

AdriaClim

Climate change information, monitoring and management tools for adaptation strategies in Adriatic coastal areas

Project ID: 10252001

D.5.7.2 Guidance for local adaptation and mitigation strategies

Study of the Adaptation and Planning of Measures for Mitigating Climate Change Impacts in the Municipality Dubrovačko primorje

(Slano bay)

December 2022.

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Legislative framework

International policy for adaptation to climate change

The Paris Agreement aims to combat climate change and accelerate activities and investment in a sustainable low-carbon future. The goal is to limit the increase in global average temperature to "significantly less" than 2 °C, i.e. up to 1.5 °C compared to the pre-industrial period. A global goal for adaptation to climate change is also defined: "enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable development and ensuring an adequate adaptation response in the context of the temperature goal" (Article 7).

Negotiations are underway to define the methods for implementing and monitoring the Paris Agreement, which take place at the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement as part of the meetings of the UN Convention on Climate Change.

Croatia, as a party to the Paris Agreement, participates in these negotiations. Also, as a party to the Convention on Climate Change, it submits periodic reports in which, among other things, it reports on adaptation to climate change.

The Intergovernmental Panel on Climate Change (IPCC) is a body of the United Nations, founded in 1988, which prepares its own reports based on scientific research on climate change. The reports serve to ensure that decision-makers base their policy proposals on scientific knowledge about climate change, its implications, and potential future risks. The IPCC also proposes options for adaptation and mitigation of climate change.

European Union policy for adaptation to climate change

The Ministry participates in the work of various bodies of the European Commission and the Council of the European Union on the further development of climate change adaptation policy at the EU level. There are no specific EU rules (directives, regulations) related to adaptation to climate change, but the concept of adaptation is integrated into various other policies as well as the EU budget, and various guidelines are being drawn up.

The European Commission adopted a new EU climate change adaptation strategy on 24 February 2021. The new strategy sets out how the European Union can adapt to the inevitable impacts of climate change and become resilient to the coming changes by 2050. The impact of climate change is so widespread that our answer to them must be systematic. Therefore, the European Commission will actively include aspects of climate change resilience in all relevant policy areas related to both the public and private sectors.

The European Commission supports implementation of adaptation strategies and plans at all levels of management. In this systematic approach, there are three cross-sectoral priorities:

- inclusion of adjustment in macro-fiscal policy
- implementation of adaptation with Nature-based Solutions (NbS) and
- implementation of adaptation measures at the local level.

National policy for adaptation to climate change

Legislative and strategic framework

The Ministry of Economy and Sustainable Development, as the coordinator of the climate change policy, has been working intensely to promote the policy of adaptation to climate change. Pursuant to the Act on Climate Change and Protection of the Ozone Layer (Official Gazette “Narodne novine” no. 127/19), the Climate Change Adaptation Strategy in Croatia for the period up to 2040 with a view to 2070 was prepared (Official Gazette “Narodne novine” no. 46/20) and was adopted by the Croatian Parliament on 7 April 2020.

Climate change adaptation strategy

Adaptation strategy is the first strategic document that provides an assessment of climate change for Croatia by the end of 2040 and 2070, along with possible impacts and vulnerability assessments. The goal of the Strategy is to raise awareness of the importance and threats of climate change to the society and the necessity of integrating the concept of adaptation to climate change into existing and new policies, and to do that in order to reduce the vulnerability of the environment, economy and society caused by climate change. In addition, the goal is to stimulate direct scientific research to better understand the complexity of the impact of climate change and reduce the degree of uncertainty related to the effects of climate change.

The Strategy shows the vulnerability of sectors to climate change, among which eight key sectors (water resources, agriculture, forestry, fisheries, biodiversity, energy, tourism, and health) and two cross-sectoral thematic areas (physical planning and development and risk management) were selected. There are 83 specified climate change adaptation measures for these sectors and areas, and they are divided into five groups. These also highlight estimates of the necessary amounts and sources of financing by sector.

The adaptation strategy will be implemented through action plans, which will contain the elaboration of specific measures and activities and will be adopted every five years. Action plans for each measure and activity will provide a description, method of implementation, order of implementation of activities, deadline for implementation, obligatory parties and coordinators of the implementation of measures and activities, as well as sources of funding.

Low-carbon development strategy of the Republic of Croatia until 2030 with an outlook to 2050

The Act on Climate Change and Ozone Layer Protection (Official Gazette „Narodne novine“ no. 127/19) defines the obligation to develop the Low-Carbon Development Strategy of the Republic of Croatia until 2030 with an Outlook to 2050 and the Action Plan for the Implementation of the Low-Carbon Strategy for a Period of Five Years. This document represents the first long-term strategy which will analyse the possibilities of developing a society that contributes to the reduction of greenhouse gases. The strategy shows three scenarios that help to identify activities necessary to reduce greenhouse gas emissions in Croatia.

During the development of the Low-Carbon Strategy, a series of scenarios was analysed, and numerous simulation and optimisation models were applied, along with the development of an integral model for national projections of greenhouse gases (Low-Carbon Strategic Planning of the Republic of Croatia). Greenhouse gas emissions and projections are displayed according to the methodology from the guide of the Intergovernmental Panel on Climate Change of 2006 and in

accordance with the appropriate factors for greenhouse potential to calculate CO₂ emission equivalents.

Description of the Pilot Site

Dubrovačko primorje Municipality is located at a favourable geographical and traffic location in the south of the Republic of Croatia and is a constituent part of the Dubrovnik-Neretva County. The surface area of the Municipality is 197.11 km², and its territory is divided into 20 settlements, some of which are located at the very coast, while others are dispersed across the hinterland of the Dubrovačko primorje.

From a geographical point of view, the area of the Municipality can be divided into two natural units:

- lower coastal area (Doli-Banići-Kručica-Slano-Majkovi) with the Adriatic tourist road as the backbone and the long coastline serving as the attraction; and
- the higher hilly hinterland (from Trnova in the southeast to Imotica in the northwest) with some particularities in the eastern and western area.

The majority of the coastal part of the terrain rises steeply above the sea, but the terrain is less demanding on some areas (Slano-Banići area). In parallel with the coastline, the terrain rises towards the hinterland, where the far eastern parts of the Municipality have the highest altitude of over 900 m a.s.l. The highest peak is Neprobić with an altitude of 965 m and it is located north of the Slano village, near the state border. The hinterland has several larger fields or plateaus. These are the areas of Imotica-Ošlje, Smokovljani-Visočani, Točionik-Podimoč and Rudine.

Hydrological, geomorphological characteristics

Two natural units can be distinguished in the area, the lower coastal area that extends to the string of villages Doli - Banići - Kručica - Slano - Majkovi and the rather hilly hinterland from Trnova in the south-eastern part of the Municipality to Imotica in the northwest. The Dubrovačko primorje area is a typical waterless karst Dinaric area; limestones, dolomites, and flysch are the most common in the composition and structure of rocks. When going from the inner land to the coast, there is a combination of Upper Cretaceous and Jurassic limestone, Upper-Triassic dolomites, Eocene flysch and carbonates, which partially follow after Cretaceous limestone and dolomites. The geomorphological shaping of the area of the Dubrovačko primorje Municipality is determined by the geological structure and prevailing exogenous and endogenous processes (Savin et al., 2021). On the territory of the Municipality there are occasional streams - torrents, but there are no permanent streams due to the high permeability of the terrain. Water springs are very rare, but they are more common on the coast at the contact of permeable and impermeable deposits. Hydrogeological research determined the layers of individual major springs and groups of springs located in the Municipality:

- the basin of springs and submarine springs in the area of Klek, Bistrina cove and the Mali Ston channel
- the basin of springs Mali Zaton – Slano
- the basin of springs and submarine springs of the Doli - Banići - Slano area.

