precipitation occurs. In all three sites, actions of naturalization along the river to manage correctly the high volume of water in the urban areas are conducted. Moreover, in each site further actions of recovering urban areas are implemented: in the Municipality of Cadoneghe an ex-industrial area decommissioned and degraded is restored; in Vigodarzere hydraulic issues affecting the sports center near the Brenta River are solved; then in Curtarolo works to limit the flooding events coming along the Plovetta drain are conducted. By increasing green areas, further improvements are obtained, with the maintenance of ecosystem services and the absorption of urban pollution.

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Green infrastructure, spatial planning, GIS

Adaptation measures applied

The interventions foreseen by the project are hydraulic requalification, resolution of criticisms by improving the environment in the area subject to floods in urban areas, improving the quality of air and water, increasing soil permeability, and increasing water availability. In Cadoneghe urban drainage techniques were applied, with the creation of basins, the realization of phyto depuration systems, and a decrease of waterproofing soil. In the Municipality of Curtarolo a new canal and a new basin with the aims of collecting water and recharge of the stratum. In conclusion, the interventions in the Municipality of Vigodarzere consist of an urban drain on parking areas and the realization of a filter zone. All three interventions consist also in increment the vegetation ideal to adapt to climate change.

LIFE VIMINE – environmental engineering applications for the protection of the lagoon

BRIEF DESCRIPTION AND CHALLENGES

Erosion is one of the main effects of climate change. With an integrated approach, LIFE VIMINE tested the efficacy of the protection of the most internal sandbar from erosion. These are fragile environments where usual means of protection do not have any effects. With LIFE VIMINE soft protection measures are implemented from environmental engineering supported by ordinary maintenance actions. These interventions must be regular in order to intervene when erosion occurs and before damages become higher. This allows to save finance and make the interventions more efficient. Sandbars are essential for their capacity to protect the coast and being an important hotspot for fauna and flora. In addition, these formations are protected by the Habitat Directive 92/43/EEC, and Birds Directive 2009/147/EC.

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Wetlands



Pictures courtesy of LIFE VIMINE PROJECT – Grant Agreement LIFE12 NAT/IT/001122

Adaptation measures applied

The measure applied by LIFE VIMINE is an integrated approach to protect the most internal sandbar and wetlands from erosion. The area Palude dei Laghi in Laguna Nord di Venezia is characterized by the natural sandbar, difficult to be replaced with reconstructed ones. Their conservation is planned through the application of environmental engineering techniques consisting in implementing organic and natural materials (plants, wood, sediment, etc.) and by exploiting natural processes such as the ability of plants in consolidating soil and to facilitate sedimentation. The process of maintenance is in charge of local workers for their capacity in moving in these environments. Summarizing, the approach promoted by LIFE VIMINE is considered as a method contrasting the morphological decline of these environments. An added value is the application of environmental engineering and manual work (no mechanical ones were permitted); applying prevention actions; implementing local workers; employing material from the territory, and promoting participation and education.

ASTERIS – Saltwater Intrusion connected to management of water resources

BRIEF DESCRIPTION AND CHALLENGES

Salinization is caused by multiple sources, from inundation or storm surges, from the encroachment of freshwater/saltwater, and from upcoming groundwater caused by pumping. Assessing the risk of salinization considers either loss, in terms of economic costs, and vulnerability, meaning aquifer susceptibility and hazard threats. Mapping hazards from salt intrusion allow to characterize aquifers and anthropic pressure; ASTERIS provided, in this way, a large-scale definition of aquifer vulnerability for different areas within the northern Adriatic basin. Furthermore, the development of a conceptual model for the risk assessment extended to a broad area consisting of 3 countries and 2000 km of coast including a variety of geological, morphological, and socioeconomic conditions. The map created with this model becomes a helpful tool for the administration for authorizing further water extraction and compare different locations.

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Saltwater intrusion

Flood and hazard risk maps and data

Adaptation measures applied

The conceptual model considers simultaneously vulnerability and potential loss, it considers also future scenarios in order to provide not a status map but a dynamic tool to address the government's choices about water resource use. The analysis, conducted with GIS, considered a buffer area of 5km from the coast to the interior combining aquifer susceptibility, hazard threats, and loss. Aquifer susceptibility is based on hydrogeology, lithology, and aquifer type, together with elevation and distance from the coast. Hazard threats consist of sea level rise and storm surge, with projections in the future, and pumping from wells. Economic loss is represented by economic consequences due to contamination of water supply: damage to intensive business (e.g. agriculture) and costs of replacement and restoration. The assessment permitted the creation of maps of risk, an example is applied to the area of Fano at two resolutions: 1km x 1km and 250m x 250m permitting to understand of the variation of risk in the function of the density of wells in the Metauro River alluvial plan.

Joint_SECAP – exchange of experiences to solve criticisms

BRIEF DESCRIPTION AND CHALLENGES

Technical workshops are organized to compare and disseminate experiences made in different territories and validate them. It is fundamental to bring results obtained in different target areas, find criticisms and develop original approaches. The methodology applied should be evaluated in detail, to find problems and successes encountered. To this aim a “vademecum” collecting all the experiences gained by the project, is produced as a small guide with the operational indication for the repeatability of the methodology in other territories. Undertake joint adaptation actions, not focusing on administrative boundaries, permit to reach more effective results.

