AdriaClim

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

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D.5.8.4 Proposal of new measures and guidance to update the existing national climate change adaptation strategy

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Table of contents

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1. Introduction

On the 7th April 2020, the Croatian Parliament adopted the Strategy for Adaptation to Climate Change in the Republic of Croatia for the period to 2040 with a view to 2070 (Official Gazette 46/2020) (Adaptation Strategy or Strategy in the following text). This is the first national strategic document that provides an assessment of climate change for Croatia by the end of 2040 and 2070, along with possible impacts and vulnerability estimates. The aim of the Adaptation Strategy is to raise awareness of the importance and threats of climate change for society and the need to integrate the concept of climate change adaptation into existing and new policies. In addition, the aim is to encourage scientific research to better understand the complexity of the impacts of climate change and to reduce the degree of uncertainty associated with the effects of climate change.

The aim of the AdriaClim project – improvement of climate-related documents at the national, regional and local level with information from scientifically based monitoring – is in line with goals of the Adaptation Strategy.

The main aim of this deliverable is to give an overview of the Adaptation Strategy, to point out some of its weakness and to propose the guidance to improve it. Proposed guidance is supposed to fill the gaps in the Strategy and to increase the effectiveness and efficiency of adaptation and mitigation measures already given in the current Strategy. In the compilation of this document, besides Adaptation Strategy, we used results of the AdriaClim project, particularly deliverable D.5.1.1 made by CMCC team, D.5.8.1 made by IOF team and results obtained in the work package 3. In addition, we considered Climate Menu (https://www.climatemenu.eu/en/about/) developed within Interreg project RESPONSe and outcomes from Interreg projects CHANGE WE CARE and AdriaAdapt.

After a brief overview of the current Adaptation Strategy and its potentially weak points, we have listed the climate-related hazards that are either missing or not received enough attention in the Strategy, together with measures against their adverse influence.

2. National Adaptation Strategy

Assessment of the climate change impact in the Adaptation Strategy is obtained by comparison of the climate projections for the periods 2011 – 2040 and 2041 – 2070 with referent period 1971 – 2000. Climate projections for the near and far future are obtained using Regional Climate Model (RegCM) with two different horizontal resolutions: 50 and 12.5 km. Simulations for the future periods are conducted for two scenarios of the greenhouse gas concentrations: RCP4.5 and RCP8.5 (RCP – Representative Concentration Pathway). RCP4.5 is moderate scenario, called also stabilization scenario, simulating a future world where considerable efforts have been put into mitigation policies and RCP8.5 is a high-emissions climate scenario, often called pessimistic climate scenario, which simulates a future world without climate mitigation policies. Twenty climate variables are analysed and used in assessment of climate change impact in eight sectors important for Croatia: water resources, agriculture, forestry, fisheries and aquaculture, biodiversity, energetics, tourism, health care, and in two cross-sectoral thematic areas: spatial planning and risk management. Results of regional models are also used to estimate the vulnerability of each sector in the context of predicted change. Adverse impacts for each sector are listed, together with actions to reduce vulnerability. The Adaptation Strategy describes 83 adaptation and mitigation measures for key sectors and areas and also gives instructions for implementation and assessment of their effectiveness and efficiency. Estimates of the necessary funds and sources of financing are suggested in the final part of the Adaptation Strategy. The Adaptation Strategy is implemented through action plans, which contain the elaboration of specific measures and activities and will be updated every five years. Action plans for each measure and activity 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.

Even though, the Adaptation Strategy is the first national strategic document on adaptation to climate change and therefore extremely valuable, there are several ways to improve it and also give guidance for similar future documents.

First of all, list of variables used for assessment of climate change impact should be expand. Better insight in the climate change impact would be obtained with more atmospheric variables included, particularly some complex indicators like those considered in the AdriaClim project: consecutive dry days index per time period, consecutive summer days index per time period, consecutive wet days index per time period, heat waves per time period, heat wave duration index, etc.

In addition, there is only one variable for assessment of changes in the sea - sea level, which is estimated from the global model results. To improve our understanding of future changes in the

sea, ocean modelling on the regional and local scale should be included in the climate change assessment. Moreover, to assess the impact of climate change on the marine ecosystem, and particularly on biodiversity, fisheries, aquaculture and tourism (sectors studied in the current Adaptation Strategy) list of the variables should be extended to sea temperature, salinity, currents, waves but also to some more complex parameters like mixed layer depth, marine heat waves and heat content. It is advisable to include also the wave model into the modelling system, since the wave dynamics is important for protection of the coastal infrastructure. Erosion also depends on the wind, storm surges and waves, and therefore definition of measures for reducing the erosion threat will benefit from wave model results.