The territory of Dubrovačko primorje belongs to the Mediterranean range of climate and vegetation. According to the Köppen classification, it is an area of Csa climate, which is a moderately warm rainy climate with dry summers. Winters are rainy and mild, and summers are hot and dry. There is no dedicated meteorological station in the territory of the Municipality, and basic

climatological characteristics of the Dubrovačko primorje Municipality are estimated based on the data from the meteorological station Tršteno, which is located closest to this area. In the Dubrovačko primorje area from autumn to spring, bora (advection of air from the land) and the sirocco wind (advection of air from the southern quadrant) stand out. During the summer, the weather is undisturbed, and the maestro wind is prevalent. An important climate indicator is the annual course of air temperature: the mean annual value of the air temperature is 15.6 °C. The lowest mean monthly air temperature is in January and is 8.2 °C, while the highest mean monthly air temperature is in July and it is 24.1 °C (Savin et al., 2021).

The annual distribution of precipitation is typical Mediterranean. In total, a relatively large amount of precipitation falls annually (1122.4 mm). This amount of precipitation indicates a distinct orographic effect, because in the immediate hinterland there are high elevations. The most precipitation falls in the autumn and winter months, and the least in the summer, where 33.6 mm was recorded in July. (Savin et al., 2021).

The annual average of days with precipitation is 110, with every third day being rainy, if we exclude the summer period. The most frequent winds in Tršteno, and therefore in the Dubrovačko primorje area, are from the direction of the south (18%), north (13.7%), and west (11.4%), while a period without wind was recorded with a frequency of 10.5%. Winds in the Dubrovnik area are mostly of moderate strength, rarely reaching a strength greater than 6 on the Beaufort scale. There are occasional surges of bora from the Ston channel, which, due to the morphology of the terrain, is channelled in the NNW-SSE direction.

Biodiversity

Habitat and Vegetation

According to phytogeographical regionalisation, this area belongs to the thermo-Mediterranean vegetation zone of the Mediterranean phytogeographical region. A general feature of this region is the reduced amount or even complete lack of vegetation caused by high summer temperatures and significant droughts which have detrimental effects on both the natural vegetation cover and cultivated plants, most specifically olive and vine. According to the basic data of the Dubrovačko primorje Municipality, there is sparse woodland cover, and the largest surface area is taken up by low-growth communities of maquis, garrigue and thicket. The following information is characteristic of certain plant species: indigenous stands of evergreen or holm oak (*Quercus ilex*) are dominant within the indigenous community of maquis (*Orno-Quercetum ilicis typicum*). According to basic data of the Municipality, alongside the evergreen oak, the following species are the most prevalent in the forest and maquis:

- laurel (*Laurus nobilis*)
- strawberry tree (*Arbutus unedo*)
- mastic tree (*Pistacia letiscus*)
- juniper (*Juniperus oxycedrus*, *J. macrocarpa*, *J. phoenicea*)
- common myrtle (*Myrtus communis*)
- mock privet / green olive tree (*Phyllirea latifolia*)
- laurustine (*Viburnum tinus*)
- rush broom (*Spartium junceum*)
- butcher's broom (*Ruscus aculeanus*)
- sorb tree (*Sorbus domestica*)

- almond-leaved pear (*Pirus amygdaliformis*)
- sloe (*Prunus spinosa*)
- wild olive (*Olea oleaster*)

Some of the garrigue species are the following:

- rosemary (*Rosmarinus officinalis*)
- pink-rock rose (*Cistus vilosus*)
- tree heath (*Erica arborea*)
- kermes oak (*Quercus coccifera*)
- white wormwood (*Artemisia alba*)

Some of the low-growth communities are the following:

- sage (*Salvia officinalis*)
- tree spurge (*Euphorbia dendroides*)
- everlasting (*Helicrysum italioicum*)
- burdock clover (*Trifolium lappaceum*)
- thyme (*Thymus longicaulis*)
- rattail sixweeks grass (*Vulpis myoris*)
- yellow serradella (*Ornithopus corpressus*)
- European cornel (*Cornus mas*)

as well as many other.

Maquis and garrigue are intertwined with lianas and climbing plants. Isolated trees or groups of Mediterranean cypress (*Cupressus sempervirens pyramidalis*) stand out in the landscape. Subtropical and tropical species are also present in this area: palm, acacia, aloe, eucalyptus, cactus, agave; and other decorative, but already domesticated species: oleander, tamarisk, and other. Some of the more prominent cultivated species are olive, vine, carob tree, fig, rosehip. Some of the cultivated citruses are lemon, mandarin orange, orange, citrus, almond, sorb tree, peach, various species of plums, apple, mulberry, walnut, and quince (dubrovackoprимorje.hr).

The plant species that is the target species in the ecological network is *Himantoglossum adriaticum*, which grows in the Dubrovačko primorje area of Doli.

According to the Red List categories of the International Union for Conservation of Nature (IUCN), there are also some threatened species of vascular flora represented at the area of the Municipality (Table 1).

Table 1 Threatened species of vascular flora at the area of the Dubrovačko primorje Municipality

Latin species name	Red List categories
<i>Carex divisa</i>	endangered (EN)
<i>Carex flava</i>	endangered (EN)
<i>Delphinium staphisagria</i>	endangered (EN)
<i>Urtica membranacea</i>	endangered (EN)
<i>Cyperus longus</i>	vulnerable (VU)

<i>Hordeum marinum</i>	vulnerable (VU)
<i>Lilium martagon</i>	vulnerable (VU)
<i>Ophrys sphegodes</i>	vulnerable (VU)
<i>Suaeda maritima</i>	vulnerable (VU)
Latinski naziv podvrste	
<i>Blackstonia perfoliata ssp. serotina</i>	endangered (EN)

At the area of the Dubrovačko primorje Municipality there are several types of endangered and rare land habitats according to the Regulations on the List of Habitat Types and Habitat Maps, but there are also generally significant habitats to the ecological network, as is specified in the following table (Table 2):

- Alpine-Carpathian-Balkan limestone rocks: chasmophytic plant communities in the cracks of limestone rocks of the sub-alpine and alpine, and more rarely in the montane and alti-montane vegetation zones
- Tyrrhenian-Adriatic limestone rocks: chasmophytic plant vegetation developed in the cracks of dry carbonate rocks
- Illyrian-Adriatic littoral screes
- sub-Mediterranean and epi-Mediterranean dry grassland: communities developed on carbonate soil where there are effects of the Mediterranean climate – they stretch along the East Adriatic littoral and in parts of the inner Dinaric Alps
- stony pastures and dry grassland of the eu-Mediterranean and thermo-Mediterranean: communities developed on carbonate soil where there are effects of the Mediterranean climate – they stretch along the East Adriatic littoral and in parts of the inner Dinaric Alps
- bush: low evergreen thickets growing on an alkaline substrate; degradation stage of evergreen forest vegetation; they are comprised of under-developed shrubs mostly of the following families: *Cistaceae*, *Ericaceae*, *Fabaceae*, *Lamiaceae*
- littoral thermophilic forests and thickets of downy oak
- mixed forest and maquis of holm oak with manna ash
- maquis of wild olive and tree spurge: the composition is dominated by *Euphorbia dendroides*, while the following species are also present in such communities: *Olea europaea subsp. sylvestris*, *Pistacia lentiscus*, *Myrtus communis*, *Ceratonia siliqua*, *Phillyrea media*, *Ephedra fragilis*, *Prasium majus*, *Arisarum vulgare*, *Coronilla emeroides*
- biocenosis of the upper mediolittoral rock: more exposed to drying, dominated by lithophytic cyanobacteria, some snails that are of the *Patella* genus and barnacles of the *Chthamalus stellatus* species
- biocenosis of the lower mediolittoral rock: less exposed to drying than the biocenosis of upper mediolittoral rock; important associations with the limestone encrusting red algae
- infralittoral fine sand with more or less mud: infralittoral habitats on a sand substrate
- posidonia beds: areas covered with a flowering seagrass of the *Posidonia oceanica* species
- infralittoral hard beds and rocks: infralittoral habitats on a rocky, hard bottom.

