Strengthening the capacity of the Ministry of Environment and Energy for adaptation to climate change and preparation of the Draft Climate Change Adaptation Strategy

Draft Climate Change Adaptation Strategy in the Republic of Croatia for the period to 2040 with a view to 2070

(White book)

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NOTE: The data obtained by climate modelling in the Republic of Croatia described in this strategy will be publicly available without commercial fees and for all purposes after the completion of the "Climate Change Adaptation Strategy" project (17 November 2017), with the obligation to clearly indicate data sources.
Information on the possibilities and the manner of data download will be published on the project's web site (http://prilagodba-klimi.hr/) and the Ministry of Environment and Energy (www.mzoip.hr).

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List of used abbreviations and acronyms

Acronym	Meaning
CTS	Central heating system (*Centralni toplinski sustav*)
DUZS	National Protection and Rescue Directorate (*Državna uprava za zaštitu i spašavanje*)
DHMZ	Meteorological and Hydrological Service (*Državni hidrometeorološki zavod*)
EEA	European Environment Agency (*Europska agencija za okoliš*)
EES	Electric power system (*Elektro energetski sustav*)
EFRR	European Regional Development Fund (*Europski fond za regionalni razvoj*)
ESF	European Social Fund (*Europski socijalni fond*)
EU	European Union (*Europska unija*)
FLAG	Fisheries Local Action Group (*Lokalna akcijska skupina u ribarstvu*)
FZOEU	Environmental Protection and Energy Efficiency Fund (*Fond za zaštitu okoliša i energetsku učinkovitost*)
HAH	Croatian Food Agency
HAOP	Croatian Environment and Nature Agency (*Hrvatska agencija za okoliš i prirodu*)
HEP	Croatian Electrical Power company (*Hrvatska elektroprivreda*)
HEP ODS	HEP Distribution System operator (*HEP Operator distribucijskog sustava*)
HERA	Croatian Energy Regulatory Agency (*Hrvatska energetska regulatorna agencija*)
HGI	Croatian Geological Survey
HGK	Croatian Chamber of Economy (*Hrvatska gospodarska komora*)
HHI	Hydrographic Institute of the Republic of Croatia (*Hrvatski hidrografski institut*)
HKISDT	Croatian chamber of engineers of forestry and wood technology (*Hrvatska komora inženjera šumarstva i drvne tehnologije*)
HOK	Croatian chamber of trades and crafts (*Hrvatska obrtnička komora*)
HOPS	Croatian Transmission System Operator Ltd. (Hrvatski operator prijenosnog sustava)
HROTE	Croatian energy market operator Ltd. (*Hrvatski operator tržišta energije*)
HŠ	Croatian Forests company (*Hrvatske šume*)
HŠI	Croatian Forest Research Institute (*Hrvatski šumarski institut*)
HTZ	Croatian national tourism board (*Hrvatska turistička zajednica*)
HV	Croatian Waters company (*Hrvatske vode*)
HVZ	Croatian firefighting association (*Hrvatska vatrogasna zajednica*)
HZJZ	Croatian Institute of Public Health (*Hrvatski zavod za javno zdravstvo*)
HZPR	Croatian Institute for Spatial Development (*Hrvatski zavod za prostorni razvoj*)
HZZO	Croatian Health Insurance Fund (*Hrvatski zavod za zdravstveno osiguranje*)
HŽ	Croatian Railways (*Hrvatske željeznice*)
IPCC	Intergovernmental Panel on Climate Change (*Međuvladin panel za klimatske promjene*)
IPCC AR5	The fifth assessment report of Intergovernmental Panel on Climate Change (2013.)
JLP(R)S	Local and regional self-government unit (*Jedinica lokalne i područne (regionalne) samouprave*)
JLS	Local Self-Government Units (*Jedinice lokalne samouprave*)
JPP	Public-Private Partnership (*Javno-privatno partnerstvo*)
JP(R)S	Units of regional self-government (*Jedinice područne (regionalne) samouprave*)
JUZP	Public Institution for the Management of Protected Areas (National Parks and Nature Parks) *Javna ustanova za upravljanje zaštićenim područjima (Nacionalnim parkovima i Parkovima prirode)*
MSP	Small and Medium Enterprise (SME) (*Malo i srednje poduzeće)*
MZOE	Ministry of Environment and Energy (*Ministarstvo zaštite okoliša i energetike*)
RES	Renewable energy sources (*Obnovljivi izvori energije*)
OPG	Family farm (*Obiteljsko poljoprivredno gospodarstvo*)
SPUO	Strategic Environmental Impact Assessment (*Strateška procjena utjecaja na okoliš*)
TDU	State administration bodies (*tijela državne uprave*)

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SUMMARY:

The impact of climate change on the Republic of Croatia

Climate change is a growing threat and will be a challenge for all humankind by the end of the 21st century. There is an indisputable scientific and political consensus, confirmed by the adoption of a series of international arrangement and agreements (including the Paris Climate Agreement, which is in force since 4 November 2016, ratified by the European Union on 5 October 2016 and by the Republic of Croatia on 17 March 2017), that climate change is already occurring and significant. The Republic of Croatia has been exposed to the negative effects of climate change for a long time, resulting, among other things, in significant economic losses. According to the European Environment Agency (EEA) report, the Republic of Croatia belongs to a group of three countries, together with the Czech Republic and Hungary, with the highest share of the damage from extreme weather and climate events in relation to Gross Domestic Product (GDP). It is estimated that these losses, in the period from 1980 to 2013, amounted about 2.25 billion EUR or about 68 million EUR per year on average. These losses have increased significantly during 2014 and 2015 (to 2.83 billion EUR in 2015). Some economic sectors were significantly affected in that period. According to some estimates, between 2000 and 2007 extreme weather conditions caused damage to the agricultural sector of 173 million EUR, while the drought in 2003 caused damage of between 63 and 96 million EUR to the energy sector. It is also estimated that in August 2003 the mortality rate was 4% higher due to a heat stroke.

What is adaptation to climate change?

For the purposes of the Climate Change Adaptation Strategy of the Republic of Croatia to 2040 with the view to 2070 (hereinafter: the Adaptation Strategy) adaptation to climate change is, pursuant to the Air Protection Act (Official Gazette No. 130/11, 47/14 and 61/17) defined as a process that "*... implies assessment of adverse impacts of climate change and taking appropriate measures to prevent or reduce the potential damage they may cause*." The definition of adaptation to climate change in the aforementioned act is also the cornerstone of the Adaptation Strategy. Adapting to climate change implies undertaking a set of activities to reduce the vulnerability of natural and social systems to climate change, increasing their ability to recover after the impact of climate change, as well as exploiting the potential positive impacts that may also be a consequence of climate change.

The main, long-term goal of the Adaptation Strategy is the reduction of the vulnerability of social and natural systems to the adverse impacts of climate change, *i.e.* to strengthen their resilience and the ability to recover from these impacts. Finally, taking into consideration the possible positive effects of climate change, by implementing the Adaptation Strategy the aforementioned systems should be stronger and more resilient than they are today, and thereby contribute to achieving long-term sustainable development of the Republic of Croatia.

Adaptation to climate change is considered, along with mitigation (i.e. reduction of net greenhouse gas emissions), the second important pillar of the implementation of climate policy, which is in the function of preserving the values of society, the environment and the economy and ensuring the sustainable development of the Republic of Croatia in a long-term perspective. It should be emphasized that the Republic of Croatia, due to its size and

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economic power, can only make a small contribution to mitigation efforts but it is nevertheless exposed to a significant impact of the adverse effects of climate change, as is clear from the above mentioned data on damages, especially if the climate change adaptation activities do not begin to be planned and implemented immediately.

The Air Protection Act, as the basic legal act of the Republic of Croatia regulating the issue of adaptation to climate change (Articles 118 and 118a), defines the sectors most exposed to climate change as follows: hydrology and water resources; agriculture; forestry; biodiversity and natural land ecosystems; biodiversity and marine ecosystems; coastal management and coastal area; tourism and human health. This list was expanded during the drafting of the Adaptation Strategy to include additional sectors that were considered to be key for the implementation of a comprehensive and effective adaptation to climate change and are also extremely vulnerable to climate change: energy, fishery and the cross-sectoral themes of spatial planning and risk management.

The process of preparing of the Adaptation Strategy

The drafting of the Adaptation Strategy was preceded by the creation of the so-called Green Book, based on technical documents related to: climate modelling that resulted in climate projections for the Republic of Croatia to 2040 and 2070; analysis of climate change impacts and vulnerability to projected climate change; defining the initial program of measures that will be applicable in the process of adaptation to climate change; an analysis of cost effectiveness of the measures and an assessment of the need to strengthen capacity to adapt to climate change. The purpose of the Green Book was to encourage debate on all the important issues for adapting to climate change and launching a debate at the national level. After consultation with key stakeholders, this document has been developed (so-called White Book), in which the conclusions of public debates have been incorporated. Along with the Adaptation Strategy, an Action Plan for the first five years of implementation (2019-2023) has been created (in the remainder of the text “Action Plan”).

Adapting to climate change is a long-term continuous planned process. The drafting of the Adaptation Strategy starts with the results of climate models projection for two periods taking into account two scenarios for the development of greenhouse gas concentrations in the future: RCP4.5 and RCP8.5, as defined by the Intergovernmental Panel on Climate change - IPCC). Scenario RCP4.5 is considered a more moderate scenario, while RCP8.5 is treated as more extreme. Climate projections are made for two time periods: the first to end in 2040 and the second to end in 2070.

Climate projection in the Republic of Croatia until 2040 with a view to 2070

In addition to the "historical" climate simulation for the period 1971-2000, the RegCM regional climate model calculated change (projections) for the future climate in two periods: 2011-2040 and 2041-2070, assuming the IPCC scenarios RCP4.5 and RCP8.5 of the greenhouse gases concentration development. The RCP4.5 scenario is characterized by the medium level of greenhouse gas concentrations with relatively ambitious expectations of their future reduction, which would peak in around 2040. The RCP8.5 scenario is characterized by a continuous increase of greenhouse gas concentrations, which would be, by the year 2100, up to three times higher than today.

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Table 0-1: Climate projection in the Republic of Croatia to year 2040 with a view to year 2070

Climatological parameter		Future climate projections according to the RCP4.5 scenario compared to the period 1971-2000 obtained by climate modelling	
		2011 – 2040	**2041 – 2070**
PRECIPITATION		**Average annual quantity**: a slight decrease (except for a slight increase in the northwest of Croatia)	**Average annual quantity**: *further decrease trend* (up to 5%) in almost all of Croatia except for north-western parts
		Seasons: different signs; **winter and spring** in most of Croatia *a slight increase* + 5-10%, and **summer and fall** decrease (most - 5-10% in southern Lika and north Dalmatia)	**Seasons**: *decrease* **in all seasons** (up to 10% of the mountains and northern Dalmatia) *except* **in winter** (increase of 5 - 10% in northern Croatia)
		Decrease in the number of **rainy seasons** (except in central Croatia where it would slightly increase). The number of **dry seasons** would increase.	The number of **dry seasons** would increase.
SNOW COVER		*Decrease* (highest in Gorski Kotar, up to 50%)	*Further decrease* (especially mountainous areas)
SURFACE RUNOFF		There are no major changes in most regions; but in the mountainous areas and the hinterland of Dalmatia a *decrease* up to 10%	*Decrease* of runoff throughout Croatia (especially in spring)
AIR TEMPERATURE		Medium: *increase* of **1 to 1.4 °C** (all seasons, the entire Croatia)	Medium: *increase* from **1.5 to 2.2 °C** (all seasons, the entire Croatia - especially continent)
		Maximum: increase in all seasons **1 – 1.5 °C**	Maximum: up to **2.2 °C** in summer (up to 2,3 °C on islands)
		Minimum: the highest *increase* **in winter, 1.2 – 1.4 °C**	Minimum: the highest *increase* in continent **in winter** 2.1 – 2.4 °C; and 1.8 - 2 °C coastal zones
EXTREME WEATHER CONDITIONS	**Heat** (number of days with Tmax> +30 °C)	**6 to 8 days** *more* than the reference period (reference period: 15 - 25 days a year)	Up to **12 days** *more* than the reference period
	Cold (number of days with Tmin <-10 °C)	*Decrease* in the number of days with Tmin <-10 °C and increase in Tmin values (1.2-1.4 °C)	*Further decrease* in the number of days with Tmin <-10 °C
	Warm nights (number of days with Tmin ≥ + 20 °C)	*Increase*	*Increase*
WIND	**Medium speed** at 10 m	**Winter and spring** *without change*, but **in the summer and especially in the autumn** on the Adriatic *increase* up to 20-25%	**Winter and spring** *mostly without change, but the trend of strengthening* in **summer and autumn** in the Adriatic.
	Max. speed at 10 m	On an annual basis: *no change* (the highest value in the islands of southern Dalmatia)	Per seasons: *decrease* in all seasons except in the summer. *The highest decrease* in **winter**

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		Per season: *decrease* in **winter** in southern Adriatic and hinterland	in southern Adriatic
EVAPOTRANSPIRATION		Increase in **spring and summer** 5 - 10% (outlying islands and west Istria> 10%)	Increase in **spring and summer** 5 - 10% (outlying islands and western Istria> 10%)
AIR HUMIDITY		Year-round increase (**most in summer** in the Adriatic)	Year-round increase (**most in summer** on the Adriatic)
SOIL HUMIDITY		*Decrease* in northern Croatia	Decrease throughout Croatia (**most in summer and autumn**).
SOLAR IRRADIANCE (INPUT SOLAR ENERGY FLUX)		In the summer and autumn increase throughout Croatia, in spring increase in northern Croatia, and decrease in western Croatia; in winter decrease throughout Croatia	*Increase* in all seasons except winter (the highest increase in mountainous and central Croatia)
MEAN SEA LEVEL		2046 – 2065 **19 – 33 cm** (IPCC AR5)	2081 – 2100 **32 – 65 cm** (estimation of average mean values for the Adriatic from various sources)

Assessment of climate change impact and sector vulnerability to climate change

Adapting to climate change is fundamentally a horizontal issue, *i.e.* a problem that needs to be resolved in an integrated way with a high degree of co-ordination between participants. However, it should be emphasized that the Adaptation Strategy is based on an analysis of those sectors and cross-sectoral areas that are relevant to the adaptation due to their socio-economic importance for the Republic of Croatia and/or are of importance to nature and the environment. For this purpose, eight key sectors have been selected (hydrology; water and marine resources; agriculture; forestry; fishery; biodiversity; energy; tourism and health) and two cross-sectoral thematic areas (spatial planning; coastal areas management and risk management). The fact that the development of this strategy is based on the analysis of vulnerability of particular sectors and cross-sectoral thematic areas does not mean that the methodological approach to the analysis of the state of climate change as well as to the issues of adaptation to climate change is itself sectoral. On the contrary, the Adaptation Strategy is the result of an integral approach, which, starting from the analysis of the situation in selected sectors and cross-sectoral thematic areas, results in an overview of cross-sectoral impacts and vulnerabilities as well as a set of measures, taking into account the implementation possibilities, as well as the cross-sectoral impacts of an individual measure implementation.

Table 0-2: Overview of main expected impacts and challenges of high vulnerability causes by sectors and possible responses to reduce high vulnerability

Impacts and challenges that cause high vulnerability	Possible responses to reduce high vulnerability
Hydrology, water and marine resources	
• Reduction of water levels in watercourses and in springs • Reduction of underground water resources and lowering groundwater levels	• Strengthening research and management capacities to assess the occurrence and risk of adverse impacts of climate change and adaptation of freshwater and marine water

Impacts and challenges that cause high vulnerability	Possible responses to reduce high vulnerability
• Reduction of water levels in lakes and other lake-type natural or built-up systems • Sea level rise and change of its thermohaline features • Salinization of coastal aquifers and aquatic systems • Water temperature rise followed by reduction of reception capability of aquatic receivers • Increased frequency and intensity of flooding in vulnerable areas • Increasing the frequency and intensity of torrents • Increasing the frequency and intensity of rainwater flooding in urban areas	systems • Construction, reconstruction and upgrading of existing systems for protection against harmful effects of water, water use systems (multi-purpose systems, water supply, energy, irrigation, etc.) and water protection in new (future) climatic conditions • Strengthening the resilience of coastal water-communal infrastructure against the possible impacts of climate change • Applying an integrated approach to water resources and systems management and intensifying of cross-sectoral observations and activities • Strengthening the protection of natural water and maritime systems, particularly protected areas, from the adverse impacts of climate change and their adaptation
Agriculture	
• Change in the duration/length of the vegetative period of agricultural crops and lower yields • Higher demand for irrigation water due to frequent droughts • Longer vegetation period will enable the cultivation of some new cultures and varieties • More frequent flooding and stagnation of surface water - which will reduce or completely destroy yields	• Strengthening the capacity to understand and implement climate change mitigation measures • Increasing the absorption capacity of soil for water on agricultural land • Conservation oriented soil treatment • Breeding of species, sorts and breeds resistant to climate change • Irrigation of agricultural land • Construction of water accumulations • Application of anti-erosion measures
Forestry	
• Increased incidence of forest fires including the occurrence of fires in the continental part of Croatia due to increased temperature and decreased precipitation • Decreased productivity of some forest ecosystems • Migration of harmful organisms • Moving of phenological phases of forest tree species • Damage to forest ecosystems due to the frequency of extreme weather events • Reduced value of certain generally-beneficial functions of forests	• Establishment of cross-sector monitoring of forest ecosystem status as a prerequisite for informed planning and implementation of adaptation measures • Developing recommendations for mitigating the adverse impact of harmful organisms under the influence of climate change • Identification of species and provenance of forest trees that are genetically best adapted to the influence of climate change and are of economic significance • Acquainting participants in the forest sector about the impact of climate change on forest ecosystems, vulnerabilities, risks and possible adaptation measures • Establishment of green infrastructure in

Impacts and challenges that cause high vulnerability	Possible responses to reduce high vulnerability
	larger urban areas • Strengthening of the fire protection capacity
Fisheries	
• Migration to the northern Adriatic Sea or to the deeper sea of cold-water species due to rising sea temperatures • Increase in the number of alien species and the influence on domestic species due to rising sea temperatures • Decrease of primary production with consequences on the number of pelagic fish due to change in water circulation due to thermohaline causes • Weaker growth and higher mortality of shellfish due to increased sea acidity	• Strengthening the capacity for predicting the future status of bio resources • Development of techniques and tools for exploiting alien species • Strengthening research capacities in the field of selective breeding, feeding of fish and breeding in recirculation systems • Increased resilience of aquaculture to reduced flow of water, change in physicochemical parameters of water and occurrence and spread of diseases • Mitigating the negative impacts of climate change by applying integrated forms of aquaculture
Biodiversity	
• Abortion of flowering of plant cryophyllofen and stenothemical species with shortening of vegetation and reduction of vigour • Damage to and extinction of populations due to climatic extremities (long-lasting droughts, excessive short time precipitation, stormy winds, excessive sunlight, etc.) • Spread of thermophilic species range (both positive and negative) due to an increase in average air temperature • Reduction of turgor and vigour, drying and extinction of hygrophilic species due to decrease in quantity and change of precipitation schedule • Spread of xerofiline species range (both positive and negative) due to decrease of quantity and change of precipitation schedule • Reducing populations of forest species due to frequent fires caused by increased average air temperature and reduced and unevenly distributed precipitation • Reduction and disappearance of freshwater species of the Adriatic basin due to salinization of coastal habitats caused by sea level rise • Sea species spreading to the north and the appearance of thermophilic (tropical) alien invasive marine species due to rising sea temperature	• Strengthening awareness of the importance of natural ecosystem services and their impact on all aspects of life and economy • Defining habitats and species most vulnerable to climate change consequences • Defining the zero state and establishment of monitoring for the most vulnerable habitats and biodiversity • Preservation of habitats and species susceptible to climate change • Defining measures to reduce the spread and limit alien invasive species populations • Reduction of anthropogenic impacts on natural ecosystems, primarily via sustainable development measures • Implementation of integrated management of freshwater ecosystems • Strengthening the capacity of research institutions and responsible authorities to manage natural ecosystems and biodiversity • Providing an economically stimulating regulatory environment for the implementation of planned projects (tax reliefs, funds withdrawal platform, investment aid etc.)

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Impacts and challenges that cause high vulnerability	Possible responses to reduce high vulnerability
Energy	
• Decrease in the production of electricity in hydropower plants due to reduced precipitation by up to 10% in all seasons except winter and consequentially lowered flow rate, numerous dry periods and increased evapotranspiration • Increase in the consumption of electricity for cooling purposes (higher number of cooling degree days) due to increased average air temperature • Reduction of thermal energy production in thermal power plants due to increased average air temperature in the winter months • Decrease in the production of electric and thermal energy in thermal power plants due to insufficient cooling of the plants due to flow reduction • Damage to power plants and infrastructure due to extreme weather events – ice breaking and floods	• Strengthening the capacity for climate hazards impact assessments, risk prevention, readiness measures and outstanding events responses • Increasing the resilience and flexibility of the existing power system to the impacts of extreme and climate hazards and expected climate change • Increasing the transmission and distribution grid's resilience to the impacts of extreme and climate hazards and expected climate change • Increasing the security of electricity supply in the summer • Securing of an incentivizing legal framework for the use of renewable energy sources with the aim of diversifying sources and increasing decentralized production of electricity and thermal energy
Tourism	
• The tourist offer is not tailored to projected climate change (high temperatures, increased solar irradiance, frequency of extreme weather events, etc.) • Changing attractiveness of the coastal parts areas and inland areas of the Republic of Croatia • Damage to and/or reduced functionality of various infrastructure systems (water supply, drainage, beach infrastructure, horticulture etc.) • Deterioration of the status of ecosystems important for tourism and biodiversity due to the indirect and direct effects of climate change	• Adaptation of the tourism sector to changed operating conditions due to climate change impacts • Harmonization of tourism activities with projected climate change • Strengthening the competence related to adaptation to climate change of all persons directly related to the tourism sector • Inclusion of climate change adaptation measures in all segments of sustainable Croatian tourism • Inclusion of climate change adaptation measures in all segments of sustainable Croatian tourism • Revitalization of tourist offer in the entire territory of the Republic of Croatia and exploitation of up-to-now insufficient or unused potentials.
Health	
• Increased mortality of the population • Change in epidemiology of chronic non-infectious diseases • Change in epidemiology of acute infectious diseases • Reduced quality of outdoor and indoor air due to extremely high and low temperatures and precipitation	• Strengthening the competence of the health system in climate change impacts on health • Strengthening the competence of the health system as the response during future adaptation • Determination of sectoral priorities of climate change related activities

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Impacts and challenges that cause high vulnerability	Possible responses to reduce high vulnerability
• More frequent and longer periods of unavailability of safe (health safe and compliant) water for human consumption • Increased levels of contaminants in the environment • Impact on epidemiology of diseases related to climatological factors	• Extension of monitoring system of health and environmental indicators related to climate change and risk assessment
Spatial planning and management of the coastal area	
• Sea floods caused by rising sea levels • Floods in settlements due to extreme amounts of precipitation • Urban heat islands due to increased average temperatures in the summer months	• Improving the information base as a basis for making rational decisions related to planning of climate change adaptation measures • Capacity strengthening within the spatial planning system with the aim of integrating adaptation measures into spatial planning and management of coastal areas • Integrating of the adaptation measures into the spatial planning system • Application of spatial planning measures to programs and rehabilitation projects of the most endangered areas/locations • Raising of public and decision-makers' awareness in planning of climate change adaptation measures
Risk management	
• Open-type fires due to extended periods of high solar irradiance and extended periods of high air temperatures • Epidemics and pandemics due to the impact on the manner of transmission of diseases or the features of diseases caused by changing precipitation, humidity and evaporation rates • Increased scope of community health and socioeconomic burden due to environmental contamination after risks such as flooding or landslides	• Strengthening the competencies of key participants in managing climate change risks • Strengthening capacities for management and recovery after the risks related to climate change • Establishing of multidisciplinary priority guidelines for climate change management. • Expanding the risk tracking and risk assessment system using climate change risk monitoring tools • More effective remediation of damage as a consequence of climate change risks • Modification of the community's burden after exposure to climate change related risks

Climate change adaptation measures

Based on the principles for defining measures, sectoral analysis of the current state and assessing the degree of vulnerability and possible responses to the challenges of adaptation to climate change, for each sector a set of measures has been determined aimed at effectively

defining the climate change adaptation system set before each sectoral activity. In addition to the above-mentioned sectoral measures, a set of horizontal measures has been defined, which are relevant to several sectors, i.e. have a cross-sectoral character (spatial planning and management of coastal areas and risk management).