Some of the climate hazards related to the sea are at the moment part of the Marine Strategy, but to stress their importance and vulnerability of the marine ecosystem to climate change, they should be part of the Adaptation Strategy, as well. Unfortunately, many of possible adverse effect of the climate change for the marine ecosystem are missing from both documents, and therefore should be considered in the future documents.

Most of the proposed adaptation and mitigation measures in the Strategy are so-called 'soft' measures or measures for society, and therefore the list of the measures should be enlarged with structural measures, particularly with the green ones.

In the future Strategy more sectors that can be affected by climate change must be considered. Possibly vulnerable sectors missing from the Adaptation Strategy are: waste management, potable water management, public building management, management of green areas, management of natural habitats, traffic and socio-economic conditions. Although the problem of the water resources is recognized in the Adaptation Strategy, more attention should be given to possible lack of potable water, water for irrigation and salinization problem.

Since the adopt of the Adaptation Strategy, new and more reliable numerical models have been developed and they should be used to assess the climate change impact. Better spatial resolution of the models will give a better insight into wind dynamics along the eastern Adriatic coast and their influence to physical, chemical and biological marine parameters. Moreover, higher horizontal resolutions in the models improve presentation of the coastline, which is important for many hazards that could endanger the coastal zone like erosion, floods, storm surges, destructive breaking waves etc. The model results obtained within AdriaClim project, but also in other climate-related projects, could be compared with model results used in the Croatian Adaptation Strategy.

3. Hazards and adaptation and mitigation measures

The entire Adriatic coast, is exposed to climate-related hazards such as: sea level rise, floods, coastal storms, heatwaves, forest fires, sea water warming, sea acidification, hydrological droughts and hails. In the following we listed the hazards that we believe are either missing or not received enough attention in the National Adaptation Strategy.

3.1. Coastal erosion

Coastal erosion is the process by which local sea level rise, strong wave action, and coastal flooding wear down or carry away rocks, soils, and/or sands along the coast. All coastlines are affected by storms and other natural events that cause erosion; the combination of storm surge at high tide with additional effects from strong waves—creates the most damaging conditions. The extent and severity of the problem is worsening with global sea level rise, but it differs in different parts of the coast, so there is no unique solution.

In the past, protecting the coast often meant "hardening" the shoreline with structures such as seawalls, groins, rip-rap, and levees. As understanding of natural shoreline function improves, there is a growing acceptance that structural solutions may cause more problems than they solve. Structural projects interfere with natural water currents and prevent sand from shifting along coastlines. Additional reasons to avoid structural protective measures include the high costs to install and maintain them, national or local prohibitions against them, their propensity to cause erosion to adjacent beaches and dunes, and the unintended diversion of stormwater and waves onto other properties.

Loss of beaches due to erosion could cause general loss of attractiveness of coastal areas, which could strongly affect tourism, key economic sector for the Croatia.

Protecting the sandy and gravel beaches from erosion is delicate problem and its solution requires knowledge of geomorphological, oceanographic, meteorological and geological conditions in the beach area. Reliable solutions should be obtained through several phases: 1) collecting data on geomorphological, oceanographic, meteorological and geological conditions in the beach area; 2) dedicated numerical experiments with appropriate wave model; 3) calculations of the beach sediment transport; 4) proposal of the structural solutions like cliff strengthening, building sea-walls, groins, installing breakwaters etc.; 5) establishment of monitoring and early warning systems; 6) proposal of appropriate beach and shoreface nourishment.

3.2. Salinization

Salinization of the river estuaries has significant adverse effect on many aspects, like agriculture, drinking water sources and estuarine ecosystem. It is expected that salinization problem will become even more severe in the future under projected climate change with sea level rise and reduced precipitation and freshwater inflow during the summer. Therefore, it is important to raise awareness of the problem in the local communities and plan permanent protection in the areas. Adaptation of the local fisheries and aquaculture to new conditions should be envisaged. For example, saline intrusions will favour the farming of euryhaline species. Shortages of potable water and water for irrigation is possible due to salinization but also due to long drought periods and alternative plans should be prepared.

In the agricultural areas water retention and irrigation efficiency should be improved. If possible, rainwater should be used for irrigation instead river or underground waters.

3.3. Air temperature and precipitation trends

All available climate models for Croatia predict positive temperature trends, while precipitation trends are more variable and depend on season and study area

Temperature and precipitation trends affect almost all sectors of human activities and ecosystem services.

Particularly endangered are urban areas. Some of the useful measures are: planting trees, urban farming and gardening, creation of green spaces, corridors and public courtyards, green roofs and walls. Creation or reparation of the fountains are useful to cope with heat waves in cities.