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Adaptation, mitigation and capacity building

Adaptation measures applied

A common methodology, the so-called “vademecum”, has been produced with the objective to become an easy-to-read technical support for building homogeneous SECAP between municipalities. This comprehends climatic, environmental, and development dynamics, adapting the methodology of the territory permitting to share of basic knowledge, and promoting the assessment of the vulnerabilities and climatic risks. Joint and shared actions permit combined efforts on the preparation, implementation, and monitoring of the action plan. The vademecum developed exposes the construction of actions configured as a step-by-step process involving stakeholders and structured as follows: a first phase consisting of a recognition of plans and measures already planned; a climatic analysis; the recognition of international case studies to compare different methodologies. The part referring to the construction of the adaptation actions consists of the construction of “0” and “optimal” scenarios; identification of a list of adaptation measures; prioritize the joint adaptation actions.

Redevelopment of the Premi Nobel Square

BRIEF DESCRIPTION AND CHALLENGES

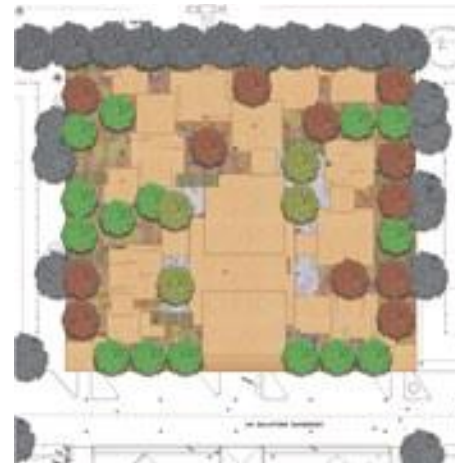
Localities along the coast of Emilia-Romagna are characterized by criticalities such as heat islands, rainfall floods, and droughts, with an increment of their frequency and intensity. The city of Cervia is investing in urban regeneration using Nature Based Solutions (NBSs) and other climate change mitigation and adaptation solutions. Cities are characterized by obsolete and critical issues deriving from older construction and planning. An example is Piazza Premi Nobel in Cervia (RA), which suffers from issues regarding proportions, accessibility, safety, environment-sustainable criteria of construction and material, and furnishing. The restoration of this place is considered in a view of improving environmental performance and rebalancing the proportion by putting vegetation in a central role covering approximately 50% of the total surface area. The project will solve critical issues and will improve the square's environmental performance with a significant increase in the permeable surface area, insertion of rain gardens, and increase of tree surface to improve air quality, reduce heat island and recover rainwater.

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Green infrastructure, spatial planning, GIS



Picture courtesy of Eng. Arch. Caterina, Girelli; Arch. Marialuisa Cipriani (architectural project); Devis Lombardi (industrial expert, the plants project related to public lightning works); Eng. Luigi Bartoli (Safety coordinator); and Arch. Manuel Pazzaglia (Sole Manager of the Procedure)

Adaptation measures applied

The interventions in terms of the restoration of Piazza Premi Nobel is one of the administration's priorities because of its central role in the locality, frequently visited by tourists and citizens but unattractive due to its obsolete and critical condition. The restoration intervention, in view of adaptation to climate change, comprehends an increase of the square permeability by changing its pavement in 50% of the area, leading to increased absorption of 90% of the total rainwater. The remaining surface will be dedicated to the placement of flowerbeds and vegetation in order to make them 100% able to absorb rainfall. Furthermore, another benefit will be obtained from the implementation of these measures given their capacity of filtering and purify the water, allowing a smoother slowdown of the inflow. Besides, implementing vegetation mitigation of the microclima is guaranteed, creating shaded areas.

Integrated Adaptation Planning Tool

BRIEF DESCRIPTION AND CHALLENGES

Safety of citizens and of the territory is safeguarded by a good preparation to climate change. Boost adaptation capacity can improve resilience and reduce costs from damages and impacts.

At the same time applying an integrated approach permit to improve life of citizens and sustain the principle of sustainable development. An integrated approach permits also to deal with the complex of nature of climate change and their effects. It allows to reach the maximal benefit and tackling resilience. Governance is the first step to be undertake to prepare adaptation plan.

Governance is the capacity to respond effectively to changing conditions and to problems that may occur. To achieve a climate solution, cities and regions need support from as many social groups as possible. Governance requires also the support from stakeholders acting as key players.

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Governance, integrated coastal planning

Adaptation, mitigation and capacity building



<https://adriadapt.eu/it/>

Adaptation measures applied

Even if governance is a long-term process, it must be implemented building trust, relationships, and support communities. AdriAdapt provides a simple, stepwise approach, leading to the process of preparing local and regional adaptation plan. This process foreseen 5 steps: starting the process, assessing the vulnerability, setting the vision, designing the plan, implementing the plan. Furthermore, specific attention is considered also with a chapter on "stakeholders engagement". Each step is supported by clear indications on how to conduct the processes, with expected outcomes and, according to the chapter considered, also the suggested tool to procedure in the right direction. A fundamental role is in the review process, aiming to understand if the plan developed "is going into the right way". Monitoring and evaluating are crucial part of plans, permitting to focus the potentiality of adaptation measures.

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