Table 0-3: Adaptation measures

Measure's ID	Measure's name	Key stakeholders
Hydrology, water and sea resources management		
HM-01	Strengthening the capacity for the implementation of non-structural measures for protection against the harmful effects of water in case of occurrence of extreme hydrological conditions whose increase in intensity and frequency of occurrence is conditioned by climate change	Ministry responsible for water management, ministry responsible for construction and spatial planning, ministry responsible for science and education, HV (Croatian Waters - *Hrvatske vode)*, DHMZ
HM-02	Strengthening the capacity to build, reconstruct and upgrade the system for protection against harmful effects of water and related multi-purpose hydro-technical systems (structural measures) and lowland natural floodplains flooded in a controlled fashion	Ministry responsible for water management, HV, HEP, Program Sava d.o.o., spatial planning institutions
HM-03	Strengthening research and management capacities to assess the occurrence and risk of adverse impacts of climate change and adaptation of freshwater and marine water system in current and future climatic conditions	Ministry responsible for water management, ministry responsible for construction and spatial planning, ministry responsible for science and education, HV, DHMZ, HGI, HHI, relevant faculties
HM-04	Strengthening the management capacities of responsible institutions to act on the occurrence of extreme hydrological conditions	Ministry responsible for water management, ministry responsible for construction and spatial planning, HV, DUZS, water supply companies
HM-05	Strengthening the capacities for effects of the sea on the coastal water-communal infrastructure and coastal water resources in conditions of sea level rise caused by climate change (non-structural measures)	Ministry responsible for water management, ministry responsible for construction and spatial planning, ministry responsible for maritime affairs, transport and infrastructure, HV
HM-06	Strengthening urban areas' resilience to anthropogenic pressures conditioned by climate change	Ministry responsible for construction and spatial planning, ministry responsible for water management, HV, JLS
HM-07	Strengthening the capacity for exploration and sustainable management of groundwater	Ministry responsible for environmental protection, HV, DHMZ, HGI
HM-08	Strengthening the resilience of coastal water utility infrastructure and coastal water resources (structural measures)	Ministry responsible for water management, HV, JLP(R)S
HM-09	Strengthening the protection capacity of particularly valuable aquatic ecosystems	Ministry responsible for nature, JUZP and Public institution for the management of protected natural values in the counties
Agriculture		
P-01	Implementation of an experimental climate change adaptation programme in agriculture	Ministry responsible for agriculture, scientific research institutions, Advisory service, DHMZ

P-02	Increasing the water absorption capacity of agricultural soil	Ministry responsible for agriculture, OPG, SMEs
P-03	Application of conservation soil treatment	Ministry responsible for agriculture, OPG, SMEs
P-04	Breeding of species and cultivars of agricultural crops and breeds of domestic animals that are more resilient to climate change	Ministry responsible for agriculture, Scientific research institutions, Advisory service, DHMZ
P-05	Construction of reservoirs for irrigation	Ministry responsible for agriculture, family farms, SMEs
P-06	Application of irrigation	Ministry responsible for agriculture, HV
P-07	Application of anti-erosion measures	Ministry responsible for agriculture, OPG, SMEs
P-08	Reconstruction and construction of drainage systems	Ministry responsible for agriculture, HV, OPG, SMEs
P-9	Insurance of agricultural production from production losses caused by adverse climatic conditions	Ministry responsible for agriculture, OPG, SMEs
Forestry		
ŠU-01	Incorporation of adaptation measures into key documents pertaining to forests and forestry sectors	Ministry responsible for forestry, Advisory service, HŠ, Union of private forest owners' associations, HŠI, Faculty of Forestry, Croatian Forestry Society, HKISDT, Academy of Forestry Sciences
ŠU-02	Research on species and provenance of forest trees that are more resilient to climate change	Ministry responsible for forestry and environmental protection, Croatian Science Foundation (HRZZ), HŠI, HŠ, Faculty of Forestry
ŠU-03	Strengthening the capacity for systematic monitoring of forest ecosystem conditions as a prerequisite for informed planning and implementation of climate change adaptation	Ministry responsible for forestry, HAOP, HŠI, HŠ, Faculty of Forestry, Advisory service for forestry, Croatian Science Foundation (HRZZ)
ŠU-04	Strengthening capacity for fire protection	DUZS, fire protection community, DHMZ, HŠ, Advisory service, HKISDT, scientific community, JLP(R)S
ŠU-05	Implementation of the green infrastructure concept	TDU at all levels responsible for spatial planning, JLP(R)S, city municipal utilities, HŠ, Program Sava d.o.o., urbanists, landscape architects, scientific community
ŠU-06	Prediction (forecast) of change in the distribution of harmful organisms	Ministry responsible for forestry, HŠI, Faculty of Forestry
ŠU-07	Afforestation	Ministry responsible for forestry, HŠ
ŠU-08	Bringing awareness to the participants in the forestry sector on climate change and the adaptation measures	Ministry responsible for forestry, HKISDT, HŠI, Faculty of Forestry, Advisory service, HŠ, Academy of Forestry Sciences, Union of private forest owners' associations, JUZP and public institutions for the management of protected natural values in the counties
ŠU-09	Strengthening awareness and sensitization of private forest owners for sustainable forest management as a prerequisite for adapting to climate change	Ministry responsible for forestry, Advisory service, private forest owners' organizations, private forest owners, JLP(R)S
Fishery		
RR-01	Strengthening the sector by investing in development of new markets and	Ministry responsible for fishery, ministry responsible for economy, entrepreneurship and

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	expanding the range of products offered	crafts, HGK, HOK, JLP(R)S, FLAG-s, fishermen
RR-02	Strengthening capacities to assess the future state of the sector due to climate change impacts	Ministry responsible for fishery, ministry responsible for science and education, scientific institutions, DHMZ, fishermen
RR-03	Strengthening the resilience of natural resources through adaptive fisheries management	Ministry responsible for fishery, scientific institutions, fishermen
RR-04	Increasing the involvement of fishermen in the tourism sector	Ministry responsible for economy, entrepreneurship and crafts, ministry responsible for tourism, tourist boards in the counties, cities and municipalities, FLAGs, fishermen
RR-05	Exploitation of alien fish species	Ministry responsible for fishery, scientific institutions, fishermen
RA-01	Strengthening aquaculture capacities by greater breeding of organisms at lower trophic levels and new forms of breeding	Ministry responsible for fishery, scientific institutions, breeders
RA-02	Strengthening aquaculture capacity through breeding in recirculation systems	Ministry responsible for fishery, scientific institutions, JLP(R)S, breeders
RA-03	Strengthening aquaculture capacity by breeding new species of fish	Ministry responsible for fishery, scientific institutions, producers of fish feed and fish equipment, breeders
RA-04	Strengthening aquaculture capacities by selective breeding	Ministry responsible for fishery, scientific institutions, breeders
RA-05	Strengthening aquaculture capacities by adapting the quantity and quality of food to changed climate conditions	Ministry responsible for fishery, scientific institutions, producers of fish feed, breeders, HAH (Croatian Food Agency)
Biodiversity		
B-01	Preservation of traditional agriculture in natural ecosystems	Ministry responsible for agriculture, Ministry responsible for regional development and EU funds and other responsible institutions, primarily HPA (Croatian Agricultural Agency) in cooperation with ministry responsible for nature
B-02	Establishment of a climate monitoring and early warning system for protected areas and ecological network of the Republic of Croatia and monitoring of protected wild habitat types and wild species	Ministry responsible for climate change and DHMZ in cooperation with ministry responsible for protection of nature
B-03	Improvement of knowledge and creation of databases of natural ecosystems and biodiversity	Ministry responsible for protection of nature, and HAOP in cooperation with Hrvatske šume d.o.o. (HŠ), speleological associations, individual experts
B-04	Integrated management of freshwater resources for the conservation and revitalization of natural ecosystems and biodiversity	Ministry responsible for protection of nature, HV, JP(R)S
B-05	Integrating knowledge about the effects of climate change into a system of nature protection	Ministry responsible for water management, and Croatian Waters company for water management together with ministry responsible for nature and bodies of local and regional governments
B-06	Strengthening endangered habitats and species	Ministry responsible for protection of nature, HAOP, HŠ, HV, JLP(R)S
B-07	Improving sustainable management and infrastructure in natural ecosystems	Ministry responsible for construction and spatial planning, ministry responsible for agriculture, ministry responsible for tourism cooperating with

		ministry responsible for protection of nature, HŠ, HV et al.
B-08	Strengthening the human and financial capacities of the nature protection system	Ministry responsible for protection of nature, HAOP, JUZP, Public institutions for the management of protected natural areas in the counties, HŠ, HV
B-09	Strengthening the transfer of knowledge on the importance and services of ecosystems and biodiversity and their vulnerability to climate change	Ministry responsible for protection of nature, HAOP, JUZP, Public institutions for the management of protected natural areas in the counties
Energy		
E-01	Strengthening the resilience of production facilities through the storage of electrical energy	Ministry responsible for energy, HERA, HROTE, HOPS, HEP ODS, legal entities performing electrical energy generation, eligible electrical energy producers
E-02	Strengthening the capacities and ensuring of an incentivizing legal framework to increase the capacity of renewable energy and distributed sources	Ministry responsible for energy, HERA, HROTE, HOPS, HEP ODS, Program Sava d.o.o., legal entities performing electrical energy generation, eligible electrical energy producers
E-03	Strengthening the resilience of existing electricity and heat production capacity	Ministry responsible for energy, ministry responsible for construction and spatial planning, HERA, legal entities performing electrical energy generation, eligible electrical energy producers
E-04	Development of the monitoring capacity and rapid elimination of negative effects of climate impacts on the electrical energy system (EES)	Ministry responsible for energy, DUZS, HERA, HOPS, HROTE, HEP ODS
E-05	Strengthening the electrical energy system's resilience (EES)	Ministry responsible for energy, HERA, HROTE, HOPS, HEP ODS, legal entities performing electrical energy generation, eligible electrical energy producers
E-06	Strengthening the distribution network's resilience	Ministry responsible for energy, HERA, HROTE, HEP ODS
E-07	Strengthening the transmission network's resilience	Ministry responsible for energy, HERA, HROTE, HEP ODS
Tourism		
T-01	Integration of climate change into the tourism development strategy	Ministry responsible for tourism, ministry responsible for environmental protection, JLP(R)S, tourist boards in counties, cities and municipalities
T-02	Raising awareness of persons involved in the tourism sector on the possibilities of adaptation to climate change	Ministry responsible for tourism, HGK, tourist boards in counties, cities and municipalities
T-03	Strengthening the competencies of high school and university students	Ministry responsible for science and education, Agency for Vocational Education and Training
T-04	Strengthening the resilience of tourism infrastructure to different weather extremes	Ministry responsible for tourism, ministry responsible for construction and spatial planning, ministry responsible for environmental protection, ministry responsible for sea, transport and infrastructure, JLP(R)S

T-05	Strengthening the resilience of local communities in the tourism sector	Ministry responsible for tourism, JLP(R)S, tourist boards in counties, cities and municipalities
T-06	Development of sustainable tourism with included adaptation to climate change	Ministry responsible for tourism, JLP(R)S
Health		
ZD-01	Establishment of a system for calculating health-economic indicators for climate change-related conditions	Ministry responsible for health, HZZO, HZJZ, county institutes of public health
ZD-02	Integration of various information systems within healthcare to monitor indicators associated with climate change	Ministry responsible for health, HZZO, HZJZ, county institutes of public health, HAH
ZD-03	Establishment of a framework for the implementation of human biomonitoring for tracking environmental factors related to climate change	Ministry responsible for health, HZZO, HZJZ, county institutes of public health, scientific institutes, medical faculties
ZD-04	Implementation of health impact assessments and health assessments of risks related to climate change	Ministry responsible for health, ministry responsible for environmental protection, HZJZ, county institutes of public health, HAH, health risk and health impacts assessment experts
ZD-05	Networking and upgrading of monitoring system of environmental indicators related to climate change	Ministry responsible for health, ministry responsible for environmental protection, ministry responsible for agriculture and forestry, ministry responsible for water management, HV, HŠ, HAOP, private labs, HZJZ, county institutes of public health, HAH
ZD-06	Increasing the number of secure points in case of extreme meteorological conditions	Ministry responsible for health, ministry responsible for environmental protection, HZJZ, county institutes of public health, JLP(R)S
ZD-07	Strengthening the allergen species monitoring system	Ministry responsible for health, ministry responsible for agriculture and forestry, ministry responsible for transport and infrastructure, ministry responsible for utilities, Advisory service, HŠ, HV, HŽ, HZJZ, county institutes of public health, State administration offices in counties (UDUs), JLP(R)S
ZD-08	Strengthening the awareness of public and key stakeholders within health and other priority professions (*e.g.* educational and preschool institutions, facilities for elderly and helpless people, home care etc.)	Ministry responsible for health, HZJZ, county institutes of public health, HAH, JLP(R)S
ZD-09	Integration of climate change subject into the national school curriculum	Ministry responsible for science and education, JLP(R)S, public institutions that provide educational and nurturing services
Spatial planning and coastal area management		
PP-01	Strengthening of the knowledge base, as well as the monitoring and evaluation system	Ministry responsible for environmental protection, ministry responsible for spatial planning, HV, HAOP, JLP(R)S
PP-02	Strengthening the human and institutional capacities of professional stakeholders in the spatial planning system	Ministry responsible for spatial planning, ministry responsible for environmental protection, expert authors, carriers and coordinators of spatial plans, HKA (Croatian Chamber of Arhitects), ministry responsible for environmental protection, authorities for preparation of strategic studies, ministry responsible for education and science, HZPR, county institutes of spatial planning, JLP(R)S
PP-03	Integration of adaptation measures into the spatial planning system	Ministry responsible for spatial planning, HZPR, county institutes of spatial planning, JLP(R)S

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PP-04	Raising awareness of the public and decision-makers at all levels	Ministry responsible for environmental protection, ministry responsible for spatial organization, JLP(R)S, citizens
PP-05	Preparation of programs and rehabilitation projects	Ministry responsible for construction and spatial organization, ministry responsible for culture, JLP(R)S, public and private property owners, responsible legal entities with public authority
Risk management		
UR-01	Mapping of water sources outside the public water supply system	Ministry responsible for water management, DUZS, JLP(R)S, HZJZ, county institutes of public health, private and public owners of sources outside the public water supply system
UR-02	Multi-sectoral risk assessment for various threat / risk scenarios associated with climate change	Ministry responsible for health, ministry responsible for agriculture, ministry responsible for environmental protection, ministry responsible for defence, ministry responsible for sea, transport and infrastructure, security agencies, HVZ, HZJZ, County institutes of public health
UR-03	Expansion of the *Croatian Platform for Disaster Risk Reduction* to include climate change-related indicators for the development of an early warning system	DUZS, JLP(R)S, HZJZ, County institutes of public health, responsible ministries, HAH, HŠ, HV
UR-04	Strengthening the capacities to assess dangers and responses during disasters, major accidents, extraordinary events or incidents/crisis situations related to climate change	DUZS, DHMZ, JLP(R)S, HAH, responsible ministries, scientific community, insurance companies, civil associations
UR-05	Establishment of human and technological capacities for recovery after complex risks related to climate change	DUZS, responsible ministries, HZJZ, County institutes of public health
UR-06	Expanding capacities and models for coverage of risk related to climate change and catastrophic damages	Ministry responsible for environmental protection, ministry responsible for finance, certification houses, insurance companies
Supra-sectoral measures		
KM-01	Strengthening human and technical capacities for implementing research and applied activities in the area of climate modelling, analysis, and interpretation of observed and expected climatic changes	DHMZ, universities, scientific research institutes, ministry responsible for the environment, agencies, institutes and other expert bodies
RP-01	Development of impact indicators of the implementation of the adaptation strategy for vulnerable sectors and society	Ministry responsible for environmental protection and climate, ministries responsible for sectors vulnerable to climate changes, universities, scientific research institutes, ministry responsible for finance

Priorities of the Adaptation Strategy

Based on the list of a total of 81 identified measures of climate change adaptation 79 sectoral measures were divided into five groups of measures based on the national priorities of the Adaptation Strategy, which were identified by stakeholders during the process of harmonizing the concept of climate change adaptation in the Republic of Croatia and ranked by the method of multi-criteria analysis. Two measures, KM-01 and RP-01, have not been taken into account in this distribution because they are supra-sectoral. Five national priorities have been identified, within which climate change adaptation measures are to be implemented. These are:

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- Ensuring sustainable regional and urban development
- Ensuring preconditions for the economic development of rural areas, coastal areas and islands
- Ensuring sustainable energy development
- Strengthening of the management capacities through a networked monitoring and early warning system
- Ensuring continuity of research activities.

Adaptation measures to climate change are grouped according to the following *types*:

- Regulatory and administrative measures (RE)
- Implementation measures (PR)
- Measures of education and bringing awareness to the public (ED)
- Research-development measures (IR).

Integrating the above mentioned measures of adaptation to climate change according to the urgency and importance of implementation, they are divided into three basic categories of *importance*:

- Measures of very high importance of implementation
- Measures of high importance of implementation
- Measures of medium importance of implementation.

Implementation of the Adaptation Strategy

The total amount of investment needed to implement the Adaptation Strategy at this point can be estimated at around 27 billion kuna, or just over 3.6 billion euros. The greatest part of this amount will be provided from the EU funds, while state budget funds would amount to only 0.23% of the total investment amount and will be used for implementation of regulatory and administrative measures (RE). More than half of the estimated amount refers to implementation of “structural” measures, particularly in the sectors of agriculture and forestry and to a lesser extent of energy and tourism. Investments in the first two sectors can be treated as “no regrets”, *i.e.* measures that are already planned to be implemented, and their effects will be positive also for adapting to climate change. The average annual cost of implementing the Adaptation Strategy will amount to around 520 million kuna, or around 70 million euros (through a period of 52 years), counting also significant capital investments. This may seem like a large sum, but it should be compared to the average annual damage (in the period from 1980 to 2015) in the Republic of Croatia, and that only as a result of extreme weather and climate events (around 80 million EUR per year). Assuming that these measures will contribute to positive economic impacts, it can be concluded that the benefits of implementing the Adaptation Strategy, despite high costs, will be significant.

Funding of the Adaptation Strategy priorities will be mainly focused on the first two priorities: ensuring sustainable regional and urban development and ensuring preconditions for the economic development of rural areas, coastal areas and islands. It should be emphasized that most of the "structural" measures will be implemented within these two priorities. Another important emphasis refers to the fact that the implementation of the

Adaptation Strategy, by funding of these two priorities, is put in the function of ensuring sustainable development.

Following the guidelines of the Adaptation Strategy, the Action Plan for Adaptation to Climate change has also been developed. The strategy lays out a vision and guidelines for developing adaptation to climate change by 2040 with a view to 2070, while the action plans are to contain elaborated measures and activities that have come as a derivative of the Adaptation Strategy for a specific five-year period. The plans provide for description of each measure, manner of implementation, order of implementation of measures, execution deadlines, obligated parties, and coordination of measures under implementation. Along with the drafting of the Adaptation Strategy, the first Action Plan was developed.

The basic principle for defining the institutional framework for the implementation of the Adaptation Strategy is that it does not foresee the establishment of new institutions and authorities and that the existing competencies within the governmental structure will be fully respected. This does not mean that the changed institutional frameworks will not be proposed in the future if the circumstances surrounding climate change and adaptation have changed.

The state authority responsible for coordinating climate change policy is the Ministry responsible for environmental protection. The task of this authority is, *inter alia*, to develop strategic and planning documents and to carry out the work of a national contact authority for reporting to EU bodies and other international bodies on climate change adaptation policy. The role in the Adaptation Strategy should also be extended to two organizational units under the responsibility of the MZOE (Croatian Environment and Nature Agency - HAOP and the Environmental Protection and Energy Efficiency Fund - FZOEU) and the Meteorological and Hydrological Service (DHMZ).

The indicator system for monitoring the implementation of the climate change adaptation process and the efficiency indicator system of the adaptation itself stem from a set of measures that will ultimately be accepted for the Adaptation Strategy as a whole, and in particular for the measures to be implemented in the first Action Plan. In this sense, one or more adaptation indicators will be determined for each measure. Monitoring information will provide a basis for making periodic evaluations of the implementation of the Adaptation Strategy. Monitoring of the Adaptation Strategy implementation will be done through the indicator system:

- Indicators of monitoring the implementation of measures and activities of the Adaptation Strategy – should provide answers, inter alia, to the following issues: (a) Are the measures and activities being implemented?, (b) Are there any improvements possible to the climate change adaptation measures and activities?, (c) Which of the measures not achieving the expected effects?
- Indicators of effectiveness of the implemented measures (impact of the Adaptation Strategy) – should show whether the measures taken have contributed to reducing the vulnerability and increasing the resilience of social and natural systems to the consequences of climate change.
- Climate indicators – parameters that give a general picture of the climate conditions and are essential for evaluating impacts and vulnerabilities in the observed sectors and thematic areas.

1 INTRODUCTION

1.1 Importance of adaptation to climate change for the Republic of Croatia

Climate change presents a growing threat and will be a challenge for all mankind by the end of the 21st century. There is an undisputable scientific and political consensus that climate change is already occurring and significant, which has been confirmed by the adoption of a series of international arrangements and agreements (including the Paris Climate Change Agreement, which has been in force since 4 November 2016, confirmed by EU on 5 October 2016, and by the Republic of Croatia on 17 March 2017). For a long time now, the Republic of Croatia has been exposed to the negative effects of climate change, which, among other things, have led to significant economic losses. According to the European Environment Agency (EEA) report, the Republic of Croatia belongs to a group of three countries, together with the Czech Republic and Hungary, with the highest share of the damages from extreme weather and climate events in relation to the Gross Domestic Product (GDP). It is estimated that these losses, in the period from 1980 to 2013, amounted to around 2.25 billion EUR or around 68 million EUR per year on average. These losses have increased significantly during 2014 and 2015 (to 2.83 million EUR in 2015). Some economic sectors were significantly affected in that period. According to some estimates, between 2000 and 2007 extreme weather conditions caused a damage of 173 million EUR to the agricultural sector, while the drought in 2003 caused damage of between 63 and 96 million EUR to the energy sector. It is also estimated that in August 2003 the mortality rate was 4% higher due to heat stroke.

The effects of climate change depend on a whole set of parameters. According to international climate modelling results (IPCC, EEA), the Mediterranean Basin is designated as a “hot” climate point with particularly pronounced effects of climate change. The Republic of Croatia, which is largely part of the Mediterranean region, will certainly experience the consequences of climate change and its vulnerability is assessed as great. The vulnerability of some sectors of the economy is more acute, especially of tourism, agriculture, forestry, fisheries and energy, because the success of all these sectors largely depends on climate factors. The degree of economic vulnerability can be assessed as high due to the fact that the share of agriculture and tourism in the total GDP of Croatia in 2017 is likely to exceed one-quarter of total GDP. Consequently, the extreme vulnerability of the economy to the impacts of climate change can negatively reflect on the overall social development, especially on vulnerable groups of society. Therefore, societies that do not begin to implement adaptation measures in time can face catastrophic consequences for the environment and the economy, endangering the sustainable development of society. The cost of investment in adaptation today will reduce the cost of repairing potential damages in the future. It is therefore of the utmost importance to initiate the social process of adopting the concept of adaptation to climate change, to determine the impact of climate change on the Republic of Croatia, to determine the degree of vulnerability and to determine priority measures. In other words, it is necessary to approach the process of adaptation to climate change strategically.

For the purposes of the Climate Change Adaptation Strategy of the Republic of Croatia to 2040 with the view to 2070 (hereinafter: the Adaptation Strategy) adaptation to climate change is, pursuant to the Air Protection Act (Official Gazette No. 130/11, 47/14 and 61/17) defined as a process that "... *implies assessment of adverse impacts of climate change and*

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taking appropriate measures to prevent or reduce the potential damage they may cause." The definition of adaptation to climate change in the aforementioned act is also the cornerstone of the Adaptation Strategy. Adapting to climate change implies undertaking a set of activities to reduce the vulnerability of natural and social systems to climate change, increasing their ability to recover after the impact of climate change, as well as exploiting the potential positive impacts that may also be a consequence of climate change.

Adaptation to climate change is considered, along with mitigation (i.e. the reduction of net greenhouse gas emissions), the second important pillar of the implementation of climate policy, which is in the function of preserving the values of society, the environment and the economy and ensuring the sustainable development of the Republic of Croatia in a long-term perspective. It should be emphasized that the Republic of Croatia, due to its size and economic power, can only make a small contribution to mitigating climate change, but it is nevertheless exposed to a significant impact of the adverse effects of climate change, as is clear from the above mentioned data on damages, especially if the climate change adaptation activities do not begin to be planned and implemented immediately.

Adaptation to climate change is a lengthy process that needs to be carried out continually and in a planned manner. The development of the Adaptation Strategy and the comprehensive Action Plan with the aim of achieving long-term goals is a fundamental prerequisite and an appropriate instrument for the successful implementation of the climate change adaptation process. Each strategy defines how a certain vision will be implemented, *i.e.* what steps must be taken to realize a certain vision. Regarding the Adaptation Strategy, the vision is the development of a system for strengthening resilience to climate change in order to mitigate its negative impacts and accept positive aspects and to develop a system for the faster recovery of natural and social systems from negative impacts. The Adaptation Strategy assumes a specific framework for climate change risk management as well as prioritization and coordination of adaptation measures implementation activities in relation to anticipated climate change and prevention of possible damage.

The Air Protection Act, as the basic legal act of the Republic of Croatia regulating the issue of adaptation to climate change (Articles 118 and 118a), defines sectors most exposed to climate change as follows: hydrology and water resources; agriculture; forestry; biodiversity and natural land ecosystems; biodiversity and marine ecosystems; coastal management and coastal area; tourism and human health. This list was expanded during the drafting of the Adaptation Strategy to include additional sectors that were considered to be critical for the implementation of a comprehensive and effective adaptation to climate change and which are also extremely vulnerable to climate change: energy, fisheries and cross-sectoral themes of spatial planning and risk management.

The process of adaptation to climate change includes all segments of society and the entire economy. It needs to be adjusted to the assessed needs, implementation options, and available resources. Adapting to climate change is a significant cost, but it can ultimately result in total positive financial effects or significant reductions in negative impacts, especially if its implementation begins sufficiently early. For this reason, the defined priorities and action plans of the Adaptation Strategy should reflect the gradual approach and concern for the rational use of human and financial resources.

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The Adaptation Strategy is not an isolated document but has been developed in synergy with the Sustainable Development Strategy of the Republic of Croatia and with all relevant sectoral strategies that have been adopted or are in the process of adoption. These strategies address, to a lesser or greater extent, climate change issues, and some of them propose appropriate measures (for example the Strategy for Maritime Development and Integral Maritime Policy of the Republic of Croatia for the period 2014-2020, the Transport Development Strategy of the Republic of Croatia, the Spatial Development Strategy of the Republic of Croatia, the Draft Management Strategy for the Marine Environment and Coastal Region of the Republic of Croatia). The Adaptation Strategy avoids the repetition of measures already mentioned in other strategies that contribute to adaptation (for example, it does not propose measures for the marine environment and its ecosystem, as this is already covered by the draft of the Draft Management Strategy for the Marine Environment and Coastal Region of the Republic of Croatia). But it is important to emphasize that, in view of its nature, the Adaptation Strategy is part of the so-called horizontal strategies or strategies that have a cross-sectoral character, and therefore, the Air Protection Act prescribes alignment of all development strategies with the Adaptation Strategy.

The drafting of the Adaptation Strategy was preceded by the creation of the so-called Green book, which was based on technical documents concerning: climate modelling that resulted in climate projections for the Republic of Croatia to 2040. *i.e.* 2070; analysis of climate change impacts and vulnerability to projected climate change; defining the initial program of measures that will be applicable in the process of adaptation to climate change; analysis of cost effectiveness of the measures and assessment of the need to strengthen capacities for adaptation to climate change. The purpose of the Green book was to encourage and initiate a national discussion on all important issues relevant to climate change adaptation. After consultations with key stakeholders, this document (so-called White book) was developed, which includes the conclusions of public discussions. Along with the Adaptation Strategy, an Action Plan has been developed.

1.2 Timeframe of the Adaptation Strategy and development of greenhouse gas concentrations in the future

Adaptation to climate change is a long-term continuous planning process. The drafting of the Adaptation Strategy starts with the results of the climate models projections for two periods, taking into account the two scenarios for the development of greenhouse gas concentrations in the future: RCP4.5 and RCP8.5 as defined by the Intergovernmental Panel on Climate Change - IPCC). Scenario RCP4.5 is considered a more moderate scenario, unlike the RCP8.5 scenario that is treated as extreme. Climate projections are created for two time periods: the first ending in 2040 and the second ending in 2070.

Based on the results of climate modelling for the whole period up to 2070, the impacts of climate change on individual sectors and expected changes and vulnerabilities in the observed sectors were estimated. Of course, the results of climate models for the first period, up to 2040, are statistically more likely because they are closer to the present, and the scenario for the development of greenhouse gas concentrations RCP4.5 is treated as more probable as well. Therefore, the proposed adaptation measures are based on this scenario of the development of greenhouse gas concentrations.

The spatial coverage of the Adaptation Strategy is the territory of the Republic of Croatia. However, it should be taken into account that global climate change analyses have, in the narrowest sense, regional and local character, and there are rarely cases of climate modelling that apply one country only; this is especially not the case when it is relatively small in size, as is the Republic of Croatia. In this sense, the projections of climate models developed for the needs of the Strategy also have a wider spatial coverage than the Republic of Croatia, but the features of the future climate change related to the Republic of Croatia and its most important regions are outlined from these projections. Similarly to other European countries, the Republic of Croatia is exposed to weather influences coming from different areas of Europe but also generated outside Europe (for example, over the Atlantic Ocean, Siberia, the Mediterranean, etc.). Weather and climate, therefore, do not recognize state borders so the same weather, climate and climate change can affect areas independently of national territories.

The assessment of climate and status in sectors between 2041 and 2070 is less certain (although the change is more pronounced in both RCP scenarios) because this time frame is too distant for greater statistical probability. For that reason, within the Adaptation Strategy, we are talking about the “outlook” on the time frame up to 2070 and the measures apply only in the smaller part to that second period. This approach is understandable because it is ineffective to plan more concrete measures for such a long period of time. However, the scenarios proposed for the first period, despite the uncertainties that are an integral part of climate modelling, are a good basis for assessing the development of climate change in the second period of the Adaptation Strategy.

1.3 The process of developing Adaptation strategy and methodological approach

The approach to the drafting of the Adaptation Strategy is a combination of (1) expert work carried out by a group of sectoral and cross-sectoral experts and scientists, and (2) contributions of interested stakeholders (institutional stakeholders such as the Ministry of Environment and Energy, other ministries, county representatives, representatives of cities and municipalities, professional stakeholders, such as representatives of a large number of scientific, educational and professional institutions, non-governmental organizations, professional chambers and other interested wider public). The drafting of documents at all stages of the Adaptation Strategy development was based on the proposals presented at a number of stakeholders' meetings (workshops) organized during the Adaptation Strategy development (18 in total) and by direct communication of project experts with involved institutions and other interested stakeholders. The drafting of the Adaptation Strategy was carried out in several phases:

i. Creating a scientific basis for the development of the Strategy:

   - All the *past research* that has been carried out in each of the selected sectors has been thoroughly analysed, and a review of a large number of professional and scientific publications which are considered relevant to particular sectors was carried out, primarily regarding the impacts and vulnerabilities and adaptation to climate change. By analysing these publications, all those topics and findings that were considered important for the drafting of the Adaptation Strategy were outlined. Based on an analysis of the current state, published scientific and

professional publications and research, and direct contacts with representatives of individual institutions, specific topic proposals were given, which would need to be explored in the future in order to create a firmer basis for the more efficient implementation of the adaptation process.