Table 2 Endangered and rare habitats in the area of the Dubrovačko primorje Municipality

CODE	Habitat type
Land habitats	
B. Undergrown and poorly grown land areas	
B.1.3.	Alpine-Carpathian-Balkan limestone rocks
B.1.4.	Tyrrhenian-Adriatic limestone rocks
B.2.2.	Illyrian-Adriatic littoral screes
C. Grassland, mires, tall herbs, and thickets	
C.3.5.	sub-Mediterranean and epi-Mediterranean dry grassland
C.3.6.	stony pastures and dry grassland of the eu-Mediterranean and thermo-Mediterranean
D. Thickets	
D.3.4.	Bush
E. Forests	
E.3.5.	littoral thermophilic forest and thickets of downy oak
E.8.1.1.	mixed forest and maquis of holm oak with manna ash
E.8.2.2.	maquis of wild olive and tree spurge
Marine habitats	
G.2.4.1.	biocenosis of the upper mediolittoral rock
G.2.4.2.	biocenosis of the lower mediolittoral rock
G.3.2.	infralittoral fine sand with more or less mud
G.3.5.	posidonia beds
G.3.6.	infralittoral hard beds and rocks

Fauna

In the area of the Dubrovačko primorje Municipality there are rare and endangered animal species of freshwater fish, odonata, amphibians and reptiles, birds, mammals, and cave fauna according to the classification of the International Union for Conservation of Nature (IUCN), and all the species are shown below (Table 3).

Table 3 Endangered animal species from the area of the Dubrovačko primorje Municipality

	Latin species name	Common species name	Red List category
Freshwater fish	<i>Acipenser naccarii</i>	Adriatic sturgeon	critically endangered (CR)
	<i>Salmo marmoratus</i>	marble trout	critically endangered (CR)
	<i>Gasterosteus aculeatus</i>	three-spined stickleback	endangered (EN)
	<i>Salmo farioides</i>	West Balkan trout	endangered (EN)
	<i>Salaria fluviatilis</i>	freshwater blenny	vulnerable (VU)
Odonata	<i>Ceragrion tenellum</i>	small red damselfly	vulnerable (VU)
Amphibians	<i>Proteus anguinus</i>	olm	endangered (EN)
Reptiles	<i>Mauremys rivulata</i>	Balkan pond turtle	endangered (EN)

Birds	<i>Aquila chrysaetos</i>	golden eagle	critically endangered (CR)
	<i>Circaetus gallicus</i>	short-toed snake eagle	endangered (EN)
	<i>Falco peregrinus</i>	peregrine falcon	vulnerable (VU)
	<i>Lymnocyptes minimus</i>	jack snipe*	vulnerable (VU)
	<i>Numenius phaeopus</i>	whimbrel	vulnerable (VU)
Mammals	<i>Miniopterus schreibersii</i>	Schreiber's bat	endangered (EN)
	<i>Rhinolophus blasii</i>	Blasius' horseshoe bat	vulnerable (VU)
	<i>Rhinolophus euryale</i>	Mediterranean horseshoe bat	vulnerable (VU)
Cave fauna	<i>Saxurinator brandti</i>	Brandt's cave water snail	endangered (EN)
	<i>Alpioniscus heroldi</i>	Herold's Illyrian woodlouse	vulnerable (VU)
	<i>Cyphoniscellus herzegowinensis</i>	Herzegovinian humpback woodlouse	vulnerable (VU)
	<i>Pholeoteras euthrix</i>	pilous cave snail	vulnerable (VU)
	<i>Proteus anguinus</i>	Olm	vulnerable (VU)

*The jack snipe probably winters at the location of the Dubrovačko primorje Municipality

The following animal species that are relevant for hunting can be found in the Municipality area: pheasant, European rabbit, rock partridge, common quail, wild boar, fox, jackal, wolf, beech marten, badger and mongoose (dubrovackoprимorje.hr).

The target species of the ecological network in the Municipality area is the Balkan pond turtle (*Mauremys rivulata*), which is also present in the Prljevići pool and in the Gornji Majkovi pools.

Protected Areas and Ecological Network Areas

At the Dubrovačko primorje Municipality there are significant natural areas that are protected pursuant to the Nature Protection Act (Official Gazette "Narodne novine" nos 80/13, 15/18, 14/19, and 127/19), while some are protected under the Ecological Network Regulation (Official Gazette "Narodne novine" no. 80/90), and they form a part of the ecological network of the Republic of Croatia.

The following parts of nature are protected in the Dubrovačko primorje Municipality under the Nature Protection Act:

- Mali Ston Bay – special reserve
- Majkovi pools – special reserve.

The table below lists parts of the Dubrovačko primorje Municipality that are part of the ecological network (Natura2000).

Table 4 Parts of the Natura 2000 ecological network at the Dubrovačko primorje Municipality and the corresponding surface areas

CODE	Area name	Surface area (ha)
HR4000015	Mali Ston Bay	5,717.24
HR2000947	Gornji Majkovi – pools	13.18
HR2000950	Slano – oleanders	80.96
HR3000163	Ston channel	569.19
HR3000165	Slano cove	133.41
HR2000555	Prljevići pool	0.08

HR2001490	Dubrovačko primorje - Doli	6.89
HR2001451	Jama za Rasohama (pit)	0.78
HR2001454	Zadubravica pit	0.78
HR2001452	Vilinska špilja (cave)	0.78

Process Dynamics at the Pilot Site within the context of Climate Change

Late Pleistocene / Holocene rising of the sea level by some 100 m created the coastline of the Dubrovačko primorje as it stands today. The Koločep channel separated the Elaphiti Islands from the Littoral, and along the littoral coastline numerous coves and bays were formed: Slano, Janska, Budima, Doli and the Bistrina cove at the Mali Ston Bay. The coast is mostly steep and rocky (Karlić, Mujo, H., 2009). Today the coast is mostly used through tourism, which is the most advantageous economic sector of the area. This pertains foremost to the coast of the Slano bay, and in a lesser part to the coastline below the villages of Kručica, Banići and Doli (Karlić, Mujo, H., 2009). This document poses the question of how the climate changes will affect primarily tourism as the main economic activity of the entire area, but also other economic sectors. In observing the World Bank models for Croatia, some parallels may be drawn at the area of the Slano cove and its surroundings.