The impact of the air temperature rise on Croatian tourism is also 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. duration of the tourist season on the coast will be shifted. Tourism should be adopted to changed conditions by new practices, changed tourist activities, settlements and infrastructure.

Annual distribution of precipitation is of paramount interest to the water industry because the annual distribution of water is key for 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 rivers and coastline. The temperature increase will 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. The generation of electric energy from hydroelectric power plants in Croatia makes up half of the total generation of electric energy. Reduced river flow due to reduced annual amount of precipitation might cause a reduction in the generation of hydroelectric energy which would result in significant additional expenses in the supply of consumers. Described problems could be partly solved by capacity building, monitoring and early warning systems.

Increased air temperature and prolonged dry periods could cause increased number of forest fires. Adaptation of the management plans and alternation of forest structure or composition are advisable to reduce risk or severity of fires.

3.4. Sea temperature and salinity trends

An increase in sea temperature and salinity could impact fisheries industry due to northward migration patterns and massive presence of invasive species. To minimise impact on economy of coastal regions fisheries practices should be adopted to new conditions by shifting towards alternative species and management of practices more suitable to changed conditions. The process can also include initiative of business diversification developing new fishing-related activities (e.g. eco-tourism with fishing vessels). Fundamental is the cross-sectoral cooperation with other related businesses (e.g. market, tourism) and with public authorities. The actions include adaptation of gears (switching to more efficient gears or flexible gears able to catch different species, better adapted to changed conditions and operational in different environments) and adaptation of fishing vessels to enhance the management control on fishing activities in different locations, enhancing fishermen mobility as fish stock distribution shifts with changing marine conditions.

3.5. Sea level rise

Coastal infrastructure could be seriously affected by sea level rise and increased frequency of extreme events (storm surges and flooding). These hazards require enhanced monitoring, modelling and establishment of forecasting systems. The coastal infrastructure and urban settlements should be improved to be flood prone.

Sea level rise and more frequent extreme events could result in loss of biodiversity and particularly endangered are wetlands, like the Neretva River valley. Such areas require additional administrative protection in the future changed conditions.

3.6. Acidification

Acidification of the sea water is a growing problem in the context of the climate change. It affects most of the marine organisms and additional monitoring and protection is required. Capacity building and establishment of monitoring and early warning systems could improve understanding of climate change impact on acidification problem.

3.7. Pollution

The effect of the climate change on the pollution from various sources (microbiological, industrial, oil and plastic, etc.) is not recognized in the Adaptation Strategy and it needs additional attention, especially from the scientific community. Capacity building and establishment of monitoring and early warning systems could shed more light on climate change impact on various pollution types and help to solve this growing problem. Traffic is an example of significant greenhouse gas pollution. Measures such as the use of alternative fuels and vehicles, the restoration of the national rail network, the organization of sustainable climate meetings, online meetings, etc. are likely to reduce negative impact of pollution from traffic.

4. Concluding remarks

The whole Adriatic area, is suffering a number of issues related to climate change such as sea level and air temperature rise, increased frequency of various extreme events like heat waves, storms, flooding events and more frequent appearance of long-lasting dry periods. Most of these issues are recognized in the Adaptation Strategy, which gives a number of measures against adverse effect of the climate change and indicators for assessing their efficiency.

Although the Adaptation Strategy is relevant and valuable document, there are several ways to improve it. Number of parameters used to climate change impact assessment could be increased, particularly those related to marine ecosystem. Number of sectors that could be affected by climate changes are probably larger than number of sectors considered in the Adaptation Strategy. And finally, new, more reliable models with higher spatial resolutions should be used to make assessment in the new similar documents.

The main goals of the climate-related actions and measures are the following: (1) to reduce the vulnerabilities of natural systems and society to the negative impacts of climate change, (2) to

improve resistance and recovery capacity from the negative effects of climate change and (3) to take advantage of the potential positive effects of climate change.

Most of the measures in the Adaptation Strategy are non-structural or 'soft' ones (administrative, political, legislative, planning actions). Although these measures are important and can actually lead to a complete transformation of society, some of negative climate change impacts could be mitigate by planning and building adequate infrastructure and developing systems of early detection and warning of possible natural threats. Therefor more structural measures should be included in the future Strategy, particularly green measures.

After implementation of the adaptation and mitigations measures it is of great importance to have monitoring and evaluation tools to assess the efficiencies of the implemented procedures, to face the issues that could arise during the implementation and application phase, and to decide whether applied measures should be continued or updated. Monitoring and evaluation are particularly relevant for the measures against climate change due to their long-term perspective and due to great uncertainty characterizing the evolution of the climate system and its effect on natural and social systems.