- Comparisons of climate change projections for future time periods 2011 - 2040 and 2041-2070 with reference period of climate state for 1971-2000 were made. Climate projections' results for future time periods were obtained on the basis of numerical integration with *Regional Climate Model* (RCM) RegCM. A total of 20 climatological variables were analysed. The model results served as the basis for sectoral scenarios when defining impacts and vulnerability to climate change.
- One of the key phases of the Adaptation Strategy is the assessment of impact of climate change on the observed sectors and assessment of vulnerability of the observed sectors to climate change. The impact and vulnerability assessment was developed for each sector separately, but for each sector an assessment of cross-sectoral impacts was made as well. This step in drafting the Adaptation Strategy is actually the first step in defining the adaptation measures.

ii. Planning for climate change adaptation:

- Based on the results of the study of impacts and vulnerabilities to climate change in individual sectors, an *assessment of adaptation measures for vulnerable sectors* was carried out. This step represents the first "look ahead" in the process of drafting the Adaptation Strategy. The proposed measures are based on the analytical background presented in the two previous documents, *i.e.* those dealing with climate modelling and the assessment of the impacts of climate change and vulnerability of particular sectors in relation to these impacts. In a certain way, this step represents a transition phase in drafting the Adaptation Strategy, because the presented proposals of measures define a wider operational context that is the basis for defining action plans as operational instruments of the Adaptation Strategy. In this step, the measures are not yet given in the order of implementation importance; rather, all assessed necessary measures for a certain sector and cross-sectoral themes were simply listed in order to achieve a desirable situation in which the negative impacts of climate change would be minimized within the timeframes of the Adaptation Strategy (until 2040 with the view up to 2070).
- *Cost-effectiveness analysis*, using the method of multi-criteria analysis, defined the basic starting point for further drafting of the Adaptation Strategy because it evaluates the adaptation measures proposed in the previous step and defines the priorities of the Adaptation Strategy affecting the ranking of customizable measures.

iii. Drafting of the Adaptation Strategy:

- Based on all collected data and prepared previous documents and in accordance with the Air Protection Act and European Union Guidelines for Development of Climate Change Adaptation Strategies, as well as accompanying documents, a draft version of the Adaptation Strategy (Green Book) was drafted.

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- Based on the public discussion, comments and suggestions received regarding the working version of the Adaptation Strategy, a Draft of the Adaptation Strategy (White Book) was made.
- Based on cost-effectiveness analysis and public discussion, a draft of the *Action Plan* was drafted.

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2 GENERAL GOALS OF THE ADAPTATION STRATEGY

The main, long-term goal of the Adaptation Strategy is to reduce the vulnerability of social and natural systems to the adverse impacts of climate change, *i.e.* to strengthen their resilience and the ability to recover from these impacts. Finally, taking into account the possible positive effects of climate change, the implementation of the Adaptation Strategy should make the systems more robust, *i.e.* more resistant than they are today, which will contribute to the achievement of the long-term sustainable development of the Republic of Croatia.

The next goal of the Adaptation Strategy is to bring together all relevant institutional, political, economic and social stakeholders to create strong enough support for the implementation of joint actions on the implementation of adaptation measures, which necessitates a proactive approach. This means that actions or measures need to be started immediately because any delay will reduce their effectiveness and make them more expensive.

The Adaptation Strategy aims at integrating the adaptation process, including the implementation of measures, into existing and new policies, programs, plans and other activities implemented at all levels of governance. In that sense, it should help adaptation principles and appropriate measures to become one of the decisive criteria for making strategic and developmental decisions in the future. This will help mitigate the negative impacts of climate change, eliminate potential conflicts between sectors in the process of adaptation, and reduce their vulnerability.

Despite significant advances in scientific knowledge on climate change and their effects, there are still many unknowns related to climate change impacts and the degree of vulnerability that they cause for particular sectors. The adaptation strategy aims to stimulate or enhance scientific research to better understand the complexity of climate change impacts and reduce the degree of uncertainty related to the effects of climate change.

Finally, the Adaptation Strategy aims to raise awareness of the importance of climate change and the inevitable launch of the adaptation process in all social segments, which are also the main beneficiaries of the positive effects of the climate change adaptation process.

3 INTERNATIONAL CONTEXT AND POLICY OF THE EUROPEAN UNION

At the EU level, there are no specific legal obligations (directives, regulations) related to climate change adaptation, but only guidance and a strategy. The EU's climate change adaptation strategy consists of a package of documents describing how adaptation to climate change should be included in different sectors. The EU Strategy has three main (general) goals:

- *Promotion of Member States' actions* by encouraging all Member States to adopt comprehensive adaptation strategies (such as the Adaptation Strategy), providing sufficient financial resources, promoting activities in cities
- *Promotion of better informed decision-making* by removing shortcomings in knowledge about adaptation and further development of the European Climate Change Adaptation Platform (Climate-ADAPT)
- *Promotion of adaptation in key vulnerable sectors* by integrating it into common agricultural, fisheries and cohesion policy, ensuring that European infrastructure is flexible and resistant to climate change, and encouraging the use of insurance against natural disasters and human-caused disaster.

At the international level, outside the EU, there are several agreements of major importance for the Adaptation Strategy, namely:

- United Nations Framework Convention on Climate Change (UNFCCC), which aims to achieve a stabilization of greenhouse gas concentrations in the atmosphere at a level that will prevent dangerous anthropogenic action on the climate system
- The Kyoto Protocol, in conjunction with the UNFCCC, is an addition to the international climate change agreement signed with the aim of reducing carbon emissions and other greenhouse gases
- The Paris Agreement, also part of the UNFCCC, aimed at limiting the rise of global average temperatures to "considerably less" than 2 °C, ensuring food supply, but also strengthening the capacity of states to deal with the consequences of climate change, the development of new "green" technologies and helping economically less-developed members to implement their national emissions reduction plans
- Goal no. 13 of Sustainable Development Agenda 2030, to take urgent action to combat climate change and their impacts, is one of the 17 Sustainable Development Goals (SDGs).

The Paris Agreement on climate change is the most important international agreement providing guidelines for adaptation. The Republic of Croatia signed it on 22 April 2016, ratified it (as the 147th country of the world) on 17 March 2017, and came into force on 23 2017. The text includes, inter alia, the following:

> "*As a Global Adaptation Goal the Parties establish strengthening of capacity for adaptation, strengthening of resilience and reducing susceptibility to climate change in order to contribute to sustainable development and to provide appropriate mitigation measures in the context of the temperature goal*."

4 SITUATION IN THE REPUBLIC OF CROATIA: FORECASTS OF FUTURE CLIMATE, IMPACT AND VULNERABILITY ASSESSMENT

4.1 Climate projection in the Republic of Croatia for 2040 with a view to 2070

The increase in global temperatures since the middle of last century is extremely high and is consistent with the increase in carbon dioxide concentration, the most important greenhouse gas. According to the estimates of the Intergovernmental Panel on Climate Change (IPCC) of 2013, the increase in carbon dioxide concentrations and the rise of global temperature can be attributed to human activity with great confidence.

In addition to the "historical" climate simulation for the period 1971-2000, the RegCM, regional climate model, calculated change (forecasts) for the future climate in two periods: 2011-2040 and 2041-2070, assuming the IPCC scenarios of greenhouse gases concentrations development RCP4.5 and RCP8.5. The RCP4.5 scenario is characterized by the medium level of greenhouse gas concentrations with relatively ambitious expectations of their future reduction, which would peak in around 2040. The RCP8.5 scenario is characterized by a continuous increase of greenhouse gas concentrations, which, by the year 2100, would be up to three times higher than today.

RegCM's numerical integrations used the marginal and initial conditions of four different Global Climate Models (GCMs) that were used in experiments in the fifth phase of the Coupled Model Intercomparison Project (CMIP5) for preparation of the Fifth Climate Change Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR5) in 2013. These are the GCM models: the model of the French meteorological service CNRM-CM5, the model of the Dutch EC-Earth consortium, the MPI-ESM model of the German Max-Planck meteorology institute and the HadGEM2 model of the British meteorological service.

For those climate parameters whose spatial variability does not change significantly (*e.g.* temperature – daily mean, maximum, minimum, then pressure, evapotranspiration, insolation, etc.), the 50 km horizontal resolution used in this regional climate model can be sufficient to describe well the state of the reference climate and the expected future change to the predetermined climate scenario. For those climatological parameters that have higher spatial variability (precipitation, snow cover, wind, etc.) or depend on the different characteristics of small spatial scales (orography, land-sea contrast), a higher (finer) horizontal resolution would be preferable. However, due to the complex orography and particularly large differences and contrasts in the coastal belt of the Republic of Croatia, adequate numerical modelling of climate and climate change is very demanding and significantly exceeds the modelling opportunities that were available during the drafting of the Adaptation Strategy.

Concrete numerical assessments that are outlined in the modelling results should be considered only as an approximation due to all the uncertainties in climate modelling, although they generally agree with similar European studies. The climate modelling results for the most commonly used climatological variables are:

Precipitation. Observed movements. During the period from 1961 to 2010, annual precipitation levels in the Republic of Croatia show prevalent statistically insignificant trends, which are positive in the eastern lowlands (increase) and negative in other areas of Croatia (decrease). Poor trends are noticeable in most seasons, but the exception is the summer precipitation that has a clearly marked negative trend across the country (decrease). In autumn there are weak trends of mixed sign, and the increase in precipitation in the interior is mainly due to the increase in the number of days with large daily precipitation quantities. During the winter, precipitation trends are not significant and are mostly negative in the southern and eastern regions. In the rest of the country precipitation trends are of mixed. In spring, the results show that there are no significant changes in the total precipitation in the southern and eastern part of the country, while the negative trend (decrease) is present in the remaining parts.

Future change of precipitation for the RCP4.5 scenario. At an *annual* level, a very small decrease of average annual precipitation is projected until 2040, which will have no significant impact on the total annual volume. In north-western Croatia, the signal of change is going in the direction of a smaller annual precipitation increase. Until 2070 it is expected further reduction of the average annual precipitation (up to about 5%), which will extend to almost the entire country, except at the northernmost and westernmost parts. The largest decrease is expected in the southern Lika region up to the Dalmatian hinterland along the border with Bosnia and Herzegovina (about 40 mm) and in the southernmost land areas (about 70 mm).

The projected change in the total amount of precipitation *per season* between 2011 and 2040 differ. In winter in Croatia as a whole, and in the spring in most of Croatia a smaller increase in precipitation is expected. In summer and autumn, the decrease in total precipitation will prevail throughout the country. The expected increase in precipitation in winter is between 5 and 10% in the northern and central regions, and in spring the total precipitation growth in western regions will be smaller. In the spring considerably lower precipitation levels are expected in the eastern and southern regions. The largest summer precipitation decrease, 5-10%, is expected in northern Dalmatia and southern Lika, whereas decrease in other parts should be less than 5%. In autumn, the largest projected reduction in the total precipitation amount is about 20 mm in Gorski Kotar and in the northern part of Lika, which makes about 5% of the total precipitation in that season, and in the far south the decrease is also about 5%.

In the period 2041-2070, the decrease of precipitation is expected in all seasons, except in winter. The biggest decrease (slightly more than 10%) will be in the spring in southern Dalmatia and in the summer, 10-15%, in the mountainous areas and in northern Dalmatia. The largest increase in total precipitation, 5-10%, is expected on the islands in autumn and in northern Croatia in winter.

Future change to the RCP8.5 scenario. Until 2040 the increase of total precipitation in relation to the reference climate in winter and spring is expected in most of the country. This increase would be the largest, 8-10%, in northern and central Croatia in the winter. In the summer, the predominant decrease in total precipitation is projected, mostly in Lika - up to 10%. In autumn, a slight increase in total precipitation is expected.

In the period 2041-2070, the increase of total precipitation for the winter is projected in whole of Croatia, and mostly, by 8-9%, in the northern and central regions. In the summer, total precipitation is expected to decrease throughout the country, mostly in northern

Dalmatia - 5 - 8%. In the spring and autumn, the signal of change includes both increase and decrease of precipitation. However, in autumn the decrease of total precipitation rate would prevail in most of the country, except in northern Croatia.

Rain and dry periods. Scenario RCP4.5. Until 2040, the expected number of rainy periods (a series of at least 5 days when the total precipitation is greater than 1 mm) would generally decrease, except for winter in central Croatia when it would slightly increase. These changes are generally small. Further decrease of the number of rainy periods is expected in the mid-21st century (2041-2070). The biggest decrease would be in the mountainous and coastal Croatia in winter and spring, but also in summer in the parts of mountainous Croatia and Northern Dalmatia.

In the period from 2011 to 2040, the number of *dry periods* could increase in autumn in almost the whole country and in the northern areas in spring and summer. The number of dry periods in the winter would decrease in central Croatia and in some locations in the coastal area in spring and summer. An increase in the number of dry periods is expected in practically all seasons by the end of 2070. The most prominent increase would be in spring and summer, and slightly less in winter and autumn.

Scenario RCP8.5. In the spring season important for vegetation no significant change in the number of dry periods is expected by 2040, but in the period 2041-2070 there will be an increase in the number of dry periods that would affect most of Croatia.

Air temperature. Observed change. During the period from 1961 to 2010, the trends of mean, mean minimum, and mean maximum air temperatures show warming throughout Croatia. Trends in annual air temperature are positive and statistically significant, and changes are greater in the continental part of the country than on the coast and in the Dalmatian hinterland. The maximum air temperature was exposed to the biggest change (increase). The highest contribution to the overall positive air temperature trend was due to the summer trends, and the trends for winter and spring equally contributed to the increase in mean maximum temperatures. The slightest changes were in regard to the autumn air temperature. Observed warming is also reflected in all temperature extremes indices.

Future change for the RCP4.5 scenario. In the period from 2011 to 2040, mean *annual* air temperature values are expected to increase almost uniformly (1.0 to 1.2 °C) throughout Croatia. In the period 2041-2070, the expected trend of rising temperatures would continue and would amount to between 1.9 and 2 °C. Somewhat warmer could only be at the far west of the country, along the western coast of Istria.

In the period between 2011 and 2040, a clear signal of increase in average ground air temperature throughout Croatia is expected in *all seasons*. In winter and summer, the highest projected temperature increase would be from 1.1 to 1.3 °C in the coastal regions. In the spring, the increase could be 0.7 °C in the Adriatic to slightly more than 1.0 °C in the north of Croatia, and in the autumn the expected increase in temperature could be between 0.9 °C in the eastern regions to about 1.2 °C in the Adriatic, exceptionally up to 1.4 °C, in western Istria.

In the period from 2041 to 2070, the highest increase in mean air temperature, up to 2.2 °C, is expected in the Adriatic in summer and autumn. In winter and spring, the largest projected

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temperature increase is somewhat smaller - up to about 2.1 °C or 1.9 °C in continental areas. In winter and spring, the spatial distribution of temperature increase is reverse of those in summer and autumn: the increase is the smallest in the Adriatic and higher towards inland. In spring, the average temperature increase is of 1.4 to 1.6 °C on the Adriatic, with gradual increase of 1.9 °C to the north.

The projected change in *maximum* air temperature by 2040 are similar to those for mean (daily) temperature and are expected to increase in all seasons. Generally, the increase would be higher than 1.0 °C (0.7 °C in spring in the Adriatic), but less than 1.5 °C. In the period 2041-2070, a further increase in maximum temperature is expected. It could be higher than in the previous period, and in relation to the reference climate it could reach 2.3 °C in summer and autumn on the islands.

The *minimum* temperature is expected to increase in the future climate as well. Until 2040 the highest expected increase in minimum temperature is in winter: up to 1.2 °C in northern Croatia and on the coast and up to 1.4 °C in Gorski Kotar, *i.e.* in the area that is usually the coldest. The slightest expected increase, less than 1.0 °C, would happen in spring. And in the period 2041-2070 the highest increase in the minimum temperature is expected in winter - from 2.1 to 2.4 °C in the continental part and from 1.8 to 2 °C in the coastal regions. In other seasons, the increase in the minimum temperature would be somewhat smaller than in winter.

Future change to the RCP8.5 Scenario. According to this scenario, in the period from 2011 to 2040, the seasonal increase in temperature would be on average higher only by about 0.3 °C compared to RCP4.5. This coincidence of results in two different scenarios is also found in the projections of temperature increase from global climate models, according to which the increase in temperatures in all IPCC scenarios in most of the first half of the 21st century is very similar. However, in the period 2041-2070, the projected increase in temperature for the RCP8.5 scenario is significantly higher than that for the RCP4.5 and is between 2.6 and 2.9 °C in summer and from 2.2 to 2.5 °C in other seasons.

For the *maximum* temperature up to 2040, the expected seasonal increase in relation to the reference period is highest in summer (up to 1.7 °C in the coastal areas and on the islands), and the lowest in spring (0.9 - 1.1 °C). In winter and autumn, the expected increase in maximum temperature is between 1.1 and 1.3 °C. In the mid-21st century (2041-2070), the highest expected increase in mean maximum temperature is up to 3.0 °C in summer on the Adriatic islands and between 2.2 and 2.6 °C in other seasons.

For the *minimum* temperature the largest projected increase in the period 2011-2040 is over 1.5 °C in north-western Croatia, northern part of Gorski Kotar and in the eastern part of Lika in winter and in the coastal regions in summer. In spring and autumn the expected increase is somewhat less, from 1.1 to 1.2 °C. By 2070 the minimum temperature would increase from 2.2 to 2.8 °C in winter and from 2.6 to 2.8 °C in summer. In spring and autumn the increase would be slightly less - between 2.2 and 2.4 °C.

Extreme temperature conditions were analysed on the basis of the frequency of the number of occurrences of an event (extremes) in the season, *i.e.* the change of frequency in the future climate.

Future changes for the RCP4.5 scenario. In the period from 2011 to 2040, a rise in the number of hot days (when the maximum temperature is over 30 °C) is expected in summer, which could also result in prolonged periods with high air temperature (*heat waves*). An increase in the number of hot days from an average of 15 - 25 days in the reference climate period (1971-2000) would amount in most of Croatia to between 6 and 8 days, and more than 8 days in Eastern Croatia and somewhere in the Adriatic. In mountainous areas also, the rise of hot days in the future climate would be the same as in the vast majority of the country. The rise in the number of hot days would continue in the period 2041 - 2070. The increase of hot days' number of slightly more than 12 days is expected in the whole of Croatia, which in mountainous areas would lead to almost doubling of the number of hot days compared to the reference period.

In the future climate until 2040 the increase in number of summer days with warm nights (when the minimum temperature is higher than or equal to 20 °C) is expected, and the highest increase is projected for the Adriatic area. By 2070, a further significant increase in the number of days with warm nights is expected.

The expected number of winter *ice days* (when the minimum temperature is below -10 °C) would fall in the period between 2011 and 2040 compared to the reference climate. For the period 2041-2070, a further decrease in the number of ice days is projected.

Future changes for the RCP8.5 Scenario. Under this scenario, a slight increase in hot days is expected by 2040, and by 2070 this increase would be about 30% higher compared to the RCP4.5. Compared to the RCP4.5 scenario, the projected number of days with warm nights will only slightly increase by 2040, but significant increase is expected in the period 2041-2070, especially in eastern Slavonia and coastal regions. Further decrease of the number of ice days, especially in the period 2041-2070, is also expected.

Medium wind speed at 10 m. The average projected wind speed in the period from 2011 to 2040 will not change in winter and spring, but projections suggest a possible rise during summer and autumn in the Adriatic. The projected increase in average wind speed is particularly pronounced in autumn in the northern Adriatic (up to about 0.5 m/s), representing a change of about 20-25% compared to the reference period. The slight increase in average wind speed is also projected in autumn in Dalmatia and the mountains. Between 2041 and 2070, a moderate decrease in average wind speed is expected in winter in parts of northern and eastern Croatia. In summer and autumn the simulated trend of wind speed improvement in the Adriatic continues, similar to the period between 2011 and 2040.

Maximum wind speed at 10 m. At an *annual* level, in future climates between 2011 and 2040 and between 2041 and 2070 the expected maximum wind speed would remain virtually unchanged in relation to the reference period, with the highest values of 8 m/s on the southern Dalmatian islands.

Until 2040, a slight reduction of the maximum wind speed for *seasonal* averages is expected in all seasons, except in summer. Winter is expected to show reduction of the maximum wind speed by about 5%, in the regions where under the reference climate the wind is the strongest - in the southern Adriatic and in the hinterland of central and southern Dalmatia. In the period 2041-2070, the maximum wind speed reduction is expected in all seasons except in summer. The largest decrease in the maximum wind speed in this period is expected in winter in the

southern Adriatic. It is worth noting that the 50 km resolution (the resolution used in this climate modelling) is insufficient for a more accurate description of spatial (local) variations of maximum wind speeds which depend on many details of more accurate scales (orography, terrain orientation - ridges and valleys, vegetation, urban barriers, etc.).

Evapotranspiration. In the future climate period, between 2011 and 2040, the increase of the evapotranspiration by 5 to 10% is expected in most of the areas in spring and summer, and a more significant increase is expected only on the outer islands and in western Istria. In most of northern Croatia, no change in the overall summer evapotranspiration is expected. Until 2070, the expected change for most of Croatia is similar to that in the period between 2011 and 2040. A somewhat more pronounced increase (10-15%) is expected in summer in the coastal areas and in the hinterland as well as up to about 20% on the outer islands.

Air humidity: By 2040, air humidity increase is expected throughout the year and mostly in summer in the Adriatic. In the period 2041-2070, a uniform increase in air humidity is expected throughout Croatia, somewhat higher in the summer in the Adriatic.

Solar irradiance: The projected changes in *the incoming solar energy flux* in the period from 2011 to 2040 do not go in the same direction in all seasons. While in winter throughout Croatia, and in spring in the western regions decrease of the incoming solar energy flux is projected, in summer and autumn and in northern areas in spring, the increase in value is expected compared to the reference period. All changes range from 1 to 5%. In the summer season, when the inflow of solar energy is the largest (in the coastal areas and the hinterland 250-300 W/m^2), the projected increase is relatively small. In the period between 2041 and 2070, the incoming solar energy flux is expected to increase in all seasons except in winter. The highest increase is in summer, 8 to 12 W/m^2 in mountainous and central Croatia, whereas the lowest is in central Dalmatia.

Snow cover: Until 2040, decrease of the *snow water equivalent*, i.e. the snow cover is projected in winter. The reduction is the largest in Gorski Kotar and would amount to 7-10 mm, which makes up slightly less than 50% of snow water equivalent in the reference climate. In the period from 2041 to 2070 further reduction of the snow water equivalent is expected throughout Croatia. Hence, a stronger reduction in the snow cover in the future climate is expected in those areas that have the highest amounts of snow in the reference climate - in Gorski Kotar and other mountainous regions.

Soil humidity: It is expected that in the period up to 2040 soil humidity will decrease in northern Croatia, and by 2070 throughout Croatia as well (in the central part of northern Croatia for more than 50 mm). The highest decrease in soil humidity is expected in the summer and fall months.

Surface runoff: In the period between 2011 and 2040 for most parts of Croatia no significant change in surface runoff is expected during most of the year. However, in mountainous areas and partly in the hinterland of Dalmatia, surface water flow could be reduced by about 10% in winter, in spring and autumn. By 2070, the amount of runoff will have declined slightly, mostly in spring, when this reduction could affect the whole of Croatia. This decrease in runoff coincides with a decrease in the total amount of spring precipitation in the mid-21st century.

Sea level: The projections of sea level rise have not been obtained with the RegCM model, but the results have been taken from the IPCC AR5 and have been made with the conclusions based on the research of domestic authors and monitoring of the current movement of the mid-level change in the Adriatic Sea. According to the CMIP5 Global Model (IPCC AR5) results for the mid-21st century (2046-2065) show expected increase in *global* mean sea level under the RCP4.5 of 19-33 cm, and with the RCP8.5 of 22-38 cm. In the period from 2081 to 2100 for the increase would be 32 - 63 cm the RCP4.5 and 45 - 82 cm for the RCP8.5. This global sea level rise will not be evenly reflected in all areas. Projections of change in the Adriatic Sea level by the end of the 21st century (according to the IPCC AR5 and domestic sources) provide a framework increase in the range of 32 to 65 cm and this has also been used when proposing measures related to the mean sea level change. However, it is worth pointing out that there are considerable uncertainties that are already to be dealt with in the calculation of the sea level for the historical climate.

Two climate scenarios, which are considered in climate modelling within the framework of the Adaptation Strategy's development, are: (1) the future envisaging the mitigation and adaptation measures (RCP4.5), and (2) the future that does not foresee changing of the existing climate change adaptation policy, *i.e.* taking of significant reduction and adaptation measures (RCP8.5) is not foreseen. The RCP4.5 scenario is the most common scenario used in drafting adaptation strategies, and the measures of this Adaptation Strategy are determined according to it, as well. The summary overview of features of climate change parameters for the Republic of Croatia according to the RCP4.5 scenario is given in Table 4-1.

Table 4-1: Projections of climate parameters for the Republic of Croatia according to the scenario RCP4.5 in relation to the period 1971 – 2000.

Climatological parameter	**Future climate projections according to the RCP4.5 scenario compared to the period 1971-2000 obtained by climate modelling**	
	2011 – 2040	**2041 – 2070**
PRECIPITATION	**Average annual quantity**: a slight decrease (except for a slight increase in the northwest of Croatia)	**Average annual quantity**: *further decrease trend* (up to 5%) in almost all of Croatia except for north-western parts
	Seasons: different signs; **winter and spring** in most of Croatia *a slight increase* + 5-10%, and **summer and fall** decrease (most - 5-10% in southern Lika and north Dalmatia)	**Seasons**: *decrease* **in all seasons** (up to 10% of the mountains and northern Dalmatia) *except* **in winter** (increase of 5 - 10% in northern Croatia)
	Decrease in the number of **rainy seasons** (except in central Croatia where it would slightly increase). The number of **dry seasons** would increase.	The number of **dry seasons** would increase.
SNOW COVER	*Decrease* (highest in Gorski Kotar, up to 50%)	*Further decrease* (especially mountainous areas)
SURFACE RUNOFF	There are no major changes in most regions; but in the mountainous areas and the hinterland of Dalmatia a *decrease* up to 10%	*Decrease* of runoff throughout Croatia (especially in spring)
AIR TEMPERATURE	Medium: *increase* of **1 to 1.4 °C** (all	Medium: *increase* from **1.5 to**

		seasons, the entire Croatia)	**2.2 °C** (all seasons, the entire Croatia - especially continent)
		Maximum: increase in all seasons **1 – 1.5 °C**	Maximum: up to **2.2 °C** in summer (up to 2.3 °C on islands)
		Minimum: the highest *increase* **in winter, 1.2 – 1.4 °C**	Minimum: the highest *increase* in continent **in winter** 2.1 – 2.4 °C; and 1.8 - 2 °C coastal zones
EXTREME WEATHER CONDITIONS	**Heat** (number of days with Tmax> +30 °C)	Up to **12 days** *more* than the reference period	Up to **12 days** *more* than the reference period
	Cold (number of days with Tmin <-10 °C)	*Further decrease* in the number of days with Tmin <-10 °C	*Further decrease* in the number of days with Tmin <-10 °C
	Warm nights (number of days with Tmin ≥ + 20 °C)	*Increase*	*increasing*
WIND	**Medium speed** at 10 m	**Winter and spring** *mostly without change, but the trend of strengthening* in **summer and autumn** in the Adriatic.	**Winter and spring** *mostly without change, but the trend of strengthening* in **summer and autumn** on the Adriatic.
	Max. speed at 10 m	Per seasons: *decrease* in all seasons except in the summer. *The highest decrease* in **winter** in southern Adriatic	By seasons: *decrease* in all seasons except in the summer. *The highest decrease* in **winter** on south Adriatic
EVAPOTRANSPIRATION		Increase in **spring and summer** 5 - 10% (outlying islands and west Istria> 10%)	Increase in **spring and summer** 5 - 10% (outlying islands and western Istria> 10%)
AIR HUMIDITY		Year-round increase (**most in summer** in the Adriatic)	Year-round increase (**most in summer** on the Adriatic)
SOIL HUMIDITY		*Decrease* in northern Croatia	Decrease throughout Croatia (**most in summer and autumn**).
SOLAR IRRADIANCE (INPUT SOLAR ENERGY FLUX)		In the summer and autumn increase throughout Croatia, in spring increase in northern Croatia, and decrease in western Croatia; in winter decrease throughout Croatia	*Increase* in all seasons except winter (the highest increase in mountainous and central Croatia)
MEAN SEA LEVEL		2046 – 2065 **19 – 33 cm** (IPCC AR5)	2081 – 2100 **32 – 65 cm** (estimation of average mean values for the Adriatic from various sources)

4.2 Assessment of climate change impacts and vulnerability of sectors to climate change

Adapting to climate change is fundamentally a horizontal issue, *i.e.* a problem that needs to be resolved in an integrated way with a high degree of co-ordination between participants. However, it should be emphasized that the Adaptation Strategy is based on an analysis of those sectors and cross-sectoral areas that are relevant to the adaptation due to their socio-economic importance for the Republic of Croatia and/or are of importance to nature and the

environment. For this purpose, eight key sectors have been selected (hydrology; water and marine resources; agriculture; forestry; fishery; biodiversity; energy; tourism and health) and two cross-sectoral thematic areas (spatial planning; coastal areas management and risk management). At the same time, the Adaptation Strategy itself is the result of an integrated approach, which, starting from the analysis of the situation in selected sectors and cross-sectoral thematic areas, results in an overview of cross-sectoral impacts and vulnerabilities as well as a set of measures, taking into account the implementation possibilities, as well as the cross-sectoral impacts of an individual measure implementation.