Air temperature

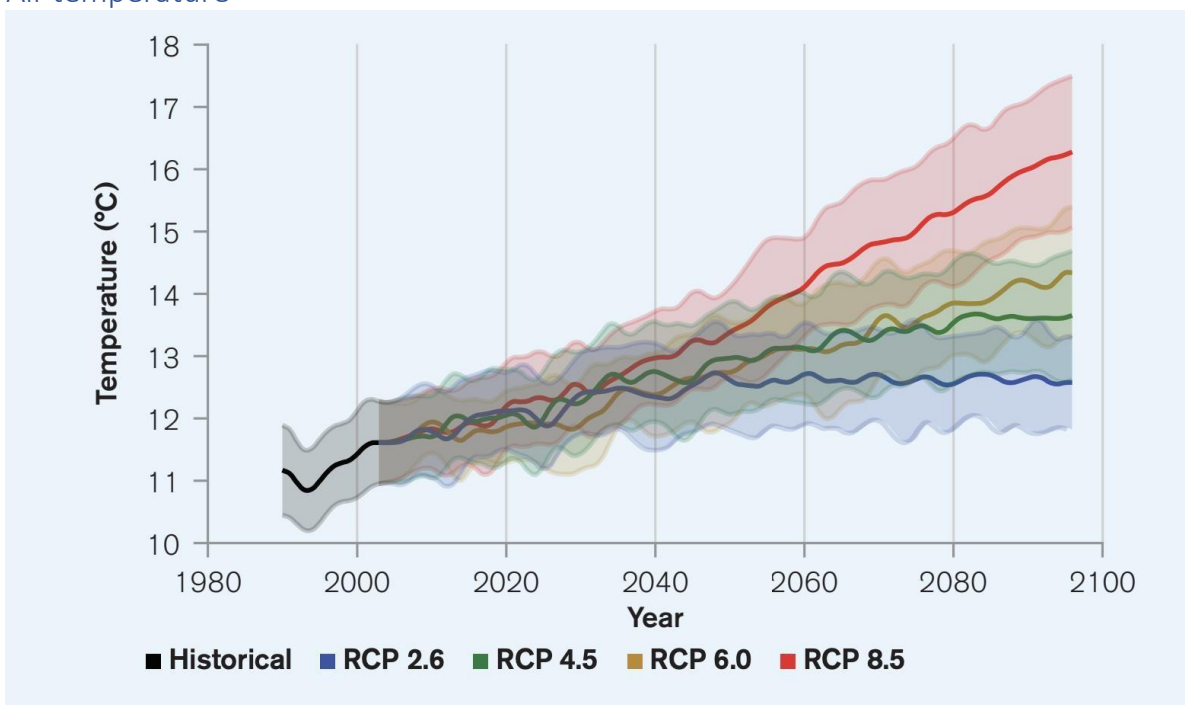


Figure 1 Projections of the average air temperature for Croatia (reference period: 1986-2095, source: CCKP 2021)

According to these projections, the expectation is that Croatia will be warmer and drier (Figure 1), which will be manifested in the summer months (May – September). Depending on the CO₂ amounts in the air by 2100, a change of less than one degree is possible in the event of a complete switch to a CO₂-neutral economy (RCP 2.6), and more than 5 degrees if the CO₂ keeps being emitted into the atmosphere at the same levels as now (RCP 8.5).

Sea level and temperature

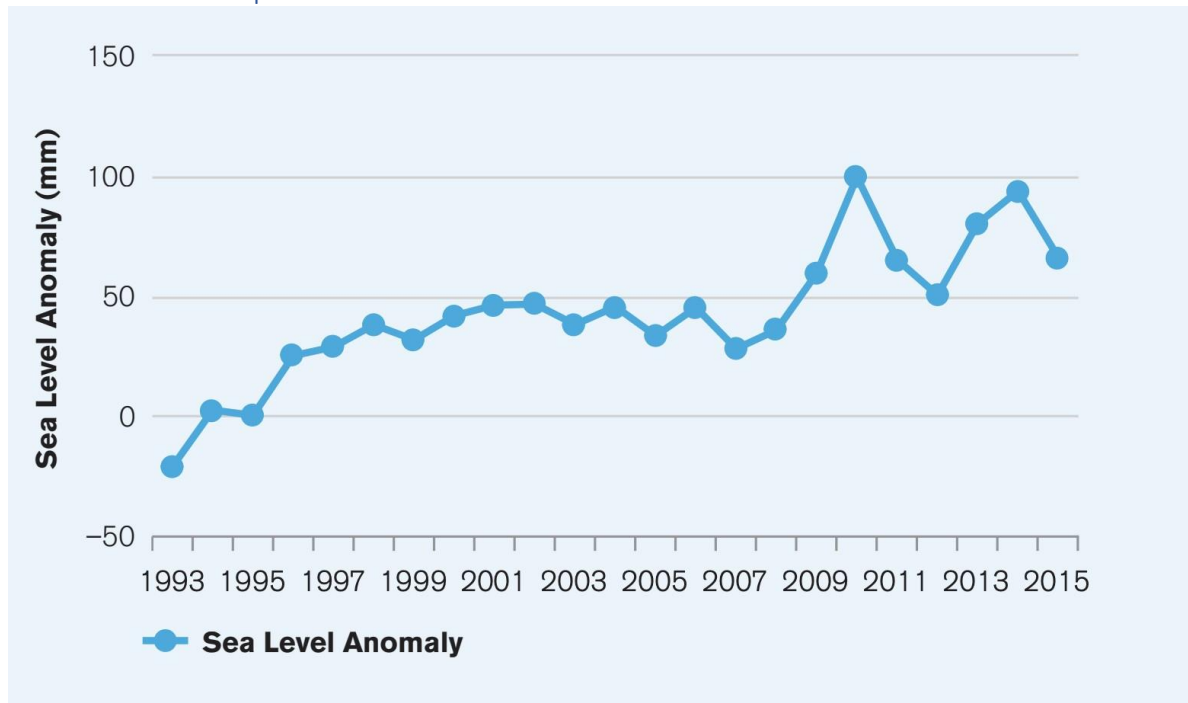


Figure 2 Changes in the sea level from 1993 to 2015 (Source: Ministry of Environment Protection and Nature, 2018)

According to the estimates of the Ministry of Environment Protection and Nature of 2018 (Ministry of Environment Protection and Nature, 2018, Figure 2), an increase in the sea level is expected and an increase in the sea temperature is also expected. Although an increase in the sea level and temperature is most likely, the intensity at which it will occur is highly unpredictable and varies in range from a few centimetres to several meters in 2100.

Precipitation

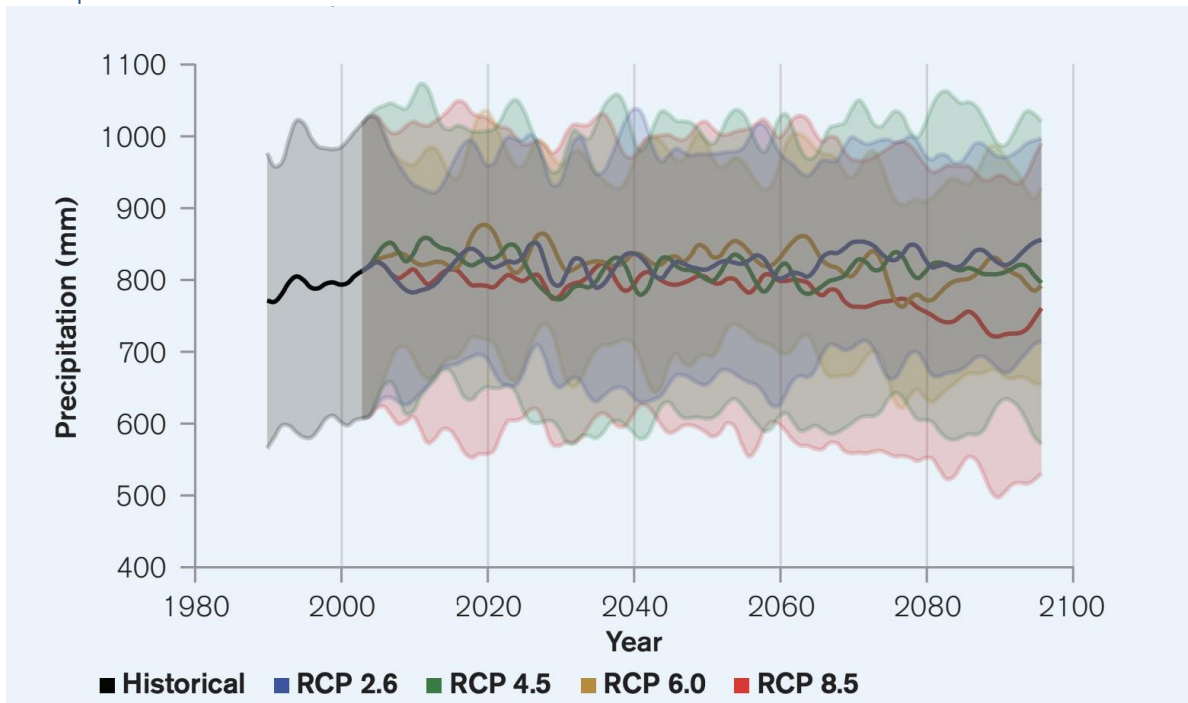


Figure 3 Projections of annual average precipitation quantities in Croatia (reference period: 1986-2005, CCKP,2021)

As can be seen from the above graph (Figure 3), average precipitation quantities do not show an increase or decrease trend until the year 2100, but it is expected that their distribution throughout the year will change along with the intensity of certain events. The same estimates mention that there will be less precipitation in coastal Croatia, especially in the summer, and that there will be an increase in the number of dry days at the south of the Adriatic coastline. It is also estimated that south Adriatic will also experience less precipitation in the spring, namely more than 10% in relation to the reference period.