The main expected impacts which can lead to a high degree of vulnerability in the sector of **hydrology, water and marine resources** are: reduction of the amount of water in the watercourses and in the springs; reduction of underground water supplies and lowering of groundwater levels; reduction of water levels in lakes and other natural or built-up lake-like systems; rising sea level, salinization of coastal aquifers and aquatic systems; increase in water temperature followed by the reduction of the receiving acceptability of receiving aquifers; increase of the frequency and intensity of flooding in vulnerable areas; increase of the frequency and intensity of torrents; increase of the frequency and intensity of rainwater floods in urban areas; rising sea level, and thus the risk of flooding at the mouths of watercourses; reduction of the efficiency of coastal infrastructure and intensifying of salinization of river estuaries and coastal aquifers. Increased degree of vulnerability of the marine environment caused by climate change will also be manifested in the risks related to the thinning of the Adriatic Sea's thermohaline circulation, which can significantly affect a variety of abiotic and biotic processes and changes, especially related to sea ventilation and change in oxygen concentration in deeper layers, increasing the acidity of the sea, as well as a series of related biological processes and impacts on marine biodiversity and fishery.

The Republic of Croatia is relatively rich in water, but not in water supply because of its geological structure with a large share of the surface with karst structures and large spatial-temporal heterogeneity of runoffs. Importantly, the karst areas that occupy about half of the territory of the Republic of Croatia generally have a small possibility of accumulation of water reserves for a long time period during critical dry periods. The state of water and sea resources in the territory of the Republic of Croatia is largely dependent on transboundary impacts due to the global impact of climate change on the dynamics of ocean and sea level change as well as the high share of cross-border and transboundary watercourses in relation to Croatia's total water resources. It is expected that deterioration of hydrological conditions due to climate change will increase the frequency and duration of dry periods on the one hand, and the frequency and intensity of flood situations on the other hand.

The projected increase in air temperature for the period up to 2070, as well as stagnation or minor reported trends of minimal change in total precipitation rates, will result in increased evapotranspiration, reduction of surface and underground runoff and, consequently, even more pronounced reduction in water resources. In such conditions, synergistic effects of negative impacts are expected due to an increase in anthropogenic pressures, above all expressed in the increased water demand. Adverse climate change will be particularly jeopardized vulnerable coastal karst aquifers and other aquatic phenomena in coastal area (lakes, watercourses, springs) precisely because of the cumulative effect of possible changes with reduced flows and groundwater levels and more intensive sea penetration into the karst coastal aquifers and lakes, as well as spreading of salty seawater along the watercourse basins deeper into the hinterland. The results of the performed modelling show that the intensity of

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short-term severe precipitation will increase in the future, of both rare and frequent possibilities of the phenomenon, creating preconditions for frequent occurrences of floods in flood watercourses, urban areas and river basins.

Particularly negative impacts of climate change are expected at watercourses in the coastal area due to the coinciding and cumulative effect of sea level rise and the occurrence of extreme flows. With the reduction of the mean annual and minimum annual flows and the increase of maximum annual flows, very pronounced changes in water temperatures are expected, which will have a negative effect on aquatic ecosystems, their diversity and reception capacity as well as the possibility of their use for other purposes. In such circumstances it is necessary to achieve the goal - to preserve good status of water in such-changed climate conditions as a result of climate change and to ensure a reduction of flood risk.

The expected rise in sea levels, but also the impact of future tides, waves and storms will have an impact on coastal infrastructure. The most vulnerable will be urban areas with low coastline (*e.g.* places on islands such as Cres, Mali and Veli Lošinj, Krk, Rab, Krapanj, Vela Luka and others, but also in coastal Croatia such as Nin, Trogir, Ston etc.). The particular negative impact of sea level rise is expected to be at sandy shores, which will be subject to increased erosion and other morphological change in terms of changing of their geometries, which can lead to their complete disappearance. However, in areas where this is possible, depending on the geomorphological features of the coast, urbanization of the area and so forth, the emergence of new sandy shores is expected. Negative changes are expected for the artificial parts of the coast, where built beaches will lose their functional optimums, and structural damage can also occur.

Table 4-2: Overview of the impacts and challenges of adaptation to climate change in the sector of hydrology, water and sea resources

Impacts and challenges that cause high vulnerability	Possible responses to reduce high vulnerability
• Reduction of water levels in watercourses and in springs • Reduction of underground water resources and lowering groundwater levels • Reduction of water levels in lakes and other lake-type natural or built-up systems • Sea level rise and change of its thermohaline features • Salinization of coastal aquifers and aquatic systems • Water temperature rise followed by reduction of reception capability of aquatic receivers • Increased frequency and intensity of flooding in vulnerable areas • Increasing the frequency and intensity of torrents • Increasing the frequency and intensity of rainwater flooding in urban areas	• Strengthening the research and management capacities to assess the occurrence and risk of adverse impacts of climate change and adaptation of freshwater and marine water systems • Construction, reconstruction and upgrading of existing systems for protection against harmful effects of water, water use systems (multi-purpose systems, water supply, energy, irrigation, etc.) and water protection in new (future) climatic conditions • Strengthening the resilience of coastal water-communal infrastructure against the possible impacts of climate change • Applying an integrated approach to water resources and systems management and intensifying of cross-sectoral observations and activities • Strengthening the protection of natural water and maritime systems, particularly protected areas, from the adverse impacts of climate change and their adaptation

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The main expected impacts of climate change that cause high vulnerability in the **agricultural** sector are: shortening the vegetative period of corn with lower yields; lower yields of all cultures and higher water demand; a longer vegetation period will enable the cultivation of some new cultures and cultivars; while more frequent flooding and stagnation of surface water will reduce or completely destroy yields. According to some predictions, agriculture is the sector that will suffer the highest damage from the consequences of climate change. It is expected that, due to climate change, the yield of agricultural crops in the Republic of Croatia will be reduced by 3 – 8% by 2050.

Longer and more frequent drought periods, as well as the increasing threat to agricultural crops from heat stress over the last decades, especially in Dalmatia, are a clear signal, primarily to fruit growers, olive growers and winemakers to implement climate change adaptation measures. The drought in the summer months in the period between 1980 and 2014 was the largest single cause of damage caused to Croatian agriculture by climate variability, while in the period from 2013 to 2016 it caused damage of a total of 3 billion kuna, or 43% of direct aid paid to agriculture in the same period.

Without increased investments, a satisfactory percentage of surfaces under irrigation and indoor production cannot be achieved, nor can the level of organic matter in the soil be significantly increased, which will result in a reduction in agricultural production compared to the existing situation.

It has been observed that climate change already affects the phenological phases of apple, grapevine, olive and corn, so that the vegetation period begins earlier, lasts less time, and ultimately yield drops. The lack of ground water (drought) and higher air temperatures in the upcoming period will be two key issues in the struggle of agriculture with climate change. At the same time, climate change will also have some positive effects in the agricultural sector, such as enabling the cultivation of some new crops and cultivars in areas where that has not been possible so far.

Table 4-3: Overview of the impacts and challenges of adaptation to climate change in the agricultural sector

Impacts and challenges that cause high vulnerability	Possible responses to reduce high vulnerability
• Change in the duration/length of the vegetative period of agricultural crops and lower yields • Higher demand for irrigation water due to frequent droughts • Longer vegetation period will enable the cultivation of some new cultures and varieties • More frequent flooding and stagnation of surface water - which will reduce or completely destroy yields	• Strengthening the capacity to understand and implement climate change mitigation measures • Increasing the absorption capacity of soil for water on agricultural land • Conservation oriented soil treatment • Breeding of species, sorts and breeds resistant to climate change • Irrigation of agricultural land • Construction of water accumulations • Application of anti-erosion measures • Construction and/or reconstruction of drainage systems

In the **forestry** sector there are several major expected impacts that cause high vulnerability. This is primarily related to a higher frequency and length of the forest fire season, including fires on the continent. The current trend in the number of forest fires shows that there were

significantly more fires in the dry years in the Mediterranean area, while projections show that the risk of forest fires in the future will be higher for the whole of the Republic of Croatia. Furthermore, the phenological phases of trees are expected to move in the sense of earlier start of vegetation and the extension of the vegetation season depending on species and habitats. Due to change in habitat conditions, migration of species and pests, including invasive species, could occur. The productivity of some forest ecosystems, such as oak-tree forests, could be reduced, although it should be emphasized that it depends not only on atmospheric change but also on the ways of management and other impacts. Due to the increased frequency of forest fires and the occurrence of strong winds, icing events that cause damage, floods, pest attacks and the like, higher damages to forest ecosystems are expected, such as a reduction in the value of wood varieties and the loss of generally beneficial forest functions.

Table 4-4: Overview of the impacts and challenges of adaptation to climate change in the forestry sector

Impacts and challenges that cause high vulnerability	Possible responses to reduce high vulnerability
• Increased incidence of forest fires including the occurrence of fires in the continental part of Croatia due to increased temperature and decreased precipitation • Decreased productivity of some forest ecosystems • Migration of harmful organisms • Moving of phenological phases of forest tree species • Damage to forest ecosystems due to the frequency of extreme weather events • Reduced value of certain generally-beneficial functions of forests	• Establishment of cross-sector monitoring of forest ecosystem status as a prerequisite for informed planning and implementation of adaptation measures • Developing recommendations for mitigating the adverse impact of harmful organisms under the influence of climate change • Identification of species and provenance of forest trees that are genetically best adapted to the influence of climate change and are of economic significance • acquainting participants in the forest sector about the impact of climate change on forest ecosystems, vulnerabilities, risks and possible adaptation measures • Establishment of green infrastructure in larger urban areas • Strengthening of the fire protection capacity

The major expected impacts of climate change in the **fisheries** sector will be additional pressure on the marine ecosystem that is already under the influence of numerous anthropogenic factors, in particular overfishing, habitat destruction and pollution.

The estimated increase in the Adriatic Sea's temperature by 1.6 to 2.4 °C by 2070 will result in the migration of fish (especially shrimp and hake) to deeper waters and towards the north, a higher number of invasive species and the reduction or disappearance of domestic species and change in choice of breeding species. Reducing of primary production is expected to result in the number of pelagic fish dropping due to changes in water circulation caused by thermohaline causes. Increasing temperatures and reduced fresh water quantities will limit the availability of water for freshwater aquaculture. The positive effects of rising water temperatures will be accelerated growth and shorter breeding cycle of fish. The acidity of the Adriatic Sea is estimated to increase by 0.1 to 0.2 degree of pH, which will prevent shellfish breeding in certain areas.

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Future climate change will jeopardize the economic viability of fishing, especially coastal and demersal. In the cultivation of marine organisms, the impact will be twofold: positive for breeding tuna and sea bream, and negative for the cultivation of sea bass and oysters. The fisheries sector will be particularly vulnerable to global trends in supply and price of fish flour and fish oil as a result of climate change.

Table 4-5: Overview of impacts and challenges of adaptation to climate change in the fisheries sector

Impacts and challenges that cause high vulnerability	Possible responses to reduce high vulnerability
• Migration to the northern Adriatic Sea or to the deeper sea of cold-water species due to rising sea temperatures • Increase in the number of alien species and the influence on domestic species due to rising sea temperatures • Decrease of primary production with consequences on the number of pelagic fish due to change in water circulation due to thermohaline causes • Weaker growth and higher mortality of shellfish due to increased sea acidity	• Strengthening the capacity for predicting the future status of bio resources • Development of techniques and tools for exploiting alien species • Strengthening research capacities in the field of selective breeding, feeding of fish and breeding in recirculation systems • Increased resilience of aquaculture to reduced flow of water, change in physicochemical parameters of water and occurrence and spread of diseases • Mitigating the negative impacts of climate change by applying integrated forms of aquaculture

Biodiversity sector is currently largely endangered by unsustainable exploitation of natural resources and pollution. The most important climate impacts in this sector are: change in average air temperatures; reducing the amount and changing in spatial distribution of precipitation; the phenomenon of climate extremities and the rise of sea level.

As a consequence at the habitat level the following is expected: increase in arid areas; reduction, change in share and disappearance of some habitats and species, with the decline in biodiversity and appearance and spread of some alien invasive species, drying out of wetland habitats, submersion of coastal habitats, salinization of land and freshwater habitats by the sea.

The main expected impacts that cause high vulnerability at the species level are: termination of flowering of plant-type cryophylla and stenothermal species with shortening of vegetation and reduction of vigour; the spread of range of thermophilic species (both positive and negative) due to an increase in average air temperature; reduction of turgor and vigour, drying and extinction of hygrophilic species due to decrease of quantity and change of precipitation schedule; the spread of ranges of the xerophilic species (both positive and negative), due to the decrease of the quantity and the change of the precipitation schedule; reduction of populations of forest species due to frequent fires because of increase in average air temperature and decrease of precipitation; reduction and disappearance of freshwater species of the Adriatic basin due to the salinization of coastal habitats caused by sea level rise; the spread of marine species to the north and the appearance of thermophilic (tropical) alien invasive marine species due to sea temperature rise; greater number of invasive species and their spreading and suppression of the indigenous species.

Table 4-6: Overview of impacts and challenges of adaptation to climate change in the thematic area of biodiversity

Impacts and challenges that cause high vulnerability	Possible responses to reduce high vulnerability
• Abortion of flowering of plant cryophyllofen and stenothemical species with shortening of vegetation and reduction of vigour • Damage to and extinction of populations due to climatic extremities (long-lasting droughts, excessive short time precipitation, stormy winds, excessive sunlight, etc.) • Spread of thermophilic species range (both positive and negative) due to an increase in average air temperature • Reduction of turgor and vigour, drying and extinction of hygrophilic species due to decrease in quantity and change of precipitation schedule • Spread of xerofiline species range (both positive and negative) due to decrease of quantity and change of precipitation schedule • Reducing populations of forest species due to frequent fires caused by increased average air temperature and reduced and unevenly distributed precipitation • Reduction and disappearance of freshwater species of the Adriatic basin due to salinization of coastal habitats caused by sea level rise • Sea species spreading to the north and the appearance of thermophilic (tropical) alien invasive marine species due to rising sea temperature	• Strengthening awareness of the importance of natural ecosystem services and their impact on all aspects of life and economy • Defining habitats and species most vulnerable to climate change consequences • Defining the zero state and establishment of monitoring for the most vulnerable habitats and biodiversity • Preservation of habitats and species susceptible to climate change • Defining measures to reduce the spread and limit alien invasive species populations • Reduction of anthropogenic impacts on natural ecosystems, primarily via sustainable development measures • Implementation of integrated management of freshwater ecosystems • Strengthening the capacity of research institutions and responsible authorities to manage natural ecosystems and biodiversity • Providing an economically stimulating regulatory environment for the implementation of planned projects (tax reliefs, funds withdrawal platform, investment aid etc.)

The main expected impacts that cause vulnerability in the **energy** sector are: reduction of electricity production in hydropower plants due to change in the temporal distribution of annual precipitation (no significant change in the mean annual level has been projected - with a possible smaller reduction, but there are changes in rain and dry periods whereby dry seasons trends are increasing); increase of electricity consumption for cooling purposes (cooling degree days increase) due to increased average air temperature; reduction of energy production in thermal power plants due to inadequate cooling of the plants because of reduction in the average annual precipitation; damage to power plants and infrastructure due to extreme weather events such as ice breaks and floods and the reduction of electricity production in hydropower plants due to droughts.

Climate parameters directly affect the energy sector in the form of increased or reduced energy resource needs at certain time periods. Climate extremes and natural disasters will significantly disrupt the safe supply of energy. The global rise of temperature in all seasons will increase the cooling energy consumption in the summer and reduce the energy needed for heating in winter. Extreme climate events will negatively affect the production, transmission and distribution of energy. Decreasing of precipitation in the summer period will lead to a reduction in the hydroelectric power plant contribution, while increasing the need for electricity in the summer months. By reducing the amount of precipitation, there will

be a problem with the thermal power plant cooling flow system, which will also negatively affect the generation.

Table 4-7: Overview of the impacts and challenges of adaptation to climate change in the energy sector

Impacts and challenges that cause high vulnerability	Possible responses to reduce high vulnerability
• Decrease in the production of electricity in hydropower plants due to reduced precipitation by up to 10% in all seasons except winter and consequentially lowered flow rate, numerous dry periods and increased evapotranspiration • Increase in the consumption of electricity for cooling purposes (higher number of cooling degree days) due to increased average air temperature • Reduction of thermal energy production in thermal power plants due to increased average air temperature in the winter months • Decrease in the production of electric and thermal energy in thermal power plants due to insufficient cooling of the plants due to flow reduction • Damage to power plants and infrastructure due to extreme weather events – ice breaking and floods	• Strengthening the capacity for climate hazards impact assessments, risk prevention, readiness measures and outstanding events responses • Increasing the resilience and flexibility of the existing power system to the impacts of extreme and climate hazards and expected climate change • Increasing the transmission and distribution grid's resilience to the impacts of extreme and climate hazards and expected climate change • Increasing the security of electricity supply in the summer • Securing of an incentivizing legal framework for the use of renewable energy sources with the aim of diversifying sources and increasing decentralized production of electricity and thermal energy

In the **tourism** sector, the main expected impacts of climate change are: the reduction of tourist demand in the summer months due to high temperatures, increased UV radiation, higher frequency and power of extreme weather events; reduction or loss of attractiveness of ecosystems and biodiversity as elements of attraction in tourism; reduction of water availability and damage to different infrastructure systems (wastewater drainage, solid waste disposal, beach infrastructure, accommodation infrastructure, horticulture of hotel complexes etc.) and/or their reduced functionality.

Change in climate parameters will have different implications for individual tourist destinations, but they can be both positive and negative. Because of climate change, the further-north regions of Europe could become attractive enough for vacation during the summer months (also due to proximity to western European and northern European guests), and the Mediterranean and the Republic of Croatia could remain attractive (only) in the rest of the year. The tourism sector will be compelled to enrich its offering and to offer higher quality products, which can positively affect competitiveness and guest composition. Favourable climate conditions on the coastal part of the Republic of Croatia in post season and pre-season can positively affect the reduction of seasonal influences and the financial efficiency of tourism in the form of extension of the season. The opportunities for tourism development in mountains and continental areas will increase.

Table 4-8: Overview of the impacts and challenges of adaptation to climate change in the tourism sector

Impacts and challenges that cause high vulnerability	Possible responses to reduce high vulnerability
• The tourist offer is not tailored to projected climate change (high temperatures, increased solar irradiance, frequency of extreme weather events, etc.)	• Adaptation of the tourism sector to changed operating conditions due to climate change impacts • Harmonization of tourism activities with

• Changing attractiveness of the coastal parts areas and inland areas of the Republic of Croatia • Damage to and/or reduced functionality of various infrastructure systems (water supply, drainage, beach infrastructure, horticulture etc.) • Deterioration of the status of ecosystems important for tourism and biodiversity due to the indirect and direct effects of climate change	projected climate change • Strengthening the competence related to adaptation to climate change of all people directly related to the tourism sector • Inclusion of climate change adaptation measures in all segments of sustainable Croatian tourism • Inclusion of climate change adaptation measures in all segments of sustainable Croatian tourism • Revitalization of tourist offer in the entire territory of the Republic of Croatia and exploitation of up-to-now insufficient or unused potentials

The main expected impacts that cause high vulnerability in the **health** sector due to increased frequency and duration of extreme weather conditions, as well as the impacts of other important climate parameters are: increased mortality; change in the epidemiology of chronic non-infectious diseases; change in the epidemiology of acute infectious diseases and reduction of air quality, water and food health safety and the level of possibly damaging factors in the environment.

Vulnerability in the health sector is most likely to be manifested by an increase in the number of people with acute and chronic illnesses, *i.e.* increased mortality due to extended periods with high air temperatures; increased illness of vector diseases; increase in respiratory disease due to increased allergenic pollen in the air, etc.

Lower drinking water health safety for human consumption can be expected due to lower availability and increased utilization of resources. The impact of climate conditions is important due to indirect impacts on surface waters and water for recreation, especially in the case of improperly organized supply or drainage systems (waste and drainage water). The impact of seawater on health is significant not only because of the rise in sea temperature and, for example, the growth of toxic algal blooms, but also because of the eutrophication processes due to the large amount of organic matter that comes into the marine ecosystem with human activity.

Climate change will have a significant impact on food security, *i.e.* availability, distribution and consumption of food. The increase of the acute infections of the digestive system incidence may be expected. Increase in the share of chronic disorders such as endocrine diseases and digestive diseases such as cancer and chronic diseases like Crohn's disease, ulcerative colitis, etc. is also expected. The reduced level of food safety due to microbiological or chemical contamination, as a result of changed macro-climate and microclimate conditions, presents significant vulnerability and future burden on the health system.

Contrary to the negative consequences described above, and due to the expected reduction in the period of low air temperature and snow cover (snow water equivalent), lower mortality is expected, i.e. a lower number of sudden deaths due to low temperature effects on health. As the climate model for both future periods predicts a reduction in the amount of snow water equivalent, *i.e.* the amount of water that would occur in the event of instant snow melting, an impact on reducing the number of injuries and more efficient diagnosis and injury therapy due to the reduction of the occurrence and duration of extreme snow precipitation is possible.

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Table 4-9: Overview of the impacts and challenges of adaptation to climate change in the health sector

Impacts and challenges that cause high vulnerability	Possible responses to reduce high vulnerability
• Increased mortality of the population • Change in epidemiology of chronic non-infectious diseases • Change in epidemiology of acute infectious diseases • Reduced quality of outdoor and indoor air due to extremely high and low temperatures and precipitation • More frequent and longer periods of unavailability of safe (health safe and compliant) water for human consumption • Increased levels of contaminants in the environment • Impact on epidemiology of diseases related to climatological factors	• Strengthening the competence of the health system in climate change impacts on health • Strengthening the competence of the health system as the response during future adaptation • Determination of sectoral priorities of climate change related activities • Extension of monitoring system of health and environmental indicators related to climate change and risk assessment

Spatial planning and management of the coastal area, including partially the management of the marine environment, has a dual function. On the one hand, it has an integrative function in the planning of spatial development and land use and sea area use, while on the other hand, it deals with quite specific measures that are in the function of adapting the built environment to climate change. In addition, it should be noted that spatial planning plays an extremely important role in reducing the effects of climate change, as changes in the land use (for example, from agriculture or forests to construction or change of forests into agricultural land) are considered to be the most important causes of increase of greenhouse gas emissions. This cross-sectoral activity also includes islands, which represent a particular geographic and problematic area.

The vulnerability of the built environment to climate change impacts include flooding in settlements due to rise and extreme sea levels as a result of extreme weather conditions and general rise of the mean sea level (high vulnerability); the occurrence of heat islands in settlements due to the influence of extreme temperatures, in particular the increase of hot days and days with temperatures above 35 °C (medium vulnerability) and flooding in settlements as a consequence of the higher incidence and intensity of extreme weather conditions that characterize large amounts of precipitation in the short term (medium vulnerability).

The average sea level rise estimates on the Croatian coast range from 0.32 m to 0.65 m by year 2100, with recent estimates increasing the value to 1.1 m. When these are joined by the effects of intermittent extreme sea levels ranging from 0.84 m to 1.15 m, extreme intermittent sea levels occurring at the end of the century will be in the range of 1.4 m to 2.2 m. Temperature rise is the most probable aspect of climate change, which among other things, is manifested by the growth of a number of days with a temperature higher than 35 ° C. The largest increase, from 3 to 5 days by 2040, is expected in most of northern Croatia, in the part of the northern Primorje and in the part of the middle of Dalmatia, where this increase is locally more than 100% compared to today's climate. In the period 2041-2070, a further increase of the same parameter is expected from 7 to 10 days in the same areas. Such extended periods of extreme temperatures influence the increased development of heat

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islands in urban environments. The projected change in the total amount of precipitation is different for different regions and different seasons. A slight increase is expected in the number of days with extreme precipitation in the fall and winter in the southern regions, particularly in the central and southern Adriatic. Larger quantities and irregular incidence of heavy precipitation affects the existing and planned infrastructure for collecting and draining of precipitation waters.

The basis of spatial planning is a multi-sectoral, interdisciplinary approach that looks at, aligns, and regulates the spatial requirements of all other sectors. Therefore, dealing with sectoral requirements and proposals and analysing of cross-sectoral impacts and their aligning are the common tasks of spatial planning and integral coastal zone management. This also applies to the planning of climate change adaptation measures. First of all, integrating these measures into spatial plans divides the responsibility of many professions that spatial planers use in two ways. The first is direct planning solutions that are the primary responsibility of spatial planners, *e.g.* planning settlement development by defining land use or urban planning of settlements themselves (street network, built structures, grey and green infrastructure, etc.). The other way is indirect, that is, the sectors in the spatial planning process submit their requests and inputs that planners, after alignment and resolution of possible conflicts, embed in spatial planning solutions. Accordingly, the sector is expected, based on its analysis and monitoring of the state, sectoral strategic documents, plans and other expert backgrounds, to define their interests, demands and needs argumentatively and participate further in the spatial planning process. In order to reduce the number of potential conflicts, it is good practice for sectors to consult spatial plans and planners in advance while preparing their sectoral documents and to anticipate the possible problems that may arise in the interaction of their needs with the requirements and expectations of other sectors.

Table 4-10: Overview of the impacts and challenges of adaptation to climate change in the sector of spatial planning and management of the coastal area

Impacts and challenges that cause high vulnerability	Possible responses to reduce high vulnerability
• Sea floods caused by rising sea levels • Floods in settlements due to extreme amounts of precipitation • Urban heat islands in settlements due to increased average temperatures in the summer months	• Improving the information base as a basis for making rational decisions related to planning of climate change adaptation measures • Capacity strengthening within the spatial planning system with the aim of integrating adaptation measures into spatial planning and management of coastal areas • Integrating of the adaptation measures into the spatial planning system • Application of spatial planning measures to programs and rehabilitation projects of the most endangered areas/locations • Raising of public and decision-makers' awareness in planning of climate change adaptation measures

Disaster Risk Management is defined as undertaking of preventive and planning activities aimed at reducing vulnerability and mitigating the adverse effects of disaster risks. Climate change can increase the risk of emergence and intensity of catastrophes (risk potential). The main expected impacts that cause high or medium vulnerability in this sector are: landslides; open type fires due to extended periods of high solar irradiance and extended periods of high

air temperatures; extreme temperatures due to extended periods of high solar irradiance and extended periods of high air temperatures; pandemics due to the effect on the transfer of diseases or the characteristics of diseases caused by precipitation levels, humidity and evaporation rates and complex risks particularly in urban areas.

The current readiness of the civil protection system in the area of response was assessed as high, while readiness in the area of prevention was assessed as low, which is in line with the actual situation given the insufficient scope of investment. A positive example of professionally directed multidisciplinary preparation of a strategic document adapted to the direction of future adaptation to climate change is the development of the "Disaster Risk Assessment for the Republic of Croatia", a document adopted by the Government of the Republic of Croatia in November 2015 In this national strategic document, the impact of climate change on each individual risk has been estimated. Negative impacts of climate change have been reported for nine out of the eleven identified risks.

In Croatia, the particular vulnerability of the risk management system is insufficient support in the implementation of internationally recognized guidelines, priority actions in risk management and sustainable development with active inclusion and partnership of all stakeholders in accordance with the Sendai disaster risk reduction framework 2015- 2030. Without monitoring the identified priority indicators, without the development of compatible and internationally comparable databases and the exchange of experiences and good practice examples, it is difficult to act within disaster risk management. Also, without multi-sectoral estimates of critical areas and areas of multi-hazard exposure to catastrophes based on climate models, it is currently impossible to quantitatively estimate multi-sectoral impacts of climate change in Croatia.

Table 4-11: Overview of the impacts and challenges of adaptation to climate change in the risk management sector

Impacts and challenges that cause high vulnerability	Possible responses to reduce high vulnerability
• Open-type fires due to extended periods of high solar irradiance and extended periods of high air temperatures • Epidemics and pandemics due to the impact on the manner of transmission of diseases or the features of diseases caused by changing precipitation, humidity and evaporation rates • Increased scope of community health and socioeconomic burden due to environmental contamination after risks such as flooding or landslides	• Strengthening the competences of key participants in managing climate change risks • Strengthening capacities for management and recovery after the risks related to climate change • Establishing of multidisciplinary priority guidelines for climate change management. • Expanding the risk tracking and risk assessment system using climate change risk monitoring tools • More effective remediation of damage as a consequence of climate change risks • Modification of the community's burden after exposure to climate change related risk

5 CLIMATE CHANGE ADAPTATION MEASURES

5.1 Principles for defining climate change adaptation measures

The approach to determining sectoral and cross-sectoral (horizontal) adaptation measures is based on several general principles:

- *Science-based adaptation approach*: By applying this principle, it is possible to reduce the uncertainties and insecurities regarding the possible effects of climate change. When analysing the status and drafting the scenario of potential effects, the latest scientific knowledge was used in certain sectors.
- *Complementarity of adaptation and mitigation of climate change impacts*: Adapting and mitigating the effects of climate change are two complementary concepts of policy related to climate change. Efficient and timely mitigation measures positively affect adaptation, or reduce socio-economic cost of adaptation. However, it is necessary to clearly separate the adaptation measures from mitigation measures to reduce the duplication of effort.
- *The precautionary principle*: The uncertainty about the future effects of climate change is not a reason for inactivity. Although there is a need to insist on the scientific foundation of the measures, even in the case of lack of scientific basis for implementation, it is necessary to carry out adaptation measures, since inaction can significantly increase the cost. In this Adaptation Strategy, the precautionary principle has been consistently implemented.
- *The adaptability principle*: The long-term perspective of the Adaptation Strategy requires that the principle of adaptability be applied in order to be able to act in timely fashion in the adaptation process, in situations where change in climate change scenarios is observed and based on models used for the needs of this strategy.
- *Principle of sustainability*: No proposed measure should jeopardize the interests of future generations, nor negatively affect the development of other sectors. From the perspective of nature and the environment the measures must have a positive effect on nature and the environment, while from the economic perspective the measure must undergo cost-effectiveness analysis and then be ranked.
- *Involvement of stakeholders in the consultation and decision making process*: Active involvement of stakeholders is a basic prerequisite for successful implementation of climate change adaptation.
- *Integration of adaptation into sectoral policies*: The issue of adaptation to climate change and appropriate measures should be integrated into sectoral policies. The Adaptation Strategy provides a framework and proposes measures, but their implementation largely depends on the degree of integration of climate change adaptation policies into other sectoral policies, strategies and plans.

5.2 Adaptation measures by sectors

Based on the general principles for defining measures, analysing the current situation by sectors and assessing the degree of vulnerability and possible responses to climate change adaptation challenges, within each sector a set of measures has been identified aimed at effectively defining the climate change adaptation system. In addition to the sectoral measures, a set of horizontal measures, i.e. cross-sectoral measures (spatial planning and

management of coastal areas and risk management) has been defined. The tables below provide an overview of the adaptation measures for climate change by sectors.

The Adaptation Strategy proposes a total of 81 measures: 79 measures within ten selected sectors and two measures that can be considered as multi-sectoral (climate modelling and development of the implementation impact indicators for the adaptation strategy). Adaptation measures were selected through multi-criteria analysis conducted in cooperation with sectoral experts and within the frame of consultation with over 130 stakeholders from all represented sectors and thematic areas. Measures are evaluated according to criteria and factors and their impact on reducing vulnerability in the individual sector.

The largest number of proposed measures falls within the so-called “non-structural” measures (administrative, political, legislative, technical and planning measures, measures to raise awareness of the need for adaptation to climate change, data gathering, monitoring and scientific-research work). A relatively small number of so-called “structural” measures (measures involving any constructed object or natural structure whose purpose is to reduce or avoid possible climate change impacts) includes certain technical interventions such as construction of protective dams and walls, construction of hydro-technical facilities, as well as afforestation, building of green infrastructure, strengthening the absorption capacity of land for the absorption of excess water, etc. It should not be surprising that great number of the measures is of "unstructured" nature. Adaptation to climate change crosses those human activities that need to be planned for an exceptionally long time with a great deal of uncertainty and insecurity. Furthermore, "structural" measures largely require exceptionally large financial investments for their implementation, and their overall effects will only be felt in the distant future - assuming that the anticipated projections of climate change will be achieved.

It is very important to start as soon as possible with the implementation of “non-structural” measures to create an adequate social climate, primarily by raising awareness of all stakeholders on the need to implement climate change adaptation measures, in order to analyse well the situation where it is necessary to undertake such measures, to estimate cost effectiveness and determine all necessary prerequisites (including the necessary scientific-data bases) for the effective implementation of the measures. For the latter, it is extremely important to create institutional prerequisites at all administrative levels, primarily by strengthening the appropriate professional capacities. Finally, the implementation of “non-structural” measures is a fundamental prerequisite for the implementation of “structural” measures which require a good foundation in scientific and measured data, with incomparably greater financial resources and which will be implemented over a much longer period of time.

Hydrology, water and sea resources management

The proposed climate change adaptation measures in this sector are identified as HM-01 to HM-09 and are, based on the overall assessment grade of importance of the individual measure grouped into three categories: of very high importance (01 - 03), of high importance (04 - 06) and of medium importance (07 - 09).

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Table 5-1: Climate change adaptation measures proposed in the sector of Hydrology, water and sea resources management: very important measures (01 – 03), measures of high importance (04 – 06) and measures of medium importance (07 – 09)

Measure's ID	Measure's name	Key stakeholders
HM-01	Strengthening the capacity for the implementation of non-structural measures for protection against the harmful effects of water in case of occurrence of extreme hydrological conditions whose increase in intensity and frequency of occurrence is conditioned by climate change	Ministry responsible for water management, ministry responsible for construction and spatial planning, ministry responsible for science and education, HV, DHMZ
HM-02	Strengthening the capacity to build, reconstruct and upgrade the system for protection against harmful effects of water and related multi-purpose hydro-technical systems (structural measures) and lowland natural floodplains flooded in a controlled fashion	Ministry responsible for water management, HV, HEP, Program Sava d.o.o., spatial planning institutions
HM-03	Strengthening research and management capacities to assess the occurrence and risk of adverse impacts of climate change and adaptation of freshwater and marine water system in current and future climatic conditions	Ministry responsible for water management, ministry responsible for construction and spatial planning, ministry responsible for science and education, HV, DHMZ, HGI, HHI, relevant faculties
HM-04	Strengthening the management capacities of responsible institutions to act on the occurrence of extreme hydrological conditions	Ministry responsible for water management, ministry responsible for construction and spatial planning, HV, DUZS, water supply companies
HM-05	Strengthening the capacities for effects of the sea on the coastal water-communal infrastructure and coastal water resources in conditions of sea level rise caused by climate change (non-structural measures)	Ministry responsible for water management, ministry responsible for construction and spatial planning, ministry responsible for maritime affairs, transport and infrastructure, HV
HM-06	Strengthening urban areas' resilience to anthropogenic pressures conditioned by climate change	Ministry responsible for construction and spatial planning, ministry responsible for water management, HV, JLS
HM-07	Strengthening the capacity for exploration and sustainable management of groundwater	Ministry responsible for environmental protection, HV, DHMZ, HGI, Program Sava d.o.o.
HM-08	Strengthening the resilience of coastal water utility infrastructure and coastal water resources (structural measures)	Ministry responsible for water management, HV, JLP(R)S
HM-09	Strengthening the protection capacity of particularly valuable aquatic ecosystems	Ministry responsible for nature, JUZP and Public institution for the management of protected natural values in the counties

Agriculture

The proposed climate change adaptation measures in this sector are identified as P-01 to P-09 and are, based on the overall assessment grade of importance of the individual measure grouped into three categories: of very high importance (01 - 05), of high importance (06 - 08) and of medium importance (09).

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Table 5-2: Climate change adaptation measures proposed in the agriculture sector: very important measures (01 – 05), measures of high importance (06 – 08) and measures of medium importance (09)

Measure's ID	Measure's name	Key stakeholders
P-01	Implementation of an experimental-research climate change adaptation programme in agriculture	Ministry responsible for agriculture, scientific research institutions, Advisory service, DHMZ
P-02	Increasing the water absorption capacity of agricultural soil	Ministry responsible for agriculture, OPG, SMEs
P-03	Application of conservation soil treatment	Ministry responsible for agriculture, OPG, SMEs
P-04	Breeding of species and cultivars of agricultural crops and breeds of domestic animals that are more resilient to climate change	Ministry responsible for agriculture, Scientific research institutions, Advisory service, DHMZ
P-05	Construction of irrigation reservoirs	Ministry responsible for agriculture, family farms, SMEs
P-06	Application of irrigation	Ministry responsible for agriculture, HV
P-07	Application of anti-erosion measures	Ministry responsible for agriculture, OPG, SMEs
P-08	Reconstruction and construction of drainage systems	Ministry responsible for agriculture, HV, OPG, SMEs
P-09	Insurance of agricultural production from production losses caused by adverse climatic conditions	Ministry responsible for agriculture, OPG, SMEs

Forestry

The proposed climate change adaptation measures in this sector are identified as ŠU-01 to ŠU-09 and are, based on the overall assessment grade of importance of the individual measure grouped into three categories: of very high importance (01-04), of high importance (05 - 06) and of medium importance (07 - 09).

Table 5-3: Climate Change adaptation measures proposed in the Forestry sector: very important measures (01 – 04), measures of high importance (05 – 06) and measures of medium importance (07 – 09)

Measure's ID	Measure's name	Key stakeholders
ŠU-01	Incorporation of adaptation measures into key documents pertaining to forests and forestry sectors	Ministry responsible for forestry, Advisory service, HŠ, Union of private forest owners' associations, HŠI, Faculty of Forestry, Croatian Forestry Society, HKISDT, Academy of Forestry Sciences
ŠU-02	Research on species and provenance of forest trees that are more resilient to climate change	Ministry responsible for forestry and environmental protection, Croatian Science Foundation (HRZZ), HŠI, HŠ, Faculty of Forestry
ŠU-03	Strengthening the capacity for systematic monitoring of forest ecosystem conditions as a prerequisite for informed planning and implementation of climate change adaptation	Ministry responsible for forestry, HAOP, HŠI, HŠ, Faculty of Forestry, Advisory service for forestry, Croatian Science Foundation (HRZZ)
ŠU-04	Strengthening capacity for fire protection	DUZS, fire protection community, DHMZ, HŠ, Advisory service, HKISDT, scientific community, JLP(R)S
ŠU-05	Implementation of the green infrastructure	TDU at all levels responsible for spatial

	concept	planning, JLP(R)S, city municipal utilities, HŠ, Program Sava d.o.o., urbanists, landscape architects, scientific community
ŠU-06	Prediction (forecast) of change in the distribution of harmful organisms	Ministry responsible for forestry, HŠI, Faculty of Forestry
ŠU-07	Afforestation	Ministry responsible for forestry, HŠ
ŠU-08	Bringing awareness to the participants in the forestry sector on climate change and the adaptation measures	Ministry responsible for forestry, HKISDT, HŠI, Faculty of Forestry, Advisory service, HŠ, Academy of Forestry Sciences, Union of private forest owners' associations, JUZP and public institutions for the management of protected natural values in the counties
ŠU-09	Strengthening awareness and sensitization of private forest owners for sustainable forest management as a prerequisite for adapting to climate change	Ministry responsible for forestry, Advisory service, private forest owners' organizations, private forest owners, JLP(R)S

Fisheries

The proposed climate change adaptation measures in the fisheries sector are identified as RR-01 to RR-05 and in the aquaculture sector as RA-01 to RA-05. Based on the overall assessment grade of importance the individual measures are grouped into three categories: of very high importance (01-04) and of high importance (05) for the fisheries sector and of very high importance (01-03), of high importance (04) and of medium importance (5) for the aquaculture sector.

Table 5-4: Climate change adaptation measures proposed in the Fishery sector: Measures in the fisheries sector are identified as RR-01 to RR-05 and in the aquaculture sector from RA-01 to RA-05. They are further grouped into 3 categories: very important measures (01-04) and measures of high importance (05) for the fisheries sector, as well as very important measure (01-03), measures of high importance (04), and medium importance (05) for the aquaculture sector

Measure's ID	Measure's name	Key stakeholders
RR-01	Strengthening the sector by investing in development of new markets and expanding the range of products offered	Ministry responsible for fisheries, ministry responsible for economy, entrepreneurship and crafts, HGK, HOK, JLP(R)S, FLAG-s, fishermen
RR-02	Strengthening capacities to assess the future state of the sector due to climate change impacts	Ministry responsible for fisheries, ministry responsible for science and education, scientific institutions, DHMZ, fishermen
RR-03	Strengthening the resilience of natural resources through adaptive fisheries management	Ministry responsible for fisheries, scientific institutions, fishermen
RR-04	Increasing the involvement of fishermen in the tourism sector	Ministry responsible for economy, entrepreneurship and crafts, ministry responsible for tourism, tourist boards in the counties, cities and municipalities, FLAGs, fishermen
RR-05	Exploitation of alien fish species	Ministry responsible for fisheries, scientific institutions, fishermen
RA-01	Strengthening aquaculture capacities by greater breeding of organisms at lower trophic levels and new forms of breeding	Ministry responsible for fisheries, scientific institutions, breeders
RA-02	Strengthening aquaculture capacity	Ministry responsible for fisheries, scientific

	through breeding in recirculation systems	institutions, JLP(R)S, breeders
RA-03	Strengthening aquaculture capacity by breeding new species of fish	Ministry responsible for fisheries, scientific institutions, producers of fish feed and fish equipment, breeders
RA-04	Strengthening aquaculture capacities by selective breeding	Ministry responsible for fisheries, scientific institutions, breeders
RA-05	Strengthening aquaculture capacities by adapting the quantity and quality of food to changed climate conditions	Ministry responsible for fisheries, scientific institutions, producers of fish feed, breeders, HAH (Croatian Food Agency)

Biodiversity

Proposed climate change adaptation measures in this sector are identified as B-01 to B-09 and are, based on the overall assessment grade of importance of the individual measure grouped into three categories: of very high importance (01-04), of high importance (05-06) and of medium importance (07 - 09).

Table 5-5: Climate change adaptation measures proposed in the sector of Biodiversity: measures of very high importance (01 – 04), of high importance (05 – 06) and of medium importance (07 – 09)

Measure's ID	Measure's name	Key stakeholders
B-01	Preservation of traditional agriculture in natural ecosystems	Ministry responsible for agriculture, , Ministry responsible for regional development and EU funds and other responsible institutions, primarily HPA (Croatian Agricultural Agency) in cooperation with ministry responsible for nature
B-02	Establishment of a climate monitoring and early warning system for protected areas and ecological network of the Republic of Croatia and monitoring of protected wild habitat types and wild species	Ministry responsible for climate change and DHMZ in cooperation with ministry responsible for protection of nature
B-03	Improvement of knowledge and creation of databases of natural ecosystems and biodiversity	Ministry responsible for protection of nature, and HAOP in cooperation with Hrvatske šume d.o.o. (HŠ), speleological associations, individual experts
B-04	Integrated management of freshwater resources for the conservation and revitalization of natural ecosystems and biodiversity	Ministry responsible for protection of nature, HV, JP(R)S
B-05	Integrating knowledge about the effects of climate change into a system of nature protection	Ministry responsible for water management, and Croatian Waters company for water management together with ministry responsible for nature and bodies of local and regional governments
B-06	Strengthening endangered habitats and species	Ministry responsible for protection of nature, HAOP, HŠ, HV, JLP(R)S
B-07	Improving sustainable management and infrastructure in natural ecosystems	Ministry responsible for construction and spatial planning, ministry responsible for agriculture, ministry responsible for tourism cooperating with ministry responsible for protection of nature, HŠ, HV et al.
B-08	Strengthening the human and financial capacities of the nature protection system	Ministry responsible for protection of nature, HAOP, JUZP, Public institutions for the

Measure's ID	Measure's name	Key stakeholders
		management of protected natural areas in the counties, HŠ, HV
B-09	Strengthening the transfer of knowledge on the importance and services of ecosystems and biodiversity and their vulnerability to climate change	Ministry responsible for protection of nature, HAOP, JUZP, Public institutions for the management of protected natural areas in the counties

Energy

The proposed climate change adaptation measures in this sector are in the further text labelled as E-01 to E-08 and are, based on the overall assessment grade of importance of the individual measure grouped into three categories: of very high importance (01-03), of high importance (04 - 06) and of medium importance (07 - 08).

Table 5-6: Climate Change adaptation measures proposed in the Energy sector: measures of very high importance (01 – 03), measures of high importance (04 – 06) and measures of medium importance (07 – 08)

Measure's ID	Measure's name	Key stakeholders
E-01	Strengthening the resilience of production facilities through the storage of electrical energy	Ministry responsible for energy, HERA, HROTE, HOPS, HEP ODS, legal entities performing electrical energy generation, eligible electrical energy producers
E-02	Strengthening the capacities and ensuring of an incentivizing legal framework to increase the capacity of renewable energy and distributed sources	Ministry responsible for energy, HERA, HROTE, HOPS, HEP ODS, Program Sava d.o.o., legal entities performing electrical energy generation, eligible electrical energy producers
E-03	Strengthening the resilience of existing capacities for electricity and heat production	Ministry responsible for energy, ministry responsible for construction and spatial planning, HERA, legal entities performing electrical energy generation, eligible electrical energy producers
E-04	Development of the monitoring capacity and rapid elimination of negative effects of climate impacts on the electrical energy system (EES)	Ministry responsible for energy, DUZS, HERA, HOPS, HROTE, HEP ODS
E-05	Strengthening the electrical energy system's resilience (EES)	Ministry responsible for energy, HERA, HROTE, HOPS, HEP ODS, legal entities performing electrical energy generation, eligible electrical energy producers
E-06	Strengthening the distribution network's resilience	Ministry responsible for energy, HERA, HROTE, HEP ODS
E-07	Strengthening the transmission network's resilience	Ministry responsible for energy, HERA, HROTE, HEP ODS

Tourism

The proposed climate change adaptation measures in this sector are identified as T-01 to T-06 and are, based on the overall assessment grade of importance of the individual measure grouped into three categories: of very high importance (01 - 04), of high importance (05) and of medium importance (06 - 07).

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Table 5-7: Climate Change adaptation measures proposed in the energy sector: measures of very high importance (01 – 04), of high importance (05) and of medium importance (06 – 07).

Measure's ID	Measure's name	Key stakeholders
T-01	Integration of climate change into the tourism development strategy	Ministry responsible for tourism, ministry responsible for environmental protection, JLP(R)S, tourist boards in counties, cities and municipalities
T-02	Raising awareness of persons involved in the tourism sector on the possibilities of adaptation to climate change	Ministry responsible for tourism, HGK, tourist boards in counties, cities and municipalities
T-03	Strengthening the competencies of high school and university students	Ministry responsible for science and education, Agency for Vocational Education and Training
T-04	Strengthening the resilience of tourism infrastructure to different weather extremes	Ministry responsible for tourism, ministry responsible for construction and spatial planning, ministry responsible for environmental protection, ministry responsible for sea, transport and infrastructure, JLP(R)S
T-05	Strengthening the resilience of local communities in the tourism sector	Ministry responsible for tourism, JLP(R)S, tourist boards in counties, cities and municipalities
T-06	Development of sustainable tourism with included adaptation to climate change	Ministry responsible for tourism, JLP(R)S

Health

The proposed climate change adaptation measures in this sector are identified as ZD-01 to ZD-09 and are based on the overall assessment grade of importance of the individual measure grouped into three categories: of very high importance (01-03), of high importance (04-06) and of medium importance (07 - 09).

Table 5-8: Climate change adaptation measures proposed in the Health sector: measures of very high importance (01 – 03), of high importance (04 – 06) and of medium importance (07 – 09)

Measure's ID	Measure's name	Key stakeholders
ZD-01	Establishment of a system for calculating health-economic indicators for climate change-related conditions	Ministry responsible for health, HZZO, HZJZ, county institutes of public health
ZD-02	Integration of various information systems within healthcare to monitor indicators associated with climate change	Ministry responsible for health, HZZO, HZJZ, county institutes of public health, HAH
ZD-03	Establishment of a framework for the implementation of human biomonitoring for tracking environmental factors related to climate change	Ministry responsible for health, HZZO, HZJZ, county institutes of public health, scientific institutes, medical faculties
ZD-04	Implementation of health impact assessments and health assessments of risks related to climate change	Ministry responsible for health, ministry responsible for environmental protection, HZJZ, county institutes of public health, HAH, health risk and health impacts assessment experts

ZD-05	Networking and upgrading of monitoring system of environmental indicators related to climate change	Ministry responsible for health, ministry responsible for environmental protection, ministry responsible for agriculture and forestry, ministry responsible for water management, HV, HŠ, HAOP, private labs, HZJZ, county institutes of public health, HAH
ZD-06	Increasing the number of secure points in case of extreme meteorological conditions	Ministry responsible for health, ministry responsible for environmental protection, HZJZ, county institutes of public health, JLP(R)S
ZD-07	Strengthening the allergen species monitoring system	Ministry responsible for health, ministry responsible for agriculture and forestry, ministry responsible for transport and infrastructure, ministry responsible for utilities, Advisory service, HŠ, HV, HŽ, HZJZ, county institutes of public health, State administration offices in counties (UDUs), JLP(R)S
ZD-08	Strengthening the awareness of public and key stakeholders within health and other priority professions (*e.g.* educational and preschool institutions, facilities for elderly and helpless people, home care etc.)	Ministry responsible for health, HZJZ, county institutes of public health, HAH, JLP(R)S
ZD-09	Integration of climate change subject into the national school curriculum	Ministry responsible for science and education, JLP(R)S, public institutions that provide educational and nurturing services

Spatial planning and coastal area management

The proposed climate change adaptation measures in this sector are identified as PP-01 to PP-05 and are, based on the overall assessment grade of importance of the individual measure grouped into two categories: of very high importance (01-04) and of high importance (05).

Table 5-9: Climate change adaptation measures proposed in the sector of Spatial planning and coastal area management: measures of very high importance (01 – 04), of high importance (05)

Measure's ID	Measure's name	Key stakeholders
PP-01	Strengthening of the knowledge base, as well as the monitoring and evaluation system	Ministry responsible for environmental protection, ministry responsible for spatial planning, HV, HAOP, JLP(R)S
PP-02	Strengthening the human and institutional capacities of professional stakeholders in the spatial planning system	Ministry responsible for spatial planning, ministry responsible for environmental protection, expert authors, carriers and coordinators of spatial plans, HKA (Croatian Chamber of Architects), ministry responsible for environmental protection, authorities for preparation of strategic studies, ministry responsible for education and science, HZPR, county institutes of spatial planning, JLP(R)S
PP-03	Integration of adaptation measures into the spatial planning system	Ministry responsible for spatial planning, HZPR, county institutes of spatial planning, JLP(R)S
PP-04	Raising awareness of the public and decision-makers at all levels	Ministry responsible for environmental protection, ministry responsible for spatial organization, JLP(R)S, citizens
PP-05	Preparation of programs and rehabilitation projects	Ministry responsible for construction and spatial organization, ministry responsible for culture, JLP(R)S, public and private

		property owners, responsible legal entities with public authority

Risk management

The proposed climate change adaptation measures in this sector are identified as UR-01 to UR-06 and are, based on the overall assessment grade of importance of the individual measure grouped into two categories: of very high importance (01-03) and of high importance (04-06)

Table 5-10: Climate change adaptation measures proposed in the Risk management sector: measures of very high importance (01 – 03) and of high importance (04 – 06)

Measure's ID	Measure's name	Key stakeholders
UR-01	Mapping of water sources outside the public water supply system	Ministry responsible for water management, DUZS, JLP(R)S, HZJZ, county institutes of public health, private and public owners of sources outside the public water supply system
UR-02	Multi-sectoral risk assessment for various threat / risk scenarios associated with climate change	Ministry responsible for health, ministry responsible for agriculture, ministry responsible for environmental protection, ministry responsible for defense, ministry responsible for sea, transport and infrastructure, security agencies, HVZ, HZJZ, County institutes of public health
UR-03	Expansion of the *Croatian Platform for Disaster Risk Reduction* to include climate change-related indicators for the development of an early warning system	DUZS, JLP(R)S, HZJZ, County institutes of public health, responsible ministries, HAH, HŠ, HV
UR-04	Strengthening the capacities to assess dangers and responses during disasters, major accidents, extraordinary events or incidents/crisis situations related to climate change	DUZS, DHMZ, JLP(R)S, HAH, responsible ministries, scientific community, insurance companies, civil associations
UR-05	Establishment of human and technological capacities for recovery after complex risks related to climate change	DUZS, responsible ministries, HZJZ, County institutes of public health
UR-06	Expanding capacities and models for coverage of risk related to climate change and catastrophic damages	Ministry responsible for environmental protection, ministry responsible for finance, certification houses, insurance companies

Supra-sectoral measures

Table 5-11: Supra-sectoral measures have been included by expert evaluation as measures of very high importance, and, as such, are included into the first Action Plan

Measure's ID	Measure's name	Key stakeholders
KM-01	Strengthening human and technical capacities for implementing research and applied activities in the area of climate modelling, analysis, and interpretation of observed and expected climatic changes	DHMZ, universities, scientific research institutes, ministry responsible for the environment, agencies, institutes and other expert bodies
RP-01	Development of impact indicators of the implementation of the adaptation strategy for vulnerable sectors and society	Ministry responsible for environment and climate, ministries responsible for climate- change-vulnerable sectors, universities, scientific research institutes

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6 PRIORITIES OF THE CLIMATE CHANGE ADAPTATION STRATEGY

6.1 Procedure for defining priority measures and activities

Based on the list of a total of 81 identified measures of climate change adaptation 79 so-called sectoral measures were divided into five groups of measures based on the national priorities of the Adaptation Strategy, which were identified by stakeholders during the process of harmonizing the concept of climate change adaptation in the Republic of Croatia and ranked by the method of multi-criteria analysis. Two measures, KM-01 and RP-01, have not been taken into account in this distribution because they are supra-sectoral. Five national priorities have been identified, within which climate change adaptation measures are to be implemented. These are:

1. Ensuring sustainable regional and urban development
2. Ensuring preconditions for the economic development of rural areas, coastal areas and islands
3. Ensuring sustainable energy development
4. Strengthening of the management capacities through a networked monitoring and early warning system
5. Ensuring continuity of research activities

Adaptation measures to climate change are grouped according to the following *types*:

- Regulatory and administrative measures (***RE***)
- Implementation measures (***PR***)
- Measures of education and bringing awareness to the public (***ED***);
- Research-development measures (***IR***).

Integrating the above mentioned 79 climate change adaptation measures according to the urgency and importance of implementation, they are divided into three basic categories of *importance*:

- Measures of very high importance of implementation
- Measures of high importance of implementation
- Measures of medium importance of implementation

Two supra-sectoral measures (KM-01 and RP-01) have also been expertly assessed as measures of very high importance, which is why they are included in the first Action Plan.

6.2 Priority measures and activities

Measures are divided into groups following five national priorities, and measures within each group are further divided into three categories of importance. For each measure, the type of activity to be implemented has been determined. The specified measures and activities after the prioritization procedure are given in the tables (**Error! Reference source not found.**- REF _Ref493645901 \h **Error! Reference source not found.**).

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Priority 1. Ensuring sustainable regional and urban development

Adaptation to climate change, prevention and risk management is set as the backbone of future regional and urban development. Disaster prevention and management, as well as adaptation to climate change, is a response to local/regional issues that local/regional administrations need to deal with in order to reduce the potential disaster impact in their area. Natural disasters and climate change impacts can have a significant impact on the socioeconomic development and competitiveness of the individual Croatian regions as well as the entire country and have far-reaching cross-border implications. Investments in prevention and adaptation contribute to the preservation of existing assets and bring a high economic return, where cost of action is far lower than the cost of inaction. Therefore, it is important in the approach to solving and implementation of adaptation measures to identify local/regional measures that will best respond to the vulnerability of a given area. Cities and urban areas are particularly exposed to the influence of climate change (heat waves, extreme precipitation, floods). In this sense, adaptation to climate change and prevention and risk management become a priority when cohesion policy supports urban development projects. Cities and urban areas, especially in coastal areas along rivers and the sea, show vulnerabilities that are usually larger than in the surrounding areas (*e.g.* to floods, to effects of urban heat islands). Because of concentration of population and economic activities in cities, special attention is paid to investments in climate-resistant urban infrastructure and activities aimed at strengthening local level resilience to climate change.