Impact of climate changes on tourism

The impact of climate changes on Croatian tourism are thought to be significant. Considering the expected temperature increase and prolonged periods of extreme heat, unpleasantly hot summers are to be expected (especially July and August) along the Adriatic coastline, which can affect visitors and especially beach tourism. We can expect an increase in the number of tourists in the spring and autumn, i.e. the duration of the tourist season on the coast will be shifted. Tourism infrastructure may also be in danger due to coastal flooding.

Impact on potable water supply

Climate change will affect the water supply in Croatia, including the agricultural sector, as well as the increased need for potable water. Annual distribution (and changing patterns) of precipitation is of paramount interest to the water industry because the annual distribution of water is key to the planning of resources as well as to the protection from catastrophes. Infrastructure and water management strategies are tightly coordinated with the annual cycle of supply and demand. In Croatia, the expected temperature and precipitation trends will likely result in hydrological impacts on basins, rivers, and coastline. The temperature increase will also have a negative effect on

evapotranspiration, changes of groundwater flow, water levels in rivers and lakes, as well as water temperature. Changes in the dynamics of precipitation will affect not only water quantities, but also the intensity, time period and frequency of precipitation and droughts, along with soil moisture, groundwater restoration and, ultimately, the total amount of in-land water streams.

Impact on the energy sector

The generation of electric energy from hydroelectric power plants in Croatia makes up half of the total generation of electric energy. Reduced river flow might cause a reduction in the generation of hydroelectric energy which would result in significant additional expenses in the supply of consumers.

Impact on agriculture

The agricultural sector is particularly sensitive to climate change due to their dependence on the weather. Extreme weather like drought and hail have brought about average losses of 76 million euro per annum in the period from 2000 to 2007 which is 0.6% of the GNP (EU, 2017). Changing climate conditions can affect the annual number of vegetation days (with a temperature above 5°C) and their increase in certain parts of Earth is to be expected. This can affect changes in the types of agricultural crops and will also change crop rotation in agricultural areas as well as the suitable area for orchards, vineyards, and olive groves. Increased temperatures, combined with the ability to provide adequate water (irrigation), can have a positive effect on the increase in yield, especially of winter crops to be cultivated in mild winter conditions.

Harmful effects, i.e. the risk of drought, hail, floods, frost etc., can impact the production of crucial basic crops such as winter wheat and maize. Higher sea temperatures will probably impact the fishing industry, potentially through an increased number of invasive species and by changing the position of shallows, which will, in turn, impact the economy of coastal regions and the island. Reduced surface runoff can also affect groundwater levels, thereby affecting potable water supplies and the availability of water for irrigation.

Changes in coastal and transitory ecosystems

Due to the climate and scarce paedologic foundation, the plant cover has xerophytic characteristics. The forest cover is scarce, and the largest surface area is taken up by maquis, garrigues and rocky soil. Since agricultural land was abandoned on account of deagrarisation, there has been intensive reforestation of such land, which is why maquis and garrigue are also prevalent on deserted agricultural landscape (Karlić, Mujo, H., 2009). Likewise, according to the basic data of the Dubrovačko primorje Municipality, the expansion of the Aleppo pine (*Pinus halepensis*) narrows the space for other plant species, and an increasing surface area has been taken up by the maritime pine (*Pinus maritima*). The vegetation is mostly numerous eu-Mediterranean species, but there is also a significant number of sub-Mediterranean species as well as imported tropical and subtropical species. The combination of Mediterranean and sub-Mediterranean impacts results in a wealth of local flora species (www.dubrovackoprимorje.hr). One of the current problems are also droughts and fires that put added pressure on coastal ecosystems.

At the area of the Dubrovačko primorje Municipality there are posidonia beds (*Posidonia oceanica*) that are included in the endangered and rare marine habitats in Croatia and are significant to the Natura 2000 ecological network, as specified in Table Table 2. However, this type of marine habitat is under considerable pressure today due to the anchoring of ships in the area.

The current ecosystems are negatively affected by pollution from ships, namely, the lack of control of wastewater drainage from the ships, and land pollution in the form of waste that reaches the sea via torrential flows (e.g. construction waste).

Participatory process at the Pilot Site

The involvement of stakeholders in the development of strategic and planning documentation is an important segment of good planning. The participatory process is therefore a way to involve citizens, stakeholders, and communities in defining plans and making decisions that affect them, which facilitates the subsequent implementation of those plans.

The general goal of the participatory process is the involvement of local stakeholders of the Pilot Site that will be affected by climate change. Since they may be threatened by the impacts of climate change, they are invited to act directly and give suggestions, feedback, as well as develop a common vision and activities, i.e., measures to adapt to climate change.

Stakeholder participation processes can generally:

- improve the quality of public policies, bring them closer to the real needs of all involved, and because of their ideas and suggestions
- motivate and empower citizens and local communities in the implementation of decisions, especially in the case of policies that need cooperation of the wider community
- strengthen social cohesion and the sense of belonging
- increase trust in institutions.

Workshops, as the main tool of this process, are aimed at local authorities, decision-makers, experts working in physical planning and nature protection, all of whom are involved in the development of strategies to mitigate climate change impact in their territories.

Stakeholders of the Pilot Site

The list below shows organizations, associations and other stakeholders that effectively participated in workshops:

Name and surname	Institution / Organisation
Miho Baće	
Ivo Đuračić	Dubrovnik-Neretva County, Administrative Department for
Vicko Grkeš	Environmental Protection and Utility Affairs
Iva Slade	
Ana Jeramaz	
Lukša Kalafatović	Public Institution for the Management of Protected Areas of Nature of
Ivana Golec	the Dubrovnik-Neretva County
Margarita Polzer	
Sanja Šaut	
Hrvoje Glavor	Dubrovnik-Neretva County, Institute of Physical planning, Department
Nikola Karaman	for Strategic Infrastructure and Development
Daniel Jokić	
Ivo Kola	Dubrovačko primorje Municipality
Nikola Knežić	

Nikola Milić	Primorsko komunalno društvo d.o.o. (limited liability company for utilities)
Slaven Zvono	Dubrovačko primorje Tourist Board
Stjepan Rezo Iva Pozniak	Regional Development Agency of the Dubrovnik-Neretva County DUNEA

Implementation of the participatory process

The participatory process for the Pilot Site of the Dubrovačko primorje Municipality is divided into three workshops with the following objectives:

- identify priorities for reducing climate-related risks, in accordance with the impacts of climate change on the Pilot Site
- educate stakeholders to understand the content of the climate change impact on different sectors
- gather expectations about the results of adaptation activities.

The main stages of the process consist of three stakeholder workshops with the following topics:

- climate change impacts at the Pilot Site
- strategies of adaptation to climate change
- action plan for adapting to and mitigating climate change at the Pilot Site.

The table below gives a brief description of the conducted workshops.