Table 6-1: Priority 1. - 1.1. Measures of very high importance

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
HM-01	Strengthening the capacity for the implementation of non-structural measures for protection against the harmful effects of water in case of occurrence of extreme hydrological conditions whose increase in intensity and frequency of occurrence is conditioned by climate change	HM-01-01. Development of models for the prediction of extreme precipitation in the broader catchment areas and their local occurrence	PR
		HM-01-02. Development of models of large water simulation in the wider catchment areas and small torrential streams	PR
		HM-01-03. Preparation of a forecast study on flood propagation, determination of flood zones and risks and opportunities for the provision of natural flood retention areas and their inclusion in spatial planning documentation	PR
		HM-01-04. Drafting of revisions to existing protection projects against the harmful effects of water and high sea levels	PR
HM-02	Strengthening the capacity to build, reconstruct and upgrade the system for protection against harmful effects of water and related multi-purpose hydro-technical systems (structural	HM-02-03. Preparation of project documentation for the construction, reconstruction and upgrade of protective embankments, dikes and similar facilities and multipurpose systems for protection from harmful	PR

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
	measures) and lowland natural floodplains flooded in a controlled fashion	effects of water	
		HM-02-04. Construction, reconstruction and extension of protective embankments, dikes and similar multifunctional facilities related to the protection against harmful effects of water	PR
		HM-02-05. Development of "green infrastructure" - arrangement of watercourse sections with natural flow characteristics or according to eco-remediation principles of river restoration and provision of natural lowland areas for controlled flooding and retention / reduction of large water - measures of "flood adaptation"	PR
HM-03	Strengthening research and management capacities to assess the occurrence and risk of adverse impacts of climate change and adaptation of freshwater and marine water system in current and future climatic conditions	HM-03-01. Provision of education for specifically chosen target groups both in the form of thematic workshops for experts and interested members of the public as well as thematic units within the regular curricula of the primary, secondary and university education populations	ED
ŠU-01	Incorporation of adaptation measures into key documents pertaining to forests and forestry sectors	ŠU-01-01. Incorporate measures of adaptation to climate change into Forestry Sector Strategy and Forest Act as well as other legal regulations concerning forests and forestry sector, including implementation indicators	RE
T-01	Integration of climate change into the tourism development strategy	T-01-01. Definition of the impact of climate change on tourism	RE
		T-01-02. Definition of guidelines for the development of Croatian tourism in accordance with adaptation to climate change	RE
		T-01-03. Development of plans for protection of tourism infrastructure against the impacts of climate change and weather extremes	PR
		T-01-04. Development of plans for the construction of future tourist infrastructure, more resilient to weather extremes	PR
		T-01-05. Continuous monitoring of the state of tourism infrastructure	PR
T-02	Raising awareness of persons involved in the tourism sector on the possibilities of adaptation to climate change	T-02-01. Organization of workshops for interested tourism professionals in order to learn about specific climate risks, their likelihood of occurrence, and adaptation options	ED
		T-02-02. Printing of promotional materials and other advertising activities to spread awareness of the necessity for adaptation – directed	ED

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
		towards tourism subjects	
T-03	Strengthening the competencies of high school and university students	T-03-01. Education of teaching personnel on climate change and adaptation measures in the tourism sector	ED
		T-03-02. Climate change and adaptation in the tourism sector - basic or elective subject / course in secondary schools and colleges geared towards tourism	ED
T-04	Strengthening the resilience of tourism infrastructure to different weather extremes	T-04-01. Development of specific destination offers adapted to climatic and spatial characteristics	PR
		T-04-02. Construction of public tourism infrastructure adapted to climate change	PR
PP-01	Strengthening of the knowledge base, as well as the monitoring and evaluation system	PP-01-02. Implementing integrated multidisciplinary assessment of coastal areas vulnerability to extreme sea levels including socio-economic aspects and cost estimates and benefits of adaptation options	PR
		PP-01-04. Implementation of an assessment of vulnerability to the occurrence of thermal islands and extreme precipitation in settlements, with emphasis on connection with spatial planning solutions	PR
PP-02	Strengthening the human and institutional capacities of professional stakeholders in the spatial planning system	PP-02-01. Strengthening of continuing professional training program for spatial planners concerning the application of climate change adaptation measures	ED
PP-03	Integration of adaptation measures into the spatial planning system	PP-03-01. Amendments to the legal framework to develop adaptation measures to climate change in spatial planning	RE
		PP-03-02. Development and strengthening of integrated physical planning methodology and strategic environmental impact assessment with emphasis on the application of climate change adaptation measures	RE
		PP-03-03. Development of the programme and guidelines for strengthening inter-sectoral coordination in the spatial planning procedure, with emphasis on the planning of climate change adaptation measures	RE
		PP-03-04. Analysis and elaboration of methods of monitoring and evaluating the efficiency and effectiveness of spatial plans in the implementation of climate change adaptation measures	RE

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
PP-04	Raising awareness of the public and decision-makers at all levels	PP-04-01. Design and implementation of public information and education programs focusing on targeted groups in vulnerable areas	ED
		PP-04-02. Design and implementation information programmes for decision-makers at all levels of government	ED
		PP-04-03. Raising awareness of social responsibility in the banking and insurance sector regarding climate change	ED

Table 6-2: Priority 1 - 1.2. Measures of high importance

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
HM-05	Strengthening the capacities for effects of the sea on the coastal water-communal infrastructure and coastal water resources in conditions of sea level rise caused by climate change (non-structural measures)	HM-05-01. Development of model of sea level estimation depending on global climate change and local coastal conditions	PR
		HM-05-02. Creation of a preliminary map of vulnerability of coastal infrastructure, especially valuable natural sites (natural strands, transitional waters) and coastal karstic water resources	PR
		HM-05-03. Creating a detailed analysis of the most vulnerable components of the water sector	PR
		HM-05-04. Proposal of Resolution (protection measure)	PR
HM-06	Strengthening urban areas' resilience to anthropogenic pressures conditioned by climate change	HM-06-01. Education of employees related to the management of urban water phenomena and urban water infrastructure and education of spatial planners and project designers of water infrastructure to new tendencies and project solutions for adaptation of urban water systems to climate change and increased anthropogenic pressures	ED
		HM-06-02. Rationalization of water use in conditions of increased needs due to climatic adverse hydrological conditions and reduction of water supply losses	PR
		HM-06-03. Purification of waste and contaminated precipitation water and its reuse or infiltration into the underground or release into surface aquatic systems	PR
		HM-06-04. Construction of water supply systems of lower quality for secondary water use and reduction of pressures on drinking water resources	PR

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Measure's ID	Measure's name	Activity's ID and name	Act. cat.
		HM-06-05. Construction of the rainwater interventions to use rainwater	PR
		HM-06-06. Construction of desalination equipment for salinized water (brackish water and exceptionally sea water)	PR
		HM-06-07. Local containment, retention and infiltration of precipitation water and reduction of pressure on sewage or pipe drainage systems	PR
		HM-06-08. Formation of green areas within urban areas intended for temporary or permanent retention and purification of precipitation water and recreational amenities	PR
ŠU-05	Implementation of the green infrastructure concept	ŠU-05-01. Analysis of the existing network of green areas in urban areas (forests, forest parks, parks and other urban green areas) whose result should show deficiencies in terms of the link between individual elements of green infrastructure	PR
		ŠU-05-02. Strategic planting of trees and other tree species in order to achieve physical and/or functional linkage between individual elements of green infrastructure, including the establishment of park and/or forest areas along the surface flow	PR
		ŠU-05-03. Strengthening the capacity of the state administration bodies at all levels for the implementation of participatory planning	ED
		ŠU-05-05. When planning new green areas, giving of preference to woody species before grass that requires a large amount of water for maintenance; trees have a better impact on reducing the effect of heat islands	RE
B-05	Integrating knowledge about the effects of climate change into a system of nature protection	B-05-01. Creating a list of the most endangered habitat types and strictly protected native species susceptible to the adverse effects of climate change with mitigation and adaptation measures	PR
B-06	Strengthening endangered habitats and species	B-06-01. Strengthening of habitats: increasing soil's water binding capacity, removing of alien invasive species, emergency intervention system	PR
		B-06-02. Strengthening of species: propagation of plant species, reintroduction, provision of an optimal corridor for migratory species, recovery, conservation *in situ* and *ex situ* (including gene banks)	PR
T-05	Strengthening the resilience of local communities in the tourism sector	T-05-01. Assessment of Climate Change Impact (defined in this Strategy) at local level	PR

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
		T-05-02. Proposed adaptation measures and their implementation at local levels	PR
T-06	Development of sustainable tourism with included adaptation to climate change	T-06-01. Development of guidelines for the implementation of adaptation measures with the aim of achieving, inter alia, the sustainable development of tourism	PR
		T-06-02. Implementation of adaptation guidelines	PR
PP-05	Preparation of programs and rehabilitation projects	PP-05-01. Development of good practice guidelines for the design of rehabilitation projects for typical situations of exposure and vulnerability to sea floods of different physical structures on the shore, especially those identified as priorities, with emphasis on spatial planning aspects	PR
		PP-05-02. Provision of technical and financial support for the design of rehabilitation projects and the financing of the realization of these projects	PR
		PP-05-03. The establishment of a national program for the rehabilitation of cultural heritage assets endangered by extreme sea levels	PR
		PP-05-04. Encouraging and stimulating JLS's co-operation on co-ordinated planning of adaptation measures	PR

Table 6-3: Priority 1 - 1.3. Measures of medium importance

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
HM-07	Strengthening the capacity for exploration and sustainable management of groundwater	HM-07-01. Revision of the existing groundwater monitoring in the Black Sea basin section of Croatia	PR
		HM-07-02. Establishment of groundwater monitoring in the Adriatic part of Croatia and the area of high karst	PR
		HM-07-03. Modelling of interdependence of climatic and hydrological conditions on surface waters and groundwater conditions	PR
		HM-07-04. Modelling of interdependence of the groundwater status and the raising sea level	PR
		HM-07-05. Creating maps of groundwater vulnerability in situations of reduced natural inflows due to climate change	PR

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
		HM-07-06. Drafting of the method of protection and exploitation of groundwater in climatic conditions	PR
HM-08	Strengthening the resilience of coastal water utility infrastructure and coastal water resources (structural measures)	HM-08-01. Reconstruction and rehabilitation of water-communal infrastructure and water resource interventions	PR
		HM-08-02. Dislocation of water interventions outside the influence of the sea	PR
		HM-08-03. Artificial replenishment of coastal aquifers with purified wastewaters	PR
		HM-08-04. Construction of controlled mobile enclosures at watercourses etc.	PR
HM-09	Strengthening the protection capacity of particularly valuable aquatic ecosystems	HM-09-01. Evaluation of existing anthropogenic pressures on the quantity and water quality of aquatic water systems in protected areas and the risk of increasing adverse impacts in changed climatic conditions and the development of solutions for reducing pressures (*e.g.* relocation of water interventions outside of protected areas, solution for precipitation drainage, etc.)	PR
		HM-09-02. Implementation of the analysis of climate change impacts on changes in abiotic and biotic features of aquatic ecosystems of protected areas (*e.g.* change in water quantity and temperature and related biogenic changes, change of water volume in surface and groundwater, change of water velocity and the like)	PR
		HM-09-03. Planning of structural and non-structural solutions for mitigation of climate change impacts on aquatic water systems and their implementation and/or construction	PR
ŠU-07	Afforestation	ŠU-07-01. Development of a plan for afforestation of suitable tree species	PR
		ŠU-07-02. Afforestation of suitable species	PR
B-07	Improving sustainable management and infrastructure in natural ecosystems	B-07-01. Develop and implement plans for sustainable infrastructure in natural ecosystems (energy, waste, water supply, food, transport)	PR
		B-07-02. Enhance anthropogenic ecosystems to create habitat for wild species (encouraging green architecture, green belts, shelters for birds and bats)	PR
		B-07-03. Improve the climate of urban areas (increase water retention, adaptation of green areas design to climate change by choice of indigenous plant species and varieties)	PR
B-08	Strengthening the human and financial capacities of the nature protection system	B-08-01 Educate and specialize and, where necessary, strengthen the capacity of expert teams by employing experts	ED
		B-08-02 Ensure financing of mitigation and adaptation measures through structural and other EU funds, Horizon 2020 program, LIFE program, and so on.	ED
B-09	Strengthening the transfer of knowledge on	B-09-01 Organize professional lectures and workshops	ED

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Measure's ID	Measure's name	Activity's ID and name	Act. cat.
	the importance and services of ecosystems and biodiversity and their vulnerability to climate change		
ZD-08	Strengthening the awareness of public and key stakeholders within health and other priority professions (*e.g.* educational and preschool institutions, facilities for elderly and helpless people, home care etc.)	B-09-02 Establish a media information system and other forms of information transfer	ED
		ZD-08-01 Preparation of annual plans for media activities, public education plans (educational materials and tools) on impact and adaptation to climate change	ED
		ZD-08-02 Planning of knowledge transfer work packages tailored to the roles of key stakeholders for the promotion of proper procedures, identification and monitoring of health consequences associated with meteorological and climatic influences	ED
ZD-09	Integration of climate change subject into the national school curriculum	ZD-08-03 Preparation, promotion and implementation of educational workshops for key stakeholders with international experience and exchange of experience at regional and national level	ED
		ZD-09-01 Defining priority groups for introducing a customized inter-subject theme of health, safety and environmental protection	ED
		ZD-09-02 Identification and education of educators within the school system	ED

Priority 2. Ensuring preconditions for the economic development of rural areas, coastal areas and islands

Adaptation of rural areas, coastal areas and islands to key climate challenges becomes a prerequisite for the survival of the economy and further economic development of these areas. The lack of moisture in the soil makes it difficult for the development and ripening of agricultural cultures, decreasing their yield, as well as cattle productivity. High air temperatures hinder or completely inhibit the development of agricultural crops and increase evapotranspiration. Long dry periods can completely destroy the harvest of agricultural crops. Existing research points to frequent lack of water in Croatian agricultural soils, and climate models suggest that this problem will become even more pronounced in the future. Spring frosts and thunder damage agricultural cultures and often destroy their crops, especially in fruit growing, vineyards and vegetable growing. Many agricultural areas have poor soil permeability. With abundant rainfall on such soils, water saturation and surface water stagnation quickly endanger soil fertility and agricultural crops. Damages from sea level rise on the narrow coastline and low coasts of the Croatian Adriatic will be reduced by applying appropriate measures to plan new and remediate existing vulnerable parts of settlements and infrastructure. In coastal areas and islands preconditions must be met for fisheries and aquaculture based on the results of climate modelling that predicts sea temperature rise, resulting in the migration of cold-water species (shrimp, hake) to colder or deeper sea and in the increase in the number of foreign species and impacts on domestic species. Changes in water circulation due to thermohaline causes decrease primary production with the decrease of the number of pelagic fish, and due to increase of acidity of the sea there is less growth and greater mortality of shellfish.

Table 6-4: Priority 2 - 2.1. Measures of very high importance

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
HM-02	Strengthening the capacity to build, reconstruct and upgrade the system for protection against harmful effects of water and related multi-purpose hydro-technical systems (structural measures) and lowland natural floodplains flooded in a controlled fashion	HM-02-01. Preparation of project documentation for the construction and upgrading of existing accumulation and retention systems within multifunctional hydro-technical systems	PR
		HM-02-02. Construction of new and upgrading of existing accumulation and retention systems within multifunctional hydro-technical systems	PR
P-02	Increasing the water absorption capacity of agricultural soil	P-02-01. Development of an operation for increasing the absorption capacity of agricultural soil and inclusion in the Rural Development Program of the Republic of Croatia for the Period 2014 - 2020	RE
		P-02-02. Design and implementation of a promotional and educational programme of popularisation of the implementation of the operation of increasing water absorption capacity of agricultural soil among farmers	ED
		P-02-03. Implementation of operations for increasing the water absorption capacity of agricultural soil	ED

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
P-03	Application of soil conservation tillage	P-03-01. Development and implementation of a promotional and educational programme of popularization of soil conservation tillage among farmers	RE
		P-03-02. Implementation of soil conservation tillage	ED
			PR
P-04	Breeding of species and cultivars of agricultural crops and breeds of domestic animals that are more resilient to climate change	P-04-01. Development of an operation for the breeding of species and sorts of agricultural crops and breeds of farm animals that are more resilient to climate change and its inclusion into the Rural Development Programme of the Republic of Croatia for the Period 2014–2020	PR
		P-04-02. Development and implementation of a promotional and educational programme of popularization among farmers of cultivation of agricultural crops and breeds of domestic animals that are more resilient to climate change	ED
		P-04-03. Implementation of the operation for cultivating species and varieties of agricultural crops and breeds of domestic animals that are more resilient to climate change	PR
P-05	Construction of reservoirs for irrigation	P-05-01. Development and implementation of a promotional and educational programme popularizing the construction of reservoirs for irrigation among farmers	ED
		P-05-02. Implementation of reservoir construction for irrigation	PR
ŠU-03	Strengthening the capacity for systematic monitoring of forest ecosystem conditions as a prerequisite for informed planning and implementation of climate change adaptation	ŠU-03-01. Evaluation of the existing forest ecosystem monitoring system with identification of advantages and disadvantages and development of guidelines for its improvement	PR
		ŠU-03-02. Creating a registry of monitoring, experiments, and research conducted by state institutions that are not part of systematic monitoring, their evaluation, and proposal for inclusion of selected items in the monitoring system	PR
		ŠU-03-03. Upgrading and integration of selected existing monitoring / experimentation / research into the monitoring system of forest ecosystem status monitoring and enabling the availability of results in accordance with	PR

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
		the INSPIRE Directive	
RR-01	Strengthening the sector by investing in development of new markets and expanding the range of products offered	RR-01-01. Implementation of research on the acceptability of new types of breeding organisms and products by consumers	PR
RR-02	Strengthening capacities to assess the future state of the sector due to climate change impacts	RR-02-01. Encouraging the development of application models for forecasting the movement of fish biomass in the future	PR
RR-03	Strengthening the resilience of natural resources through adaptive fisheries management	RR-03-01. Develop the monitoring system of the state of bioresources in marine and fresh water that will also encompass monitoring of the food chain of marine organisms	PR
RR-04	Increasing the involvement of fishermen in the tourism sector	RR-04-01. Education of fishermen to carry out tourism activities	ED
		RR-04-02. Supporting fishermen to reconstruct vessels for the purpose of carrying out tourism activities	PR
RA-01	Strengthening aquaculture capacity by breeding more organisms at lower trophic levels and new forms of breeding	RA-01-01. Implementation of a programme to encourage shellfish farming	PR
		RA-01-02. Implementation of a programme for supporting controlled farming of shellfish in hatcheries instead of collecting them in nature	PR
		RA-01-03. Preparation of a study on the feasibility of growing aquatic plants and their acceptance on the market	PR
		RA-01-04. Development and implementation of an educational programme on the benefits and uses of integrated breeding of aquatic organisms	ED
		RA-01-05. Awareness raising of the general public about the benefits of shellfish, aquatic plants and non-meat species of fish	ED
RA-02	Strengthening aquaculture capacity through breeding in recirculation systems	RA-02-01. Analysis of the possibility of using recirculation breeding systems in fisheries	PR
		RA-02-02. Development and implementation of an educational programme on the benefits of recirculation breeding systems	ED
RA-03	Strengthening aquaculture capacity by breeding new species of fish	RA-03-01. Making amendments to the legislative framework for the cultivation of new (alien) fish species	RE
		RA-03-02. Study on the possibilities of breeding new (alien) fish species	PR
		RA-03-03. Market research to determine the possibility of accepting new (alien) fish species by consumers	PR
B-01	Preservation of traditional agriculture in natural ecosystems	B-01-01. Continuation of inventory of traditional varieties and breeds	PR
		B-01-02. Development of models of restoration of traditional agriculture in	PR

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
		natural ecosystems	
		B-01-03. Develop and implement a programme of encouraging traditional agriculture and placements of value added products	PR
		B-01-04. Establishment of systemic monitoring of natural ecosystems covered in the programme of traditional agriculture	PR
B-03	Improvement of knowledge and creation of databases of natural ecosystems and biodiversity	B-03-01. Update the map of land-based non-forest and map of forest habitats of the Republic of Croatia	PR
		B-03-02. Update of habitat map with elements of vulnerability to climate change	PR
		B-03-03. Completion of inventory of flora and fauna and implementation of inventory of fungi	PR
		B-03-04. Cataloguing of invasive species particularly aggressive in the climate change process with repression and control measures and cataloguing of habitats, taxonomic groups and species particularly vulnerable to climate change	PR
		B-03-05. Updating the List of Speleological Objects of the Republic of Croatia	PR
B-04	Integrated management of freshwater resources for the conservation and revitalization of natural ecosystems and biodiversity	B-04-01. Ensure combined flood protection and protection from loss of biodiversity by restoring natural floodplains	PR
		B-04-02. Creation of retention basins for freshwater, wetland and hygrophilic ecosystems	PR
		B-04-03. Prevention of salinisation of coastal sources and wetland habitats by building dams, embankments and by other measures	PR

Table 6-5: Priority 2 - 2.2. Measures of high importance

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
P-06	Application of irrigation	P-06-01. Continue and extend the implementation of the National project on irrigation and management of agricultural land and water in the Republic of Croatia (NAPNAV): elaboration of conceptual solutions, preparation	PR

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
		of pre-investment studies and project documentation, rehabilitation and reconstruction of existing systems and construction of new irrigation systems	
		P-06-02. Through the structural funds and the rural development program provide sufficient means for irrigation for at least 100,000 ha	PR
		P-06-03. Establish systematic implementation of monitoring and evaluation of implementation (evaluation) of the entire program	PR
P-07	Application of anti-erosion measures	P-07-01. Define agro-technological operations and requirements for the implementation of anti-erosion measures (note: existing anti-erosion measures of rural development program relate solely to grassing of permanent crops and soil cultivation methods, but not to other conventional anti-erosion measures such as contour sowing and processing, grass strips etc.)	RE
		P-07-01. Carry out promotional and educational program of popularizing the use of anti-erosion measures among farmers	ED
		P-07-03. Investing in the application of anti-erosion measures in agriculture such as contour sowing and processing, setting up grass strips, etc.	PR
P-08	Reconstruction and construction of drainage systems	P-08-01. Define technical measures for reconstruction and construction of drainage systems and conditions of use of aids for their application	RE
		P-08-02. Through the structural funds and the rural development program provide sufficient funds to implement the measure on at least 100,000 ha	PR
RR-05	Exploitation of alien fish species	RR-05-01. Investigate the eligibility of potential new (alien) species among consumers	PR
		RR-05-02. Choose techniques and tools for catching of new (alien) species	PR
		RR-05-03. Explore all the possibilities of exploiting new (alien) species for different purposes	PR
RA-04	Increasing the involvement of fishermen in the tourism sector	RA-04-01. Educate at all levels the staff that will be involved in selective breeding	ED
		RA-04-02. Developing a model for predicting the fish biomass movement in the future	PR
		RA-04-03. Making a Study on the possibilities of selective fishing; determine the types of fish to be subjected to selective breeding; determine the characteristics of the fish that will be selected	PR
		RA-04-04. Encourage breeders to participate in selective breeding	ED

Table 6-6: Priority 2 - 2.3. Measures of medium importance

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
P-09	Insurance of agricultural production from production losses caused by adverse climatic conditions	P-09-01. Continuation of Operation 1 (Reclamation of Agricultural Land and Production Potential) Measure 5 of the rural development program, which provide support for the restoration of natural production potential damaged by elemental disasters and catastrophic events and for the introduction of appropriate preventive activities; this Operation, for example, possibly finances the repair or procurement of agricultural machinery, mechanization and equipment; procurement of basic herd/flock of domestic animals; buying and planting of perennial plants etc.	PR
		P-09-02. Continuation of Application of Sub-measure 17.1. (Crop, animal and plants insurance) of Measure 17 of rural development program, which grants aid for co-financing part of premium for crop, animal and plant insurance; the subject of the aid is plant and livestock production recorded in the appropriate record system for agricultural land and domestic animals	PR
ŠU-08	Bringing awareness to the participants in the forestry sector on climate change and the adaptation measures	ŠU-08-01. Education of licensed and other forestry engineers, forestry technicians, employees of the JU for the management of protected parts of nature related to climate change	ED
ŠU-09	Strengthening awareness and sensitization of private forest owners for sustainable forest management as a prerequisite for adapting to climate change	ŠU-09-01. Developing of education and awareness programs for private forest owners on climate change and adaptation to climate change	ED
RA-05	Strengthening aquaculture capacities by adapting the quantity and quality of food to changed climate conditions	RA-05-01. Investigate the influence of elevated water temperature on fish metabolism	PR
		RA-05-02. Investigate the influence of eating habits, the amount and composition of meals on the intensity of fish growth in elevated temperature water	PR

Priority 3. Ensuring sustainable energy development

On the one hand reduction in the average annual precipitation rate reduces the production of electricity in hydropower plants and on the other hand poses a serious problem in ensuring efficient cooling of thermal power plants and thermal power plants – thermal plants (CTS – centralised / district heating systems). Due to the rise in outside temperature, there is also a reduction in the energy needs of buildings, which is the problem for the sustainability and profitability of existing centralised heating systems, if they are not technically prepared to extend services in terms of providing not only centralised heating services but also centralised cooling service of buildings. However, challenges in the energy sector need to be approached with extreme attention in order to ensure sustainable energy, both in terms of electricity production and heat, as well as their distribution and transmission. Also, ever more frequent damages to the power system and its facilities due to extreme weather events (ice and flooding) represent a major financial burden for all energy sector stakeholders, ending with citizens as end-consumers of heat and electricity who ultimately pay the final price of heat and electricity.

Table 6-7: Priority 3. – 3.1. Measures of very high importance

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
E-01	Strengthening the resilience of production facilities through the storage of electrical energy	E-01-01. Conducting a vulnerability analysis of currently important production plants to adverse climate change impacts to define the most vulnerable ones and make a priority list	PR
		E-01-02. Analysis of the possibilities of the construction of energy storage facilities	PR
		E-01-03. Preparation of project documentation for construction of a test facility for energy storage	PR
		E-01-04. Construction of a test facility for energy storage	PR
		E-01-05. Development of a study on the possibilities of building small autonomous energy systems on islands and rural areas, based on the integration of wind energy, photovoltaic and battery power storage systems	PR
		E-01-06. Development of project documentation for the installation of small autonomous energy systems on the islands, based on the integration of wind energy, photovoltaic and battery power storage systems	PR
		E-01-07. Construction of autonomous energy systems on islands that are based on the integration of wind energy, photovoltaic and battery power storage systems	PR
E-02	Strengthening the capacities and ensuring of an incentivizing legal framework to increase the capacity of renewable energy and distributed sources	E-02-01. Development of a map of the climate potential (positive and negative) of Croatian regions for the production of energy from alternative sources in different climatic scenarios	PR
		E-02-02. Development of a study of possibilities of development of diversified energy	PR

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
		sources with emphasis on exploitation of alternative (renewable) energy sources in the territory of the Republic of Croatia	
		E-02-03. Development of a study on the possibilities of using renewable energy sources in rural areas such as agricultural micro-installations	PR
E-03	Strengthening the resilience of existing electricity and heat production capacity	E-03-01. Development of preliminary analysis on the vulnerability of existing thermal power plants to the occurrence of extreme weather and climate hazards and reduced precipitation in order to define the most vulnerable power plants and create a list of priorities	PR
		E-03-02. Development of a detailed analysis of vulnerability for the most vulnerable thermal power plants with proposed measures which will involve technical and economic analysis	PR
		E-03-03. Development of preliminary analysis of the vulnerability of existing hydro power plants related to the occurrence of extreme weather and climate hazards and the reduction of rainfall in order to define the most vulnerable hydro power plants and to create a list of priorities	PR
		E-03-04. Development of detailed vulnerability analysis for the most vulnerable hydroelectric power plants with proposed of measures which will involve technical and economic analysis	PR
		E-03-05. Development of project documentation for the revitalisation of parts of settlements in urban areas connected to the central heating system (CHS) by introducing a low-temperature regime to heating pipes, increasing cost-effectiveness of the CHS	PR
		E-03-06. Revitalization of urban areas connected to the central heating system (CHS) through introducing a low-temperature regime in hot-water pipelines, thus increasing the profitability of CHS	PR

Table 6-8: Priority 3. – 3.2. Measures of high importance

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
E-04	Development of the monitoring capacity and rapid elimination of negative effects of climate impacts on the electrical energy system (EES)	E-04-01. Establish a working group for crisis situations in the energy system, which will be composed of stakeholders from the energy sector (institutional representatives and representatives of larger power companies) and other relevant sectors (climatology, protection and rescue, internal affairs, etc.) and independent experts as needed	PR

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
		E-04-02. Develop a detailed analysis of the identified vulnerabilities of the existing power system (power plants and infrastructure) (detailed analysis should target the most vulnerable parts of the EES for which the adverse impact of climate change is expected); consider the need to establish a national center for crisis situations in the Energy Sector as well as a list of stakeholders that should be involved in the work of the National Center and intervention teams, including their roles and responsibilities during and after emergent events (crisis situations)	PR
		E-04-03. If a decision is made on the need to set-up, take all the steps necessary to establish a national crisis situations center in the energy sector and emergency intervention teams	PR
		E-04-04. Develop action plans in case of extraordinary events	PR
		E-04-05. Strengthen the capacities of all stakeholders, especially newly established intervention teams, through a system of continuous training	ED
E-05	Strengthening the electrical energy system's resilience (EES)	E-05-01. Develop detailed maps (mapping) of the existing power system and seasonal results of climate modelling according to parameters important for the energy sector	PR
		E-05-02. Develop advanced IT tools and solutions for the management of power systems and prediction of weather conditions and hazards and favourable/unfavourable climatic conditions for generation, transmission, distribution and consumption of energy	PR
		E-05-03. Strengthen the capacities of all stakeholders	ED

Table 6-9: Priority 3. – 3.3. Measures of medium importance

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
E-06	Strengthening the distribution network's resilience	E-06-01. When developing new distribution network development plans take into account the expected climate change and the observed electricity system vulnerabilities	PR
		E-06-02. Determine the most vulnerable parts of the existing distribution network with regard to the identified vulnerabilities and make a list of priority parts of the grid when exposed to adverse weather and climatic hazards	PR
		E-06-03. Develop detailed vulnerability analysis for the most vulnerable parts of the existing distribution network with proposals of measures that will include techno-economic analysis	PR

		E-06-04. Take the results of the analyses into account when developing sectoral strategies, plans and development programs	RE
E-07	Strengthening the distribution network's resilience	E-07-01. When developing new plans for the development of the Croatian transmission network, consider the expected climate change and the vulnerabilities of the power system	RE
		E-07-02. Determine the most vulnerable parts of the existing transmission grid with regard to the identified vulnerabilities and make a list of priority parts of the network when exposed to adverse extreme weather and climatic hazards	PR
		E-07-03. Develop detailed vulnerability analysis for the most vulnerable parts of the existing transmission network with proposals of measures that will also include techno-economic analysis	PR
		E-07-04. Take the results of the analyses into account when developing sectoral strategies, plans and development programs	RE
		E-07-05. Strengthen the capacities of all stakeholders	ED

Priority 4. Strengthening of the management capacities through a networked monitoring and early warning system

Adapting to climate changes and preventing and managing risk is a horizontal theme, which means that a solid and efficient administration needs to be established to ensure the quality of investment. Responsibilities of the ministries, especially for aspects of cohesion policy, need to be clear and need to include regional and local authorities in the implementation. Namely, weak implementation and administrative capacities at the local and regional levels are the main obstacles to the successful implementation of the measures. Therefore, it is necessary to plan investment in training and capacity-building and adaptation-based expertise, especially for those local units that are most vulnerable to climate change.

Table 6-10: Priority 4. – 4.1. Measures of very high importance

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
KM-01	Strengthening human and technical capacities for implementing research and applied activities in the area of climate modelling, analysis, and interpretation of observed and expected climatic changes	KM-01-01. Supporting the development of applied sector models and strengthening capacity for the use of these models in the development of climate models at spatial resolutions 1-4 km and development of climate scenarios for wider Croatian area	ED
		KM-01-02. Involvement of new human capacities in the development of combined climate models (atmosphere-ocean-soil) and drafting climatic scenarios for the Adriatic and Mediterranean area	ED
RP-01	Development of impact indicators of the implementation of the adaptation strategy for vulnerable sectors and society	RP-01-01 Development of the project plan	ED
		RP-01-02 Detailed development of all adaptation indicators	
HM-03	Strengthening research and management capacities to assess the occurrence and risk of adverse impacts of climate change and adaptation of freshwater and marine water system in current and future climatic conditions	HM-03-03. Improvement of monitoring system of quantitative status and quality of inland water and the condition of the Adriatic Sea and the public availability of their results (measurement, information)	PR
ŠU-04	Strengthening capacity for fire protection	ŠU-04-01. Improvement of the system of early warning for forest fires	PR
		ŠU-04-02. Develop models of the spreading of forest fires and predictive models entailing all elements of fire prediction and relevant risks	PR
		ŠU-04-03. Development of a plan and raising public awareness on the importance of implementation of preventive measures to prevent forest fires	ED
		ŠU-04-04. Maintenance of existing fire roads in the Mediterranean and Sub-Mediterranean zone and construction of new ones	RE
B-02	Establishment of a climate monitoring and early	B-02-01. Establish a monitoring and early warning system for all protected areas and areas of the	PR

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
	warning system for protected areas and ecological network of the Republic of Croatia and monitoring of protected wild habitat types and wild species	ecological network of the Republic of Croatia	
		B-02-02. Establish expert monitoring of natural habitat types and wild species for monitoring the impacts and consequences of climate change, in accordance with regulations on the protection of nature	RE
ZD-01	Establishment of a system for calculating health-economic indicators for climate change-related conditions	ZD-01-01. Development of a calculation system of health-economic indicators by selecting priority diagnoses according to the International Classification of Diseases and Related Health Problems that can be linked to the impact of meteorological or climatic parameters	PR
		ZD-01-02. Establishment of network of persons conducting health and economic analyses	RE
		ZD-01-03. Establishment of an automated calculation within the central information healthcare system / health-ecological / public health subsystem	PR
		ZD-01-04. Establishment of a networked database and authorized stakeholders in the evaluation and monitoring of health and economic indicators related to climate change	PR
ZD-02	Integration of various information systems within healthcare to monitor indicators associated with climate change	ZD-02-01. Defining and positioning of key stakeholders within the central health IT system of health institutes, primary health care system, hospital system, emergency reception system, veterinary supervision system and others	RE
		ZD-02-02. Expansion of knowledge base through scientific and expert definition of health indicators associated with climate change	PR
		ZD-02-03. Creation of a network of meteorological information systems and air quality monitoring system with preventive, hospital, and primary health care systems	PR
PP-01	Strengthening of the knowledge base, as well as the monitoring and evaluation system	PP-01-05. Ensuring the availability of research results through existing information systems for spatial planning, environmental protection and water or the Open Data Portal or Geoportal of the National Spatial Data Infrastructure.	PR
UR-01	Mapping of water sources outside the public water supply system	UR-01-01. Mapping of water sources outside the public water supply system (private wells, spring-water intakes, etc.)	PR
		UR-01-02. Water testing and initial health risk assessment and application in the mapped water sources outside the public water supply system	PR
		UR-01-03. Comprehensive assessment of health risk and application based on results of field inspections, documentation, and laboratory analysis	PR
UR-02	Multi-sectoral risk assessment for various threat / risk scenarios associated with climate change	UR-02-01. Expansion of relevant working groups and persons responsible for certain types of threats / risks related to climate change	RE
		UR-02-02. Development of algorithms and action guidelines for handling various scenarios at all	RE

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
		levels	
		UR-02-03. Amendments to the legislative framework related to decentralisation and centralisation of management functions depending on the type of threat / risk	RE
		UR-02-04. Linking of information systems of key stakeholders	PR
		UR-02-05. Connection of civil, security, and defence services in interventions	RE
UR-03	Expansion of the *Croatian Platform for Disaster Risk Reduction* to include climate change-related indicators for the development of an early warning system	UR-03-01. Establishment of an integrated database on climate-change related threats / risks and strengthening the role of the Croatian Platform for Disaster Risk Reduction	PR
		UR-03-02. Development of an integrated database and training platform for key stakeholders	PR
		UR-03-03. Integration of the results of health and environmental databases and state databases: number of bush fires and forest fires, flood areas or sea level rise areas, condition of crops or of the soil characteristics etc., at the site of disasters or emergency incidents	PR

Table 6-11: Priority 4. – 4.2. Measures of high importance

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
HM-04	Strengthening the management capacities of responsible institutions to act on the occurrence of extreme hydrological conditions	HM-04-01. Development of scenarios for extreme situations (floods, droughts etc.) at different spatial and temporal scales for areas where there is an increased risk of adverse consequences of climate extremes	PR
		HM-04-02. Revision of existing management systems in critical hydrological conditions caused by climate extremes	ED
		HM-04-03. Update, modify and improve the management and coordination system of responsible institutions according to new (possible) scenarios and preparation of management responses to minimize the adverse consequences	PR
ZD-04	Implementation of health impact assessments and health assessments of risks related to climate change	ZD-04-01. Amendments to the legislative framework related to the obligation to make and draft the ordinance on the minimum content of the Health Impact Assessment Study (HIA) and the Health Risk Assessment Study (HRA); defining a list of strategic projects; defining the minimum composition of the multidisciplinary team according to the types of risk and content of the study	PR
		ZD-04-02. Creating an analytical background and definition of the minimum content of the Health Impact Assessment Study (HIA) and the Health Risk Assessment Study (HRA)	PR

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
		ZD-04-03. Education of key stakeholders on the methodology for the implementation and use of risk assessment tools and for health impact assessment studies (time spatial modelling, mandatory statistical data processing programs in public health institutes, etc.)	PR
		ZD-04-04.Research of health impact assessment and health risk assessment at local level	PR
ZD-05	Networking and upgrading of monitoring system of environmental indicators related to climate change	ZD-05-01. Linking the system of all existing GIS monitoring indicators, cross-sectoral planning, revision of monitoring plans and increasing / decreasing the number of parameters (indicators of harmful environmental factors for human health) based on the results of research and risk assessment	PR
		ZD-05-02.Definition of meteorological/climatic parameters impact indicators via environmental media	PR
		ZD-05-03. Evaluation of successful implementation of health risk assessments related to climate change	PR
ZD-06	Increasing the number of secure points in case of extreme meteorological conditions	ZD-06-01. Defining the priority points proposal by a multidisciplinary team with an optimal solution in relation to the spatial plan, microclimatic conditions and architectural microenvironment and at least one outlet for health-safe water for human consumption in urban and rural environments (points of public, mass gatherings, recreational areas and sports activities areas, construction sites, agricultural areas)	PR
		ZD-06-02. Planning and construction of secure points in case of extreme meteorological conditions (such as heat) on public areas at the local level	PR
		ZD-06-03. Establish a system and assess the conformity of monthly laboratory water quality control at discharge sites or aerosol dispensers	PR
		ZD-06-04. Establishment of a monthly laboratory for controlling water for human consumption at outlet sites or aerosol dispensers	
UR-04	Strengthening the capacities to assess dangers and responses during disasters, major accidents, extraordinary events or incidents/crisis situations related to climate change	UR-04-01. Defining events related to meteorological and climatological variations in accordance with the area/region/county definitions	PR
		UR-04-02. Defining sensitive subgroups/processes/locations due to climate change-related risks	PR
		UR-04-03. Education of stakeholders exposed to specific risk	ED
		UR-04-04. Strengthening awareness of events related to climate change in the local community	ED
UR-05	Establishment of human and technological capacities for recovery after complex risks related to climate change	UR-05-01. Appointment and training of key stakeholders in response to complex risks associated with climate change (flooding or landslides in areas of previously contaminated sites, contamination of areas affected by climate or meteorological disasters, etc.)	ED

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
		UR-05-02. Ensuring persistent standby of key stakeholders	ED
		UR-05-03. Establish a system for issuing requests, monitoring and refunding the cost of laboratory and expert analyses for the purpose of assessing a disaster, major accident, state of emergency or incident/crisis situations related to climate change	PR
UR-06	Expanding capacities and models for coverage of risk related to climate change and catastrophic damages	UR-06-01. Multidisciplinary analysis/development of proposals for the improvement of legislative regulations related to mandatory insurance models for the purpose of more efficient planning and maintenance of public and private facilities or high risk processes (such as those within the agricultural or construction sector) due to climate change	PR
		UR-06-02. Expanding the types of services and insurance models	PR
		UR-06-03. Bringing awareness to the public and promoting the use of different insurance models	PR

Table 6-12: Priority 4. – 4.3. Measures of medium importance

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
ZD-07	Strengthening the allergen species monitoring system	ZD-07-01. Amendments to legislative provisions and planting management plan for non-allergenic plants on public areas for the prevention and control of allergenic spread	PR
		ZD-07-02.Using the legally mandatory monitoring of allergenic pollen species within the network of public health institutes, development of time-spatial expansion assessment tool and the appearance of new species and the influence of allergenic pollen on external air quality indicators and indicators within the health system	PR
		ZD-07-03. Green and multidisciplinary planning of planting non-allergenic species at JLP (R)S levels	PR
		ZD-07-04. Planning of public awareness actions and capacity building in health and other sectors (municipal management, spatial planning, etc.) based on the results of monitoring and modelling the aeroalergenic movement	PR

Priority 5. Ensuring continuity of research activities

The main obstacle to successful adaptation to climate change is the lack of knowledge to plan adaptation measures in all sectors. Key support for tackling climate change vulnerability concerns the building of a knowledge base and data-monitoring and data-processing capacity, information exchange mechanisms and local and sector-specific action plans for adapting to climate change, risk prevention and management plans at national, regional and local level. The development of the necessary ICT tools (geographic information systems - GIS, detection and monitoring systems, early warning system, risk mapping and assessment) is a necessity and is crucial to their development.

Table 6-13: Priority 5 – 5.1. Measures of very high importance

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
HM-03	Strengthening research and management capacities to assess the occurrence and risk of adverse impacts of climate change and adaptation of freshwater and marine water system in current and future climatic conditions	HM-03-02. Support of research on the possible scenarios of climate change at the national and regional level (for research and management institutions), with the aim of identifying the impacts of climate change, analysing their impact on water and sea resources, and reversing and influencing these changes in the environment, urban areas, infrastructure, protected areas and human activity to a greater extent related to water (water supply, agriculture, hydropower, etc.)	IR
		HM-03-04. Development of international cooperation in the implementation of monitoring of the state of the inter-state watercourses and the Adriatic Sea with the aim of sustainable management and protection	IR
		HM-03-05. Implementation of the initial activities necessary for the realization of measures whose implementation is planned in the next phases of realization in the area of water use, protection of water and sea resources and protection from harmful effects of water	IR
P-01	Implementation of an experimental climate change adaptation programme in agriculture	P-01-01. Preparation for the implementation of a climate change adaptation research programme in agriculture	IR
		P-01-02. Implementation of the research programme on adaptation to climate change in agriculture	IR
		P-01-03. Transfer and promoting the achievements of the climate change adaptation research programme in agriculture	IR
ŠU-02	Research on species and provenance of forest trees that are more resilient to climate change	ŠU-02-01. Implementation of research of species and provenance of forest trees that are resilient to climate change	IR
RA-02	Strengthening aquaculture	RA-02-03. Implementation of research related to the use of recirculation systems for certain stages of	IR

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
	capacity through breeding in recirculation systems	farming and for breeding new species of fish in recirculating systems	
ZD-03	Establishment of a framework for the implementation of human biomonitoring for tracking environmental factors related to climate change	ZD-03-01. Selection of authorized stakeholders for human biomonitoring	IR
		ZD-03-02. Collection of epidemiological / descriptive population data and analyzing environmental factors related to climate change amongst people	IR
		ZD-03-03. Publication of research findings and creation of a national knowledge base	IR
PP-01	Strengthening of the knowledge base, as well as the monitoring and evaluation system	PP-01-01. Implementation of targeted research on the impact of sea level rise on the most vulnerable parts of the coast as a basis for the preparation of priority intervention plans	IR
		PP-01-03. Implementation of targeted research on climate change impacts related to spatial planning decisions in the function of tourism development	IR

Table 6-14: Priority 5 – 5.2. Measures of high importance

Measure's ID	Measure's name	Activity's ID and name	Act. cat.
ŠU-05	Implementation of the green infrastructure concept	ŠU-05-05. Implementation of research on the impact of trees and other green areas on the mitigation of climate change consequences in urban environments (reduction of heat island effects)	IR
ŠU-06	Prediction (forecast) of change in the distribution of harmful organisms	ŠU-06-01. Implementation of research on the distribution of harmful organisms in forests	IR

7 IMPLEMENTATION OF THE ADAPTATION STRATEGY

7.1 Financial framework for the implementation of climate change adaptation measures

In defining priorities and priority measures for adaptation to climate changes in the Republic of Croatia, the existing strategic framework of the European Union for financing climate change adaptation and prevention and risk management through the European Structural and Investment Funds (ESI Funds) was taken into account, as regulated by a series of EU regulations and defined as one of the eleven thematic priorities of the European Union for the period 2014-2020. Within the strategic framework of the EU for the period 2014-2020, for the first time, there was an obligation introduced to member states to devote 20% of the total budget within the seven year period 2014-2020 for planning and spending on investment related to climate change.

For this purpose, a number of EU regulations provide for direct access to funds within:

1. European Fund for Regional Development (EFRR) for financing of:
   - investment in social, health, research, innovation, business and education infrastructure
   - investment in equipment and small capacity infrastructure; including cultural infrastructure and sustainable tourism infrastructure, subsidy for research and innovation and investment in technology and applied research
2. Cohesion Fund (KF) for financing infrastructure investments in the environment, including areas related to sustainable development and energy
3. The European Maritime and Fisheries Fund (EFPR) and the European Agricultural Fund for Rural Development (EPFRR) to supplement investment activities in these areas by integrating adaptation of climate change into operational programs
4. The European Social Fund (ESF) to support targeted education, training and improvement of the workforce with regard to risk prevention, risk management and adaptation to climate change.

Although the themes of adaptation to climate change on the one hand and disaster risk prevention and management on the other hand are similar, it is necessary to notice their differences:

- Natural disasters can be considered as influenced by climate change but may have other causes, such as urbanization, irrational water exploitation, etc.
- Adapting to climate change is a much wider challenge than just preventing natural disasters. Moreover, reducing our society's vulnerability to the effects of global warming implies a comprehensive effort to accommodate many sub-systems such as health, electricity generation, transport infrastructure, water management, and so on.

The following table (Table 7-1) gives an overview of the financing options for priority measures and activities related to climate change adaptation and prevention and risk management from the European Fund for Regional Development (EFRR), the Cohesion Fund (KF), the European Agricultural Fund for Rural Development (EPFRR) and the European Maritime and Fisheries Fund (EFPR).

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Table 7-1: Review of EFRR, KF, EPFRR and EFPR's framework areas in the area of adaptation to climate change

European Fund for Reginal Development and Cohesion Fund (EFRR/KF)	European Agricultural Fund for Rural Development (EPFRR)	European Maritime and Fisheries Fund (EFPR)
• Development of national strategies for adaptation to climate change • Investments in increase of capacity for adaptation in urban areas • Prevention, risk and disaster management in case of droughts, floods, forest fires, heat waves, coastal erosion • Development of detection and warning tools and public awareness activities • Sector measures aimed at increasing disaster resilience • Prevention, risk management and warning systems, maintenance of healthy ecosystems and habitats, conservation of biodiversity	• Soil management and prevention of soil degradation, prevention of greenhouse gas emissions • Sustainable water management and reduction of irrigation pressures on water resources • Decrease in climate-induced damage to agriculture • Afforestation of fire-degraded areas • Prevention of fire and catastrophe management • Improved risk management related to adverse climatic conditions (high temperatures, droughts, floods and coastal erosion) and raising awareness of the risks • Increasing the capacity of ecosystem adaptation related to agriculture and forestry	• Support to fishermen to start operations, diversification and new forms of revenue • Mutual funds for climate disasters and environmental incidents • Innovation, counselling services and partnerships of fishermen and scientists • Replacement or modernization of engines - introduction of vessels with efficient fuel consumption, propulsion machinery and practices, including the use of renewable energy sources to reduce fuel consumption and emissions • Production investments in aquaculture - development of hatchery, diversification and introduction of new products • Limiting the impact of aquaculture on the environment • Encouragement to marketing and processing of fishery and aquaculture products • Integration of maritime surveillance

Apart from the above mentioned European funds, measures and activities related to education and public awareness can be financed from the European Social Fund (ESF) and research-development measures from the European Fund for Regional Development (EFRR).

7.2 Financing Climate Change Adaptation Measures in the Program Period 2014-2020

Within the program period 2014-2020, the Republic of Croatia provided funding for climate change mitigation measures under the thematic objective 5 - *Promotion of climate change adaptation, prevention and risk management* in the total amount of 245.4 million EUR (1,815.9 million kuna). Funding is provided by the OP Competitiveness and cohesion through

two priority axes. An overview of measures and activities is given in the table below (Table 7-2).

Table 7-2: Financing climate change adaptation measures within the OP Competitiveness and Cohesion 2014 - 2020

Thematic goals / Priority Axis / Amount	**Measures for adaptation to climate change**
5a / Support for investment to adapt to climate change, including ecosystem approaches (30,396,147 EUR)	• Measures to improve the quality and availability of data for climate monitoring purposes, data collection, modelling, and analysis and forecasting of climate related information, including warning system as a key precondition for appropriate planning and implementation of adaptation measures. This includes applied research related to climate change impacts and adaptation needs. • Strengthening the administrative and technical capacities of public institutions dealing with climate change (primary training of administrative officers with the aim of enhancing expertise). • Building awareness of climate change impacts at the national and local level, enabling more effective adaptation measures to be introduced. This will include communication strategies, workshops and public events, preparation and sharing of educational materials, counselling of the population, internet information portals, etc. • Integration of climate change into the planning process by preparing action plans for adapting climate changes at local levels, integrating adaptation measures into all strategic and development documents, developing plans to prevent climate changes impacts in sectors sensitive to climate change and developing methods and standards to implement adaptation measures
5b / Promoting investment related to special risks, disaster resilience and disaster management system development (215,000,000 EUR)	• **Prevention** Risk awareness programs, promotion and education programs, creating a resilient community; Preparation of a specific project in the sectors affected by the most commonly disastrous events and identified in existing national strategy documents (Risk Assessment). • **Preparedness** Measures to develop organizational systems and disaster protection capacity and management organizations, including the development and establishment of an early warning system, creating preconditions for appropriate disaster prevention, responsiveness and management measures (i.e. before ending risk assessment, raising awareness of the importance of knowing that the risks are priority). • **Response** Procurement and construction of equipment and infrastructure to reduce disaster damage, i.e. disaster response, but not limited to the communication system used for rescue services and mitigating consequences in the areas covered. • **Flood risk management measures** (by category of measures defined by the State Flood Defence Plan): Planning measures, preventive and preparatory measures and measures for natural water retention.

Although the Adaptation Strategy is largely planned to be financed through funds from the ESI Funds, it is necessary to provide funds within the State Budget for the preparation of some specific measures. Mostly it refers to regulatory and administrative activities whose implementation should be started immediately. The total cost of these measures amounts to 58.27 million kuna for the period 2019 – 2020. A detailed presentation of the activities is presented in the table below (Table 7-3).

Table 7-3: Proposed climate change adaptation measures for the period 2019-2020 financed by the State Budget

State Budget 2019 – 2020	
Climate change adaptation measures	**Total cost (in mil. kuna)**
RP-01-01/02 Development of indicators of effects of the implementation of the adaptation strategy for vulnerable sectors and society	0.95
Agriculture	
P-02-01. Development of an operation for increasing the water containment capacity of agricultural soil and inclusion in the Rural Development Program of the Republic of Croatia 2014 – 2020	0.10
P-04-01. Development of an operation for the breeding of species and sorts of agricultural crops and breeds of farm animals that are more resilient to climate change and its inclusion into the Rural Development Programme of the Republic of Croatia for the Period 2014–2020	0.10
Forestry	
ŠU-01-01. Incorporate measures of adaptation to climate change into Forestry Sector Strategy and Forest Act as well as other legal regulations concerning forests and forestry sector, including implementation indicators	0.50
Fisheries	
RA-03-01. Creating the amendments and additions to the legislative framework related to the cultivation of new (alien) fish species	0.00
RA-03-03. Market research to determine the possibility of accepting new (alien) fish species by consumers	1.00
Tourism	
T-01-01. Definition of the impact of climate change on tourism	1.50
T-01-02. Definition of guidelines for the development of Croatian tourism in accordance with adaptation to climate change	0.80
T-01-05. Continuous monitoring of the state of tourism infrastructure	2.00
Risk management	
UR-02-01. Expansion of relevant working groups and persons responsible for certain types of threats / risks related to climate change	0.50
UR-02-02. Development of algorithms and action guidelines for handling various scenarios at all levels	0.25
UR-02-03. Amendments to the legislative framework related to decentralisation and centralisation of management functions depending on the type of threat / risk	0.10
UR-02-04. Linking of information systems of key stakeholders	20,45
UR-02-05. Connection of civil, security, and defence services in interventions	30.02
TOTAL	**58.27**

Given that in 2018 the revision of programming documents for the use of the ESI funds for the period 2014-2020 is envisaged, the possibility exists providing some financial resources for priority measures and activities that fall into the "very highly important" category which would have been contracted in the period up to 2020. This primarily relates to the use of funds from the European Regional Development Fund (EFRR), the European Agricultural Fund for Rural Development (EPRR) and the European Fund for Maritime Affairs and Fisheries (EFPR), where financing of climate change adaptation measures is defined in

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thematic objectives, priority axes, investment priorities and concrete measures for the period 2014-2020.

Below (Table 7-4) is given a review of the concrete possibilities for financing priority actions and activities related to adaptation to climate change under the Operational Program Competitiveness and Cohesion (OPKK) 2014-2020, the Rural Development Program 2014-2020 and the Operational marine and fisheries program for 2014 - 2020.

Table 7-4: Proposed climate change adaptation measures for the period 2019-2020 financed by the OP Competitiveness and Cohesion 2014 – 2020

OP Competitiveness and Cohesion 2014 – 2020	
Climate change adaptation measures	**Total cost (in mil. kuna)**
Hydrology, water and sea resources management	
HM-01 Strengthening the capacity for the implementation of non-structural measures for protection against the harmful effects of water in the occurrence of extreme hydrological opportunities whose increase in intensity and frequency of occurrence is conditioned by climate change	19.50
HM-03 Strengthening research and management capacities to assess the occurrence and risk of adverse impacts of climate change and adaptation of freshwater and marine water systems	85.00
Forestry	
ŠU-04 Strengthening capacity for fire protection	93.00
Energy	
E-01 Strengthening the resilience of production facilities through the storage of electrical energy	65.50
E-02 Strengthening the capacities and ensuring of an incentivizing legal framework to increase the capacity of renewable energy and distributed sources	18.00
E-03-01. Development of preliminary analysis on the vulnerability of existing thermal power plants to the occurrence of extreme weather and climate hazards and reduced precipitation in order to define the most vulnerable power plants and create a list of priorities	4.00
E-03-03. Development of preliminary analysis of the vulnerability of existing hydro power plants related to the occurrence of extreme weather and climate hazards and the reduction of rainfall in order to define the most vulnerable hydro power plants and to create a list of priorities	6.00
E-03-05. Development of project documentation for the revitalisation of parts of settlements in urban areas connected to the central heating system (CHS) by introducing a low-temperature regime to heating pipes, increasing cost-effectiveness of the CHS	6.00
E-03-06. Revitalization of urban areas connected to the central heating system (CHS) through introducing a low-temperature regime in hot-water pipelines, thus increasing the profitability of CHS	300.00
Tourism	
T-01-03. Development of tourism infrastructure protection plans against the effects of climate change and weather extremes	2.00
Spatial planning and management of the coastal area	
PP-01-01. Implementation of targeted research on the impact of sea level rise on the most vulnerable parts of the coast as a basis for the preparation of priority intervention plans	4.00
PP-01-02. Implementing integrated multidisciplinary assessment of coastal areas vulnerability to extreme sea levels including socio-economic aspects and cost estimates and benefits of adaptation options	7.00
PP-01-04. Implementation of an assessment of vulnerability to the occurrence of thermal islands and extreme precipitation in settlements, with emphasis on connection with spatial planning solutions	4.00
Risk management	
UR-01-01/02/03 Mapping of water sources for human consumption outside the public water supply system	33.19
UR-02-05. Connection of civil, security, and defence services in interventions	120.08
TOTAL	**767.27**

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As can be seen from the table above (Table 7 4), within OPCC, the measures and activities of adaptation to climate change amount to 767.27 million kuna and are related to the following priorities of the Adaptation Strategy:

- (1) Ensuring Sustainable Regional and Urban Development
- (3) Ensuring Sustainable Energy Development
- (4) Strengthening of the management capacities through a networked monitoring and early warning system.