Workshop	Date	Description
Climate change impacts at the Pilot Site	15 February 2022	During the workshop, a description of the Pilot Site was presented (state of the area, overview of problems to be solved, results of previous studies), and a discussion about the vision was enabled (in accordance with the policy, local community need etc.). The results of previous research and experience regarding the impact of climate change on marine, coastal and land ecosystems of the Pilot Site were also presented, as well as existing and planned measures to prevent impact and reduce damage. During the workshop, additional information on these topics were collected from stakeholders through working groups.
Strategies for climate change adaptation	20 April 2022	The workshop presented the conclusions from the first workshop – climate change pressures identified for the project area: sea level rise, heat waves, floods, storms, droughts, sea warming, erosion, salinization of soil and freshwater ecosystems, forest fires, loss of biodiversity and alien and invasive species. The second part of the workshop was focused

on defining goals, strategies, and measures of the adaptation plan. The strategies included the following topics:

- capacity building and multidisciplinary
- conservation of natural resources and ecosystem services
- adapting practices and monitoring of positive trends in fisheries, agriculture, and tourism
- improving infrastructure
- improving physical planning / coastal management

Action plan for adapting to and mitigating climate change	25 October 2022	During the third stakeholder workshop, previous activities on the preparation of the Study of the Adaptation and Planning of Measures for Mitigating Climate Change Impacts in the Dubrovačko primorje or the Adaptation Plan were presented. The proposal of the action plan, i.e., the measures of adaptation and mitigation of climate change, which was defined at the previous workshop, was reviewed together with the stakeholders. By working with stakeholders, we defined the final list of activities and supplemented the action plan in the part related to the financial framework. Also, in cooperation with the stakeholders, the competent authorities for the implementation of measures were defined.
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Results of the participatory process

Expected results of the participatory process include:

- raised awareness of climate challenges among all stakeholders
- defined challenges and solutions, i.e. measures that can be taken to mitigate impacts of climate change
- identified needs for strengthening capacity for adaptive management, through improvement of the knowledge framework.

During three stakeholder workshops, the vision of the Pilot Site was defined, and strategies and measures for adapting to and mitigating climate change were chosen. It is important to emphasize that during the first workshop, at the proposal of the stakeholders and upon acceptance of the Client, the scope of this Plan was expanded to the Dubrovačko primorje Municipality.

Climate change adaptation plan for the Pilot Site

Identifying the vision of the Pilot Site

The Dubrovačko primorje is an area of sustainable and diversified economy, preserved nature, preserved land and sea ecosystems; with an aware and active population that, through the use of innovative solutions, contributes to the long-term strengthening of the area's resilience to climate change impacts.

Action plan for the Pilot Site

To best respond to the changes to come, and some of which are already present at the Pilot Site, the goals that should be pursued during the implementation period of this document are defined:

- Goal 1: Reduced vulnerability of natural ecosystems to the impacts of climate change
- Goal 2: General public and entrepreneurs are educated about the impacts of climate change
- Goal 3: Strengthening the resilience of vulnerable sectors to the negative impacts of climate change.

After goals had been defined, strategies were chosen whose implementation ensures the achievement of set goals:

- Strategy 1: Conservation and recovery of natural resources
- Strategy 2: Capacity building through education and encouraging inter-sectoral cooperation
- Strategy 3: Adaptation of practices in fishery, agriculture, and tourism as well as small and medium enterprises
- Strategy 4: Improving infrastructure
- Strategy 5: Improvement of physical planning (coastal management).

The process of action plan development further implied the definition of climate change adaptation and mitigation measures. Then, specific activities were defined for each measure – tools that will ensure the implementation of measures, and thus strategies and objectives of the Plan.

Priorities

For each activity, it is necessary to determine implementation indicators, the time frame, collaborators for the implementation of the activity and, where possible, give an estimate of the financial costs. Also, implementation priorities will be defined for the ten-year implementation period of this Plan. A priority level will be defined for each strategy as explained below.

Classification of priorities¹:

¹ The Ministry of Environmental Protection and Energy and the Croatian Agency for the Environment and Nature (2018) Guidelines for planning the management of protected areas and/or ecological network areas. UNDP, Croatia.

- **priority 1:** key activities that must be implemented to achieve set goals and must be executed while the plan is active. Failure to fulfil the activities of priority 1 disrupts implementation of the Plan.
- **priority 2:** activities whose temporary postponement of implementation should not cause serious consequences. Priority 2 activities should be executed while the plan is active. There is some flexibility, but a justified reason must be presented for not performing these activities.
- **priority 3:** activities that are important in the long term but can be postponed (preferred activities). They can be undertaken when time and/or funds become available, or when capacity allows it.

Strategy	Priority
Conservation and recovery of natural resources	1
Capacity building through education and encouraging inter-sectoral cooperation	3
Adaptation of practices in fishery, agriculture, and tourism as well as small and medium enterprises	1
Improving infrastructure	2
Improvement of physical planning (coastal management)	2

Strategies, measures, and activities

Goal 1 Reduced vulnerability of natural ecosystems to the impacts of climate change

Reduced vulnerability of natural ecosystems to the impacts of climate change				
Strategy 1: Conservation and recovery of natural resources				
Measure	Activity	Indicator	Responsible authority and associates	Cost estimates (EUR)
Development of conservation measures for the most vulnerable habitats that provide services for the maintenance of populations of economically important species	To implement targeted research of flora and fauna	Implemented research of targeted groups of flora and fauna	Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County	Regular monitoring activities of the Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County
	Based on research results, define conservation measures for the most vulnerable habitats	Defined Conservation measures for the most vulnerable habitats	Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County	Regular monitoring activities of the Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County
Defining the most vulnerable ecosystems, habitats, and species to the consequences of climate change	Establish expert monitoring of ecosystems, habitats, and wildlife species to monitor the impact and	Expert monitoring is established	Public institution for the management of protected areas of nature of the	Regular monitoring activities of the Public institution for the management of protected areas of nature of the

Reduced vulnerability of natural ecosystems to the impacts of climate change				
Strategy 1: Conservation and recovery of natural resources				
Measure	Activity	Indicator	Responsible authority and associates	Cost estimates (EUR)
	consequences of climate change for the purpose of assessing vulnerability in the Mali Ston Bay area		Dubrovnik-Neretva County	Dubrovnik-Neretva County / 100,000.00
Strengthening resilience and preservation of ecosystems, habitats, and species sensitive to climate change through inter-sectoral cooperation, application of traditional knowledge and adaptive management	Prevent canalization of streams to improve function of water runoff function and preserve the level of groundwater	Number of new water management projects implementing Nature-based solutions	Dubrovačko primorje Municipality, Hrvatske vode	N/A
Defining measures to reduce the spread and to limit populations of invasive and alien species	Actively removing invasive species	The number of implemented removal activities for invasive species	Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County	Regular monitoring activities / project of the Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County
	Reduce the populations of invasive species in the	Number of events held	Public institution for the management of	Projects of the Public institution for the

Reduced vulnerability of natural ecosystems to the impacts of climate change				
Strategy 1: Conservation and recovery of natural resources				
Measure	Activity	Indicator	Responsible authority and associates	Cost estimates (EUR)
	sea by encouraging selective and sports fishing		protected areas of nature of the Dubrovnik-Neretva County, Municipality	management of protected areas of nature of the Dubrovnik-Neretva County
Reducing anthropogenic impact on natural and seminatural ecosystems, habitats, and species	Improve cooperation between the County and the Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County on environmental impact assessment procedures	Number of Appropriate Assessment procedures for projects and issued nature protection conditions in which the Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County participated by giving an opinion	Dubrovnik-Neretva County, Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County	0.00
	Advocate increased inspection monitoring over the release of wastewater from ships (including ballast water exchanges)	Number of sent official letters and initiated meetings	Municipality, Dubrovnik-Neretva County	0.00
		Number of adjusted anchorage sites	Municipality, Public institution for the	0.00

Reduced vulnerability of natural ecosystems to the impacts of climate change				
Strategy 1: Conservation and recovery of natural resources				
Measure	Activity	Indicator	Responsible authority and associates	Cost estimates (EUR)
	Adjust anchoring methods where Posidonia is present		management of protected areas of nature of the Dubrovnik-Neretva County, expert NGOs	
Using Nature-based Solutions for interventions in the environment	During environmental impact studies for interventions, priority should be given to unconventional green solutions	Number of interventions using nature-based solutions	Municipality, Dubrovnik-Neretva County, Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County	0.00
	Plant vegetation in vulnerable areas to prevent future erosion	Surface area of rehabilitated area	Municipality	150,000.00 Possible use of funds from the Environmental Protection and Energy Efficiency Fund

Reduced vulnerability of natural ecosystems to the impacts of climate change				
Strategy 1: Conservation and recovery of natural resources				
Measure	Activity	Indicator	Responsible authority and associates	Cost estimates (EUR)
	Plant vegetation to reduce traffic pollution	Number of seedlings planted	Municipality	150,000.00 Possible use of funds from the Environmental Protection and Energy Efficiency Fund

Goal 2 General public and entrepreneurs are educated about the impacts of climate change

General public and entrepreneurs are educated about the impacts of climate change				
Strategy 2: Capacity building through education and encouraging inter-sectoral cooperation				
Measue	Activiy	Indicator	Responsible authority and associates	Cost estimates (EUR)
Strengthening capacities for the implementation of non-structural protection measures against the harmful effects of water, in the event of extreme hydrological conditions whose intensity and frequency was increased due to climate change	To organize workshops on the topic of green and blue infrastructure for the physical planning and civil engineering sector at the area of the Municipality	Performed educational workshops (once annually)	Dubrovnik-Neretva County, Municipality, Institute for Physical Planning of the Dubrovnik-Neretva County	70,000.00 Possible use of funds from the Environmental Protection and Energy Efficiency Fund
	To develop a plan for the implementation of green and blue infrastructure of the Municipality (restoration of water streams in accordance with their natural stream features) for the purpose of mitigating torrential flows	A developed implementation plan for green and blue infrastructure	Municipality, Dubrovnik-Neretva County, Hrvatske vode	30,000.00 Possible use of funds from the Environmental Protection and Energy Efficiency Fund

Strengthening awareness of the importance of ecosystems, habitats, wildlifespecies, protected areas and ecological network areas, as	To organizes cross-sectoral round-table discussions on the topic of biodiversity andclimate change (use IPBES guidelines for decision-	Performed round-table discussions (once annually)	Dubrovnik-Neretva County,Ministry of economy and sustainable development, expert NGOs, Public institution for the	10,000.00
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General public and entrepreneurs are educated about the impacts of climate change				
Strategy 2: Capacity building through education and encouraging inter-sectoral cooperation				
Measure	Activity	Indicator	Responsible authority and associates	Cost estimates (EUR)
well as the importance of preserving ecosystem services and the impact on all aspects of life and the economy	makers to define topics for round-table discussions)		management of protected areas of nature of the Dubrovnik-Neretva County	
	To implement the citizen science method of collecting data on nature	Number of organisations/institutions which use the citizen science method	expert NGOs, Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County, Ministry of Economy, Dubrovnik- Neretva County	Existing and new projects and regular monitoring
Capacity building of professional, research institutions and authorities for nature conservation	Design and implement volunteer programmes in protected areas and areas of the ecological network	Number of implemented programmes	Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County, expert NGOs,, independent experts	30,000.00
Strengthening knowledge bases and climate change monitoring systems	Advocate formation of a single database for physical planning data	A formed and utilised database	Dubrovnik-Neretva County, Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County, Ruđer Bošković Institute,	0.00

General public and entrepreneurs are educated about the impacts of climate change				
Strategy 2: Capacity building through education and encouraging inter-sectoral cooperation				
Measure	Activity	Indicator	Responsible authority and associates	Cost estimates (EUR)
			Croatian Meteorological and Hydrological Service, Ministry of Economy and Sustainable Development	

Goal 3 Strengthening the resilience of vulnerable sectors to the negative impacts of climate change

Strengthening the resilience of vulnerable sectors to the negative impacts of climate change				
Strategy 4: Improving infrastructure				
Measure	Activity	Indicator	Responsible authority and associates	Cost estimates (EUR)
Adaptation of coastal infrastructure to the sea level rise (climate change)	Restore existing at-risk sites (beaches (except natural ones) and other coastal infrastructure that are currently under the influence of sea level rise)	At-risk sites restored	Municipality	150,000.00 Possible use of funds from the Environmental Protection and Energy Efficiency Fund
	To reconstruct (restore) and upgrade the water and utilities infrastructure	Water and utilities infrastructure restored and upgraded	Municipality	20,000,000.00
	Map water sources (including wells) that are not part of the water supply system and analyse the possibility of using them for water supply	Remaining water sources are mapped	Municipality, Croatian Institute of Public Health	20,000.00 Possible use of funds from the Environmental Protection and Energy Efficiency Fund
Strengthening tourist infrastructure resilience to different weather conditions	Enable the construction of green roofs on structures	Number of structures (surfaces) with green roofing	Municipality	750,000.00 Possible use of funds from the Environmental Protection and Energy Efficiency Fund

Strengthening the resilience of vulnerable sectors to the negative impacts of climate change

Strategy 4: Improving infrastructure

Measure	Activity	Indicator	Responsible authority and associates	Cost estimates (EUR)
	Enable the construction of solar panels on public surfaces and structures with a tourism function (hotels, apartments)	Rooftops of hotels, apartments, as well as public surfaces are used to install solar panels	Municipality, HEP d.d.	1,000,000.00 Possible use of funds from the Environmental Protection and Energy Efficiency Fund
	Advocate implementation of structural measures for infrastructure improvement under authority of County and the government	Number of official letters sent and initiated meetings	Municipality	0.00
	Implement structural measures for infrastructure improvement under authority of Municipality	Structural measures defined and implemented	Municipality	5,000,000.00 Possible use of funds from the Environmental Protection and Energy Efficiency Fund
Strengthening resilience and development of new energy generation capacities (renewable sources)	Develop a study on the possibilities of constructing smaller energy systems on public surfaces in urban areas (e.g. solar panels)	Study is developed	Municipality, Dubrovnik-Neretva County, HEP d.d.	25,000.00
Sustainable stormwater management	Plan rainwater collection systems for irrigation in agriculture	Rainwater collection systems have been planned	Municipality	0.00

Strategy 5: Improvement of physical planning (coastal management)				
Measure	Activity	Indicator	Responsible authority and associates	Cost estimates (EUR)
Strengthening personnel and institutional capacities of professional stakeholders in physical planning system	Design and implement a professional training programme for urban planners regarding the application of climate change adaptation measures	Professional training programme implemented	Ministry, Dubrovnik-Neretva County, Institute for Physical Planning of the Dubrovnik-Neretva County	70,000.00
Development of climate change adaptation plans for specific areas	Initiate development of climate change adaptation plans for protected areas	Specific plans for adaptation to climate change are developed	Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County	40,000.00

Strategy 3: Adaptation of practices in fishery, agriculture, and tourism as well as small and medium enterprises				
Measure	Activity	Indicator	Responsible authority and associates	Cost estimates (EUR)
Preservation of traditional agriculture in natural ecosystems	Develop and implement models for the restoration of traditional agriculture	Models are developed and in use	Municipality, Dubrovnik-Neretva County, Ministry of Agriculture	150,000.00
	Valorise and encourage traditional agricultural practices that strengthen the resilience of ecosystems, habitats, and species	Support system for farmers is established	Municipality, Dubrovnik-Neretva County, Ministry of Agriculture	200,000.00
Irrigation of agricultural land with stormwater and development of a drought warning system	Implement a programme to popularize other ways of providing water for irrigation (stormwater)	Information and education programme is implemented	Municipality, Dubrovnik-Neretva County, Advisory service of the Ministry of Agriculture	30,000.00 Possible use of funds from the Environmental Protection and Energy Efficiency Fund

Strategy 3: Adaptation of practices in fishery, agriculture, and tourism as well as small and medium enterprises

Measure	Activity	Indicator	Responsible authority and associates	Cost estimates (EUR)
Encouraging development of regenerative agriculture	Implement an education programme on regenerative agriculture	Education programme implemented	Municipality, Centre for entrepreneurship of the Dubrovnik-Neretva County, Advisory service of the Ministry of Agriculture, local action groups	50,000.00 Possible use of funds from the Environmental Protection and Energy Efficiency Fund
	Educate citizens on the concept of permaculture and organic agriculture	Educational workshops implemented (once annually)	Municipality, Centre for entrepreneurship of the Dubrovnik-Neretva County, Advisory service of the Ministry of Agriculture, local action groups	50,000.00 Possible use of funds from the Environmental Protection and Energy Efficiency Fund