Special attention should be given to the priority axes *5i* and *6d* that have not been used to finance measures and activities under EFRR to date and which should be taken into account when reviewing the OPCC, as they may finance measures and activities solely linked to climate changes:

- Priority axis 5i - support for climate change adaptation investment financed from the cohesion fund
- Priority axis 6d - Protection and restoration of biodiversity and soil and promotion of "ecosystem services" through Natura 2000 and green infrastructure funded by the European Regional Development Fund.

When reviewing the top priority axes, it is necessary to consider the priority measures and activities that have entered the Action Plan.

As can be seen from the table below (Table 7 5), as part of the Rural Development Program 2014 - 2020, the cost of measures and activities of adaptation to climate change totalled 1,930 million kuna and is related to the following priorities of the Adaptation Strategy:

- Ensuring preconditions for the economic development of rural areas, coastal areas and islands
- Ensuring Sustainable Energy Development

Table 7-5: Proposed climate changes adaptation measures for the period 2019-2020 within the Rural Development Program 2014 - 2020

Rural Development Program 2014 – 2020	
Climate change adaptation measures	**Total cost (in mil. kuna)**
Agriculture	
P-02-03. Implementation of operations for increasing the water absorption capacity of agricultural soil	740.00
P-03-02. Implementation of conservation soil treatment	740.00
P-04-03. Implementation of the operation for cultivating species and varieties of agricultural crops and breeds of domestic animals that are more resilient to climate change	74.00
P-05-03. Implementation of reservoir construction for irrigation	300.00
Natural ecosystems and biodiversity	
B-01 Preservation of traditional agriculture in natural ecosystems	72.00
Energy	
E-02-03. Making a study on the possibilities of using renewable energy sources in rural areas such as agricultural micro-installations	4.00
TOTAL	**1,930.00**

It is particularly important to highlight the priority axes *5a* and *5b* that have not been used to finance the measures and activities of the EPFRR so far, and should be taken into account in

the revision of the Rural Development Program because they can finance measures and activities solely for adaptation to climate change in the agricultural sector:

- Priority axis 5a - Increasing efficiency in the use of water in agriculture
- Priority axis 5b - Increasing efficiency in energy use in agriculture and food processing.

Likewise, in the revision of the program it is necessary to activate the measure M15 related to adaptation to climate change in the forestry sector, and so far it has not been used to define the measures which could be financed within.

As can be seen from the table below (**Error! Reference source not found.**), within the perational Program for Maritime and Fisheries 2014 - 2020, the cost of measures and activities of adaptation to climate change totalled 25.25 million kuna and are linked with the priorities of the Adaptation Strategy - ensuring preconditions for the economic development of rural areas, coastal areas and islands.

Table 7-6: Proposed climate change adaptation measures for the period 2019-2020 within the Operational Program for Maritime and Fisheries 2014 - 2020

Operational Program for Maritime and Fisheries 2014 – 2020	
Climate change adaptation measures	**Total cost (in mil. kuna)**
Fisheries	
RR-01 Strengthening the sector by investing in development of new markets and expanding the range of products offered	1.00
RR-02 Strengthening capacities to assess the future state of the sector due to climate change impacts	1.50
RR-03 Strengthening the resilience of natural resources through adaptive fisheries management	7.50
RR-04 Increasing the involvement of fishermen in the tourism sector	1.00
RA-01 Strengthening aquaculture capacities by greater breeding of organisms at lower trophic levels and new forms of breeding	13.00
RA-02 Strengthening aquaculture capacity through breeding in recirculation systems	1.00
RA-03 Strengthening aquaculture capacity by breeding new species of fish	0.25
TOTAL	**25.25**

The total amount of funds that will be covered by the European Structural and Investment Funds (ESI Funds) for the implementation of the priority measures and activities within the program period 2014-2020 shall be 2,501.25 million kuna. Together with funds from the state budget (5.46 million kuna) secured for initial preparation of measures and activities it is in total 2,506.71 million kuna, of which state budget funds the amount of 0,22% of total cost.

Table 7-7: Estimate of the amount of the proposed adaptation measures that would be covered by the revision of the operational programs for the period 2014-2020

Revision of operational programs in the period 2014 – 2020	
Operational programs in the period 2014 – 2020	**Total cost (in mil. kuna)**
Operational Program Competitiveness and Cohesion 2014 – 2020	546.00
Rural Development Program 2014 – 2020	1,930.00
Operational Program for Maritime and Fisheries 2014 – 2020	25.25
TOTAL	**2,501.25**
State budget	**5.46**
GRAND TOTAL	**2,506.71**

The total cost of implementation of the first Action Plan, which includes the measures identified above, amounts to 5,843.16 million kuna, of which the share of the state budget is

1.07%, or 62.27 million kuna. Therefore, with the revision of program documents, for the period 2014-2020, it would provide funding for almost 48% of priority measures and adaptation activities by 2020, while the rest of the measures would have entered the programming procedure for the next programming period 2021-2027.

7.3 Financing Climate Change Adaptation Measures in the period up to 2040

The implementation of climate change mitigation measures and activities will be long-term funded from a variety of sources - public and private -. The financial mechanisms for adaptation to climate change will be established by using national and supranational (European) funds from three sources:

- State budget
- European Structural and Investment Funds (ESI Funds)
- Private sector (including public-private partnership - PPP).

The state budget includes funds collected via the tax system, as well as the funds collected from the auction of emission units managed and disposed by the Environmental Protection and Energy Efficiency Fund (FZOEU). State Budget funds will not be used for larger infrastructure projects, but primarily for measures and activities related to public awareness, capacity building, project documentation preparation, pilot projects, etc.

ESI funds will be the main source of funding for infrastructure measures and activities for which funds will be planned and allocated on the basis of action plans for adaptation to climate change.

Private sector investments in climate change adaptation measures and activities require coordination of the public and private sectors primarily for identifying those measures whereby the private sector will find an interest in investing in climate change adaptation projects that benefit the wider society in the communities in which this sector is operable, and at the same time reduce risk and increase business resilience.

The total amount of investment needed to implement the Adaptation Strategy at this point can be estimated at around 27 billion kuna, or just over 3.6 billion euros (Table 7-8). The greatest part of this amount will be provided from the EU funds, while state budget funds will amount for only 0.23% of the total investment amount and will be used for implementation of regulatory and administrative measures (RE). More than half of the estimated amount refers to implementation of "structural" measures, particularly in the sectors of agriculture and forestry and to a lesser extent of energy and tourism. Investments in the first two sectors can be treated as "no regret measures", i.e. measures that are already planned to be implemented, and their effects will be positive also for adapting to climate change. The average annual cost of implementing the Adaptation Strategy will amount to around 520 million kuna, or around 70 million euros (through a period of 52 years), counting also significant capital investments. This may seem like a large sum, but it should be compared to the average annual damage (in the period from 1980 to 2015) in the Republic of Croatia, and that only as a result of extreme weather and climate events (around 80 million EUR per year). Assuming that these measures will contribute to positive economic impacts, it can be concluded that the benefits of implementing the Adaptation Strategy, despite high costs, will be significant.

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Table 7-8: Overview of the amount and sources of funding for adaptations to climate change by sectors (in million kuna) for the entire implementation period of the Adaptation Strategy

Sector	State budget	European Regional Development Fund	European Fund for Maritime Affairs and Fisheries	European Agricultural Fund for Rural Development	European Social Fund	TOTAL (mil. kuna)
Supra-sectoral measures	0.95	0.00	0.00	0.00	7.50	**8.45**
Hydrology, water and sea resources management	0.00	5,443.00	0.00	0.00	6.00	**5,449.00**
Agriculture	0.20	9.10	0.00	12,569.15	10.00	**12,588.45**
Forestry	0.50	132.50	0.00	5,107.90	0.00	**5,240.90**
Fisheries	1.00	0.50	45.25	0.00	2.50	**49.25**
Biodiversity	0.00	169.50	0.00	72.00	10,00	**251.50**
Energy	0.00	1,876.50	0.00	4.00	0.00	**1,880.50**
Tourism	4.30	670.80	0.00	0.00	13,00	**688.10**
Health / health system	1.00	335.78	0.00	0.00	1.00	**337.78**
Spatial planning and management of the coastal area	4.00	56.00	0.00	0.00	4.50	**64.50**
Risk management	51.32	217.46	0.00	0.00	105.00	373.78
TOTAL	63.27	8,911.44	45.25	17,753.05	159.50	**26,932.21**
TOTAL in %	**0.23%**	**33.09%**	**0.17%**	**65.92%**	**0.59%**	**(~ 3,6 billion EUR)**

Funding priorities of the Adaptation Strategy will be mainly focused on the first two priorities: Ensuring sustainable regional and urban development and Ensuring preconditions for the economic development of rural areas, coastal areas and islands. It should be emphasized that most of the "structural" measures will be implemented within these two priorities. Another important emphasis should be placed on the fact that the implementation of the Adaptation Strategy by funding these two priorities puts it in function of achieving sustainable development. Overview of Funding Priorities of the Adaptation Strategy is given in Table 7-9.

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Table 7-9: Overview of the amount and sources of funding for climate change adaptation measures according to the Adaptation Strategy's priorities (in million kuna)

Adaptaiton Strategy priorities	Sector	State budget	European Regional Development Fund	European Fund for Maritime Affairs and Fisheries	European Agricultural Fund for Rural Development	European Social Fund
1. Ensuring sustainable regional and urban development	8.80	5,477.80	0.00	5,000.00	29.50	10,516.10
2. Ensuring preconditions for the economic development of rural areas, coastal areas and islands	1.20	761.00	45.25	12,743.05	12,50	14,233.00
3. Ensuring sustainable energy development	0.00	1,876.50	0.00	4.00	0.00	1,880.50
4. Strengthening of the management capacities through a networked monitoring and early warning system	53.27	636.24	0.00	0.00	117.50	807.01
5. Ensuring continuity of research activities	0.00	159.60	0.00	6.00	0.00	165.60
TOTAL	**63.27**	**8,911.14**	**45.25**	**17,753.05**	**159.50**	**26,932.21**

7.4 Creating of action plans for the implementation of the adaptation strategy

The Adaptation Strategy will be implemented through action plans, which will include the elaboration of concrete measures for a specific five-year period. Action plans are adopted by the Government of the Republic of Croatia. Action plans will give each measure a description, a method of implementation, a sequence of realization of measures, the deadline for execution, the obligated parties and the measures implementation coordinators. Along with developing this strategy, the first Action Plan, which contains a detailed presentation of measures and activities for the first five year period has been prepared.

7.5 The need to strengthen the capacity to implement the Adaptation Strategy

The capacity-building needs assessment study provided guidance on strengthening the capacity of experts and the capacity of institutions to adapt to climate change. Analysis of the need for capacity strengthening points to:

- The need for the development of an integrated climate change consequences management system for the purpose of further development of cross-sectoral cooperation at a strategic level (currently it is mostly performed at an operational and project level). Such an integral system implies the existence of a single central body that takes care of all the components of the management system.
- Public sector stakeholders that are part of the national administrative-regulatory-regulatory- management group related to the environment and nature in the wider sense, i.e. the sectors covered by the Adaptation Strategy, are better teamed for adaptation from other public sector stakeholders (e.g. JLP(R)S, but with the exceptions) and the larger part of the private sector, except for those whose business is related to renewable energy sources. Consequently, the implementation of the Adaptation Strategy at the regional and local level is extremely important.

- There is a lower level of private sector representation among stakeholders, especially where this might have been expected to a larger extent, *e.g.* in the tourism sector, but also in the financial and economic sector. For the insurance companies sector, no progress has been made in addressing the challenges of climate change, although that sector they may pose a hazard but also a business opportunity.
- For the tourism sector, it should be emphasized that climate change over a longer period and in the absence of a proper sectoral adaptation strategy could put into question the survival of the current models of tourism development in this area.
- There are a large number of topics per sector that may be the subject of capacity building, which also speaks of the great existing shortages in knowledge about this issue, but also of the great interest that governs this issue.
- The Adaptation Strategy has a national character, but most adaptation measures are local or regional. Lack of awareness and knowledge on the topic of adaptation to climate change, with a few exceptions, has been observed in all JLP(R)Ss. In this regard, the strengthening of JLP(R)S's professional and implementation capacities is of crucial importance for the successful implementation of measures from action plans.
- Although in some components of the public sector (mainly ministries, agencies, state administrations and others directly related to vulnerable sectors covered by the Adaptation Strategy) awareness of the subject of adaptation is somewhat satisfactory, it is proposed to further strengthen the capacity in terms of:
    - providing more material and financial resources for the implementation of future planned adaptation measures
    - employing more professionals who can deal with such topics. Although the lack of a sufficient number of relevant experts is already present, this will be even more pronounced when implementing the action plans that are being adopted for the implementation of the Adaptation Strategy.
    - further education of experts within the public sector on climate change and adaptation to climate change within their sphere of activity, especially those of the public sector that are directly involved in the implementation of action plans.
- It is necessary to strengthen the education of experts working outside the public sector on climate change and adaptation to climate change, particularly in parts of the economy whose business is directly related to climate or natural features.
- It is necessary to work on further targeted education of experts within non-governmental organizations and civil society to work on further education of wider groups of citizens.
- It is necessary to provide more material and financial resources to all the components of the company for the implementation of already available programs and adaptation topics or closely related themes, especially those for which funds are already secured in EU funds.
- The following general topics that require further attention have been recognized:
    - the issues of adaptation to climate change in the strategic planning and development of institutions and public policy
    - strengthening technical-technological knowledge on individual aspects of adaptation
    - strengthening the financing mechanism for adaptation by the public sector
    - strengthening program implementation and adaptation plans
    - strengthening the financing mechanism for adaptation by the private sector.

7.6 Institutional framework for the implementation of the Adaptation Strategy

The Adaptation Strategy refers to the period up to 2040 with a view to 2070. It is an extremely long time horizon (more than fifty years in the future), which is very unusual even for strategic planning. But, on the other hand, the thematic framework of the Adaptation Strategy is such that it is a process whose full manifestation can only be seen in the long run. For this reason, adaptation to climate change is not a "one-time" project, but a long-term planning process that the present and future generations will have to implement. The long-term perspective will require frequent adaptations and additions to the solutions that will be proposed in this Adaptation Strategy. Furthermore, adaptations and amendments, or effective revisions to the Adaptation Strategy in the future, will only be possible if an equally effective system of continuous monitoring of its implementation is established. Finally, the effective implementation of the Adaptation Strategy will require constant updating of knowledge on all thematic aspects of adaptation to climate change.

An essential component of the Adaptation Strategy's implementation is the gradual nature of its implementation. Given that the Adaptation Strategy has a long life span, it is impossible to fully detail all the elements of its implementation by the end of its term. The strategy will be implemented, as envisaged by the Air Protection Act, with action plans of a standard duration of five years. In the practice of strategic planning, such duration of action plans is considered standard in a situation when it is desirable to define in detail all the elements of implementation in that period. Bearing this in mind, the first Action Plan contains a reduced set of measures, but each of these measures has been much more elaborate than is the case with the measures in the Adaptation Strategy. Along with a description of each measure and activity, the Action Plan will indicate the implementation bodies and co-carriers and will contain implementation indicators. And finally, it should be said that for now it’s very difficult to accurately determine the time intervals in which the Adaptation Strategy will be evaluated and possibly revised. It is only possible to determine the first interval after which this will be done, which will be after the first Action Plan has expired. Revision Adaptations Strategy will depend on the information that will be generated by the implementation monitoring system, as well as the climate change monitoring system in general.

The basic principle for defining the institutional framework for the implementation of the Adaptation Strategy is that it does not foresee the establishment of new institutions and bodies and that the existing jurisdictions within the governmental organization will be fully respected. This does not mean that changes in institutional frameworks will not be proposed in the future if the circumstances surrounding climate change and adaptation have changed.

The state authority responsible for coordinating climate change policy is the Ministry responsible for environmental protection, which includes development of strategic and planning documents and carrying out the work of a national contact authority for reporting to EU bodies and other international bodies on climate change adaptation policy.

The role in the Adaptation Strategy should also be extended to two organizational units under the responsibility of the MZOE (Croatian Environment and Nature Agency - HAOP and the Environmental Protection and Energy Efficiency Fund - FZOEU) and the Meteorological and Hydrological Service (DHMZ).

Inter alia HAOP collects, verifies and aggregates data and information on the protection of the ozone layer, greenhouse gas emissions, as well as other environmental and climatic data in accordance with the regulations and the National list of indicators. Currently, most of HAOP's activities in the field of climate change are related to greenhouse gas issues and data collection and monitoring of climate change impacts on species and habitats, *i.e.* biodiversity, ecosystem services, etc. HAOP will need to expand its activities in monitoring the implementation of climate change adaptation, primarily by creating a database that will be based on the indicators proposed for monitoring the individual measures and activities of the Adaptation Strategy i.e. in the Action Plan.

FZOEU carries out activities to finance projects, programs and similar activities in the field of conservation, sustainable use, protection and improvement of the environment and in the field of energy efficiency and the use of renewable energy sources. Although the focus of the FZOEU's climate change mitigation activities is to finance climate change mitigation, it is recommended that the scope of activities of the FZOEU be extended to include measures and activities related to climate change adaptation.

In addition to the above mentioned, the DHMZ, which is the state administration body will have an important role in the implementation of the Adaptation Strategy. The DHMZ manages the meteorological and hydrological infrastructure, the air quality monitoring infrastructure and the national archive of meteorological, hydrologic and related data. Among the tasks of the DHMZ is to monitor climate and climate change and climatological research. Its role in the implementation of the Adaptation Strategy will be primarily in climatic modelling and monitoring of climatic indicators.

Since climate change concerns an area of inter-sectoral nature, it is necessary to ensure the appropriate cross-sectoral coordination. In this regard, it is proposed that the existing Inter-Sector co-ordination commission for policy and mitigation and adaptation measures for climate change (hereinafter: the Commission) which is appointed by the Government of the Republic of Croatia on the basis of the Air Protection Act take the leading role in the implementation of this coordinating function and the monitoring of the implementation of the Adaptation Strategy and Action Plan.

In addition, more active involvement of sectoral/resource ministries is expected in the implementation of the Adaptation Strategy, and their work will be coordinated by the Commission.

Other than at the national level, adaptations to climate change should be equally seriously addressed at regional (county) and local levels, primarily because in many respects adaptation to climate change is a matter of local importance and stakeholders at these levels are considered key factors for the success of adaptation. Given the definition of the scope of work of local and regional self-government units - JLP(R)Ss, it can be said that they are already carrying out a number of activities that have, to a lesser or greater extent, contact points with climate change adaptation activities: settlements and housing, communal economy, spatial and urban planning, protection and improvement of the natural environment, fire and civil protection. For the most efficient operation of JLP(R)Ss in adaptation to climate change, it is necessary to significantly strengthen their capacities, both strategically (development of regional development plans and spatial plans that will include

the component of climate change adaptation), as well as technical training by experts in specific areas of adaptation to climate change.

7.7 Monitoring of the Adaptation Strategy Implementation

Effective implementation of the Adaptation Strategy must be supported by an appropriate monitoring system for the implementation of measures and activities and the monitoring of the impact of these measures and activities in reducing the damage caused by climate change.

The indicator system for monitoring the implementation of measures and activities of the Adaptation Strategy and the indicator system to monitor the impact of these measures arise from the set of measures that will ultimately be accepted for the Adaptation Strategy as a whole, and in particular for the measures to be implemented in the first Action Plan. Monitoring information will provide a basis for making periodic evaluations of the implementation of the Adaptation Strategy. When defining individual adaptation indicators, there will be a need to take into account the following:

- Check whether some of the indicators for other similar processes are being used, or see if some of the existing indicators can be used for monitoring of adaptations to the climate change
- Analyse whether some of the effects of adaptation are the consequences of some other processes, not just implementing the measures envisioned by the Adaptation Strategy
- Develop a combination of process indicators (indicators indicating that only a certain measure has been taken and the expected results of each of its activities are achieved) and performance indicators - adaptation indicators that point to a real change in a system as a result of applying a specific measure of the Adaptation Strategy
- Check whether the data needed to control the performance of the indicator is collected in a relatively simple and inexpensive way. This requirement is much easier to implement in case of process indicators.

Indicators of monitoring the implementation of measures and activities of the Adaptation Strategy should provide answers, *inter alia*, to the following issues:

- Are the measures and activities being implemented?
- Are there any improvements possible to the climate change adaptation measures and activities?
- Which of the measures not achieving the expected effects?

These indicators are to be monitored through the implementation of measures and activities – with indicators specific to each measure and activity. These indicators can be seen within the proposed measures and activities in the accompanying Action Plan.

Indicators of effectiveness of the implemented measures (impact of the Adaptation Strategy) should show whether the measures taken have contributed to reducing the vulnerability and increasing the resilience of social and natural systems to the consequences of climate change. These indicators relate to the parameters of a particular sector that point to the effects of climate change on the state of socioeconomic and physical systems. These indicators allow decision-makers (the Government of the Republic of Croatia, Parliament) and organizations involved in the climate change adaptation process to assess the

effectiveness of their programs. At the same time, these indicators ensure the realization of the goals of this strategy, in particular its primary goal – the reduction of vulnerability of social and natural systems to climate change and the reduction of damages. From the financial perspective, valuation of the adaptation program can help justify the finances spent on adjusting measures and achieving maximum value for money.

Possible indicators for monitoring the impact of the measures in the Adaptation Strategy are as follows (some of the indicators are already monitored or partially monitored, but most of them are not systematically monitored and for most indicators a development is needed to determine the methodology for monitoring and measuring the data required for the calculation of indicators):

- Hydrology, water and sea resources management
    - the number of inhabitants in the area declared for which the state of the elemental disaster of extreme droughts has been declared
    - the number of areas designated for flood protection as precautionary measures
    - the number of developed and tested tools
    - the number of experts who passed the adaptation courses
    - the number of inhabitants in the area declared for which the state of the elemental disaster of floods has been declared
    - the number of areas with declining drinking water quality
    - the percentage of areas of particularly valuable aquatic ecosystems that are endangered by the effects of climate change
    - total length of wastewater and rainwater network threatened by climatic risks in the coastal area
    - mean water levels and flow rates at state network stations
    - extreme water levels and flows at state network stations
    - mean sea level
    - extreme sea levels
- Agriculture
    - increase of agricultural production due to irrigation
    - percentage of cultivated land sown with cultures and varieties resistant to climate change
    - mass (in thousands of tons) of eroded agricultural soil
    - capacity of newly built accumulations
    - area of agricultural land with functional drainage system
    - quantity (in thousands of tons) of cubic meters of irrigation water saved through improved methods of agricultural production
- Forestry
    - number of forest fires
    - burnt areas of forests
    - the length and density of fire-fighting roads
    - annual loss of wood mass caused by extreme meteorological events (*e.g.* icebergs, wind)
    - the number of species investigated and the provenance of forest trees that are more adaptive to climate change and are of economic importance
    - the forest area and/or the number of trees affected by forest pests occurring as a result of climate change

  - the number of areas where a comprehensive monitoring of the state of the forest ecosystems is carried out
  - the number of cities in which green infrastructure is established
  - the number of private forest owners and other forestry stakeholders who are familiar with climate change issues in forestry and adaptation measures

- Fisheries
  - number of areas with declining seawater quality
  - increase in seawater acidity
  - distribution of invasive species
  - loss of habitat due to sea temperature rise
  - reduced annual catch as a result of temperature changes
  - percentage of coastal and marine areas under protection

- Biodiversity
  - list, share and categorization of protected habitats endangered by the effects of climate change
  - list, share and categorization of protected species threatened by climate change
  - share of the total biodiversity of the Republic of Croatia endangered by climate change
  - list and share of protected areas under constant climate monitoring
  - assessment of the negative impact of climate change on protected habitats and species
  - a list of invasive species whose spreading is potentiated by climate change with the ranges and populations
  - the share of protected areas with mitigation measures and adaptation to climate change

- Energy
  - the number of time events that caused power outages
  - GDP losses arise as a result of the reduced amount of water for the production of electricity
  - the percentage of new energy facilities that incorporate climate change adaptation measures
  - the number of water saving measures used in the production of electricity
  - the number of new energy facilities located in risky areas

- Tourism
  - the GDP losses generated by tourism as a result of extreme weather and climate events
  - percentage of coastal and maritime protected areas (monitored by HAOP)
  - amount of water and energy consumed in tourist facilities per one overnight stay
  - surfaces protected as particularly valuable landscapes (areas) that are degraded by climate change
  - number of areas with declining drinking water quality (monitored by county public health institutes)
  - number of areas with declining seawater quality (monitored by HAOP)

- Health
  - the number of experts who have passed the adaptation training

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  - the number of households in the area for which the state of elemental disaster has been declared by extreme droughts
  - the number of inhabitants in the area for which the state of elemental disaster has been declared by floods
  - the number of people with a high risk of health consequences due to hot weather and extreme weather events
  - number of hospital beds in risky zones
  - the number of households with poor financial standing in risky areas
  - indicators of the prevalence and mortality of chronic non-infectious diseases
  - indicators of abnormality and mortality from acute infectious diseases
  - number of inter-sectoral indicators (monitoring indicators in the environment compatible with monitoring in the health-ecological / health system)
  - the share of non-conforming results of water analysis for human consumption
  - percentage of purified sewage
  - the share of households connected to the public wastewater collection system

- Spatial Planning and Management of Coastal Areas
  - number of JLP(R)Ss within the coastal area for which vulnerability assessments and adaptation measures have been implemented in spatial plans by SPUOs
  - the number/proportion of spatial plans for which adaptation measures contained and prescribed in spatial plans are implemented or applied
  - increase of green infrastructure in settlements estimated as vulnerable to extreme weather conditions (heat islands, extreme precipitation)
  - length of the coast (proportion of coastline estimated as vulnerable to floods), where the planned flood protection measures have been implemented
  - trend of annual damage from extreme weather events for which the Adaptation Strategy has planned adaptation measures (floods and floods in settlements)
  - the number of people living in risky areas
  - the number of flood-affected properties
  - percentage of households living in areas with a reduced risk of extreme weather and climate events
  - the number of new infrastructure facilities located in risky areas
  - the percentage of areas of particularly valuable ecosystems that are endangered by the effects of climate change
  - coastal areas covered by coastal and marine environment management plans
  - percentage of coastal and marine areas under protection

- Risk management
  - number of experts who have undergone training (training, courses) on adaptation, *i.e.* risk management and recovery
  - the number of cross-sectoral extended guidelines for action
  - the area of the area with mapped sources of water outside the public water supply system
  - number of studies on health impact and health risk assessment
  - number of newly developed risk reporting systems related to climate change developed at regional and local level
  - the share of real estate, legal entities and other entities subject to premium insurance against climate change related events

In addition to the above mentioned indicators, a set of **climatic indicators** will be used to monitor the implementation effects of the Adaptation Strategy and the Action Plan. Climate indicators are geared towards monitoring the climate and are essential for evaluating impacts and vulnerabilities in the observed sectors and thematic areas.

Possible indicators for monitoring the climatic parameters in the implementation of the Adaptation Strategy are as follows:

- Mean air temperature trend
- Mean maximum air temperature trend
- Mean minimum air temperature trend
- Warm temperature extremes index trend
- Cold temperature extremes index trend
- Precipitation trend
- Trend of dry indices of precipitation extremes
- Trend of wet indices of precipitation extremes
- Standardized Precipitation Index (SPI)
- Evaluation of anomalies of air temperature and precipitation quantities by percentile
- Assessment of aridity.

These climate indicators are included in the National List of Indicators (NLPs) prepared by the Croatian Environmental and Nature Agency (HAOP), and the legal basis for the development of indicators is defined by the Environmental Protection Act (Official Gazette 80/13, 78/15) and the Regulation on the environmental information system (Official Gazette 68/08).

In addition to the above mentioned climatic indicators, it is recommended that additional climatic indicators be developed which are relevant to the assessment of impacts and vulnerabilities in several vulnerable sectors:

- Mean wind speed trend
- Mean maximum wind speed trend
- Evapotranspiration
- Solar irradiance (inflow solar energy flux).

7.8 Reporting

Reporting on the implementation of the Adaptation Strategy will follow formats and deadlines for reporting under EU legislation in this area. Wherever possible, reporting procedures need to be harmonized and rely on the existing system with the necessary further development of the MZOE and HAOP capacities for monitoring and reporting on the implementation of the Adaptation Strategy.

The MZOE will report on the implementation of the Adaptation Strategy, with other relevant ministries, JLP(R)Ss and other bodies involved in the implementation of their tasks. Reports will include a review of the implementation of measures and actions and their impact, identify obstacles and serve as a basis for creating new action plans.

The co-ordination commission will monitor the implementation of the Adaptation Strategy and Action Plan(s) at sessions, review reports and propose measures to remove obstacles and improve implementation.