Plan Implementation Monitoring

Activity	Indicator	Responsible authority and associates	Indicator monitoring method
To implement targeted research of flora and fauna	Implemented research of targeted groups of flora and fauna	Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County	Annual work report of the Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County
Based on research results, define conservation measures for the most vulnerable habitats	Defined conservation measures for the most vulnerable habitats	Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County	Annual work report of the Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County
Establish expert monitoring of ecosystems, habitats, and wildlife species to monitor the impact and consequences of climate change for the purpose of assessing vulnerability in the Mali Ston Bay area	Expert monitoring is established	Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County	Annual work report of the Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County
Prevent canalization of streams to improve the function of water runoff and preserve the level of groundwater	Number of new water management projects implementing nature-based solutions	Dubrovnik-Neretva County, Dubrovačko primorje Municipality, Hrvatske vode	County and Municipality report on implemented environmental impact assessment procedures

Actively removing invasive species	The number of implemented removal activities for invasive species	Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County	Annual work report of the Public institution for the management of protected
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			areas of nature of the Dubrovnik-Neretva County
Reduce the populations of invasive species in the sea by encouraging selective and sports fishing	Number of events held	Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County, Municipality	Annual work report of the Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County
Improve cooperation between the County and the Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County on Environmental Impact Assessment procedures	Cooperation in EIA procedures	Dubrovnik-Neretva County, Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County	County and Municipality report on implemented environmental impact assessment procedures
Advocate increased inspection monitoring over the release of wastewater from ships (including ballast water exchanges)	Number of sent official letters and initiated meetings	Municipality, Dubrovnik-Neretva County	
Adjust anchoring methods where Posidonia is present	Identified areas where anchoring adjustments are necessary	Municipality, Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County, expert NGOs	Decision on anchoring adjustment for the area inside Municipality borders
During environmental impact studies for interventions, priority should be given to unconventional green solutions	Number of interventions using nature-based solutions	Municipality (by issuing decisions and opinions on interventions)	County and Municipality report on implemented environmental impact assessment procedures
Plant vegetation in vulnerable areas to prevent future erosion	Surface area of rehabilitated area	Municipality	Budget execution report of the Dubrovačko primorje Municipality

Plant vegetation to reduce traffic pollution	Number of seedlings planted	Municipality	Budget execution report of the Dubrovačko primorje Municipality
To organise workshops on the topic of green and blue infrastructure for the physical planning and civil engineering sector at the area of the Municipality	Performed educational workshops (once annually)	Municipality, Dubrovnik-Neretva County	Budget execution report of the Dubrovačko primorje Municipality
To develop a plan for the implementation of green and blue infrastructure of the Municipality (restoration of water streams in accordance with their natural stream features) for the purpose of mitigating torrential flows	A developed implementation plan for green and blue infrastructure	Municipality, Dubrovnik-Neretva County, Hrvatske vode	Budget execution report of the Dubrovačko primorje Municipality
To organize cross-sectoral round-table discussions on the topic of biodiversity and climate change (use IPBES guidelines for decision-makers to define topics for round-table discussions)	Performed round-table discussions (once annually)	Municipality, Dubrovnik-Neretva County, Ministry of Economy, expert NGOs	Budget execution report of the Dubrovačko primorje Municipality
To implement the citizen science method of collecting data on nature	Number of organisations/institution performing the method	expert NGOs, Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County, Ministry of Economy, Dubrovnik-Neretva County	Reports on implemented projects

To develop and implement volunteer programmes in protected areas and areas of the ecological network	Number of implemented programmes	Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County, expert NGOs, independent experts	Annual work report of the Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County
Advocate formation of a single database for physical planning data	A formed and utilised database	Dubrovnik-Neretva County, Public institution for the management of protected areas of nature	

Restore existing at-risk sites (beaches (except natural ones) and other coastal infrastructure that are currently under the influence of sea level rise)	At-risk sites restored	Municipality	Budget execution report of the Dubrovačko primorje Municipality
To reconstruct (restore) and upgrade water and utilities infrastructure	Water and utilities infrastructure restored and upgraded	Municipality	Budget execution report of the Dubrovačko primorje Municipality
Map water sources (including wells) that are not part of the water supply system and analyse the possibility of using them for water supply	Remaining water sources are mapped	Municipality, Croatian Institute of Public Health	Budget execution report of the Dubrovačko primorje Municipality
To plan and construct green roofs on structures	Number of structures (surfaces) with green roofing	Municipality	Physical plan of the Municipality and the Physical plan of the Dubrovnik-Neretva County
To plan and construct solar panels on public surfaces and structures with a tourism function (hotels, apartments)	Rooftops of hotels, apartments, as well as public surfaces are used to install solar panels	Municipality, HEP d.d.	Physical plan of the Municipality and the Physical plan of the Dubrovnik-Neretva County
Advocate implementation of structural measures for infrastructure improvement under authority of the County and the government	Number of official letters sent and initiated meetings	Municipality	
Implement structural measures for infrastructure improvement under authority of the Municipality	Structural measures defined and implemented	Municipality	Budget execution report of the Dubrovačko primorje Municipality
Develop a study on the possibilities of constructing smaller energy systems on public surfaces in urban areas (e.g. solar panels)	Study is developed	Municipality, Dubrovnik-Neretva County, HEP d.d.	Budget execution report of the Dubrovačko primorje Municipality
Plan rainwater collection systems for irrigation in agriculture	Rainwater collection systems have been planned	Municipality	Budget execution report of the Dubrovačko primorje Municipality

Design and implement a professional training programme for urban planners regarding the application of climate change adaptation measures	Professional training programme implemented	Ministry, Dubrovnik-Neretva County	Budget execution report of the Dubrovnik-Neretva County
Initiate development of climate change adaptation plans for protected areas	Specific plans for adaptation to climate change are developed	Public institution for the management of protected areas of nature	Annual work report of the Public institution for the management of protected areas of nature of the Dubrovnik-Neretva County
Develop and implement models for the restoration of traditional agriculture	Models are developed and in use	Municipality, Dubrovnik-Neretva County, Ministry of Agriculture	Budget execution report of the Dubrovačko primorje Municipality
Valorise and encourage traditional agricultural practices that strengthen the resilience of ecosystems, habitats, and species	Support system for farmers is established	Municipality, Dubrovnik-Neretva County, Ministry of Agriculture	Budget execution report of the Dubrovačko primorje Municipality
Implement a programme to popularize other ways of providing water for irrigation (stormwater)	Information and education programme is implemented	Municipality	Budget execution report of the Dubrovačko primorje Municipality
Implement an education programme on regenerative agriculture	Education programme implemented	Municipality	Budget execution report of the Dubrovačko primorje Municipality
Educate citizens on the concept of permaculture and organic agriculture	Educational workshops implemented (once annually)	Municipality	Budget execution report of the Dubrovačko primorje Municipality

Closing remarks and indications for the implementation of the Plan for the Pilot Area

This document defines the vision, goals, measures, and activities that contribute to adaptation to climate change for the pilot area of the Dubrovačko primorje Municipality. The measures and activities defined in this document will be implemented in the next ten years.

Cooperation and communication between a large number of stakeholders from the civil, private and public sectors is essential for the successful implementation of this Plan.

It is important to emphasize that the Dubrovnik - Neretva County and Dubrovačko primorje Municipality cannot be held responsible for the successful implementation of this Plan, given that the approach to climate change issues requires the joint action of various institutions at the local, regional, and national level. The Adaptation plan brings a number of measures that are not exclusively under the jurisdiction of the Dubrovačko primorje Municipality or Dubrovnik-Neretva County, and for certain measures/ activities, they can encourage other sectors (institutions) to act but cannot be the implementer of the measure/activity.

This document should serve as a basis for adapting the area to climate change and as a basis for adopting key strategic documents at the local and county level.

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