CLIMATE RISK COUNTRY PROFILE

CROATIA

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This profile is part of a series of Climate Risk Country Profiles developed by the World Bank Group (WBG). The country profile synthesizes most relevant data and information on climate change, disaster risk reduction, and adaptation actions and policies at the country level. The country profile series are designed as a quick reference source for development practitioners to better integrate climate resilience in development planning and policy making. This effort is managed and led by Veronique Morin (Senior Climate Change Specialist, WBG) and Ana E. Bucher (Senior Climate Change Specialist, WBG).

This profile was written by MacKenzie Dove (Senior Climate Change Consultant, WBG). Additional support was provided by Jason Johnston (Operations Analyst, WBG) and Yunziyi Lang (Climate Change Analyst, WBG).

Climate and climate-related information is largely drawn from the Climate Change Knowledge Portal (CCKP), a WBG online platform with available global climate data and analysis based on the latest Intergovernmental Panel on Climate Change (IPCC) reports and datasets. The team is grateful for all comments and suggestions received from the sector, regional, and country development specialists, as well as climate research scientists and institutions for their advice and guidance on use of climate related datasets.

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FOREWORD

Climate change is a major risk to good development outcomes, and the World Bank Group is committed to playing an important role in helping countries integrate climate action into their core development agendas. The World Bank Group is committed to supporting client countries to invest in and build a low-carbon, climate-resilient future, helping them to be better prepared to adapt to current and future climate impacts.

The World Bank Group is investing in incorporating and systematically managing climate risks in development operations through its individual corporate commitments.

A key aspect of the World Bank Group's Action Plan on Adaptation and Resilience (2019) is to help countries shift from addressing adaptation as an incremental cost and isolated investment to systematically incorporating climate risks and opportunities at every phase of policy planning, investment design, implementation and evaluation of development outcomes. For all IDA and IBRD operations, climate and disaster risk screening is one of the mandatory corporate climate commitments. This is supported by the Bank Group's Climate and Disaster Risk Screening Tool which enables all Bank staff to assess short- and long-term climate and disaster risks in operations and national or sectoral planning processes. This screening tool draws up-to-date and relevant information from the World Bank's Climate Change Knowledge Portal, a comprehensive online 'one-stop shop' for global, regional, and country data related to climate change and development.

Recognizing the value of consistent, easy-to-use technical resources for client countries as well as to support respective internal climate risk assessment and adaptation planning processes, the World Bank Group's Climate Change Group has developed this content. Standardizing and pooling expertise facilitates the World Bank Group in conducting initial assessments of climate risks and opportunities across sectors within a country, within institutional portfolios across regions, and acts as a global resource for development practitioners.

For developing countries, the climate risk profiles are intended to serve as public goods to facilitate upstream country diagnostics, policy dialogue, and strategic planning by providing comprehensive overviews of trends and projected changes in key climate parameters, sector-specific implications, relevant policies and programs, adaptation priorities and opportunities for further actions.

It is my hope that these efforts will spur deepening of long-term risk management in developing countries and our engagement in supporting climate change adaptation planning at operational levels.

Bernice Van Bronkhorst
Global Director
Climate Change Group (CCG)
The World Bank Group (WBG)

COUNTRY OVERVIEW

The Republic of Croatia belongs to the Adriatic-Mediterranean and Pannonia-Danube group of countries in Central Europe. The total area of Croatia is 87,661 kilometers square (km^2), with a land area of 56,594 km^2; territorial sea and internal sea waters account for 31,067 km^2. Croatia's seacoast extends 6,278 km (29.9% of inland, 70.1% of islands). The state sea border is 948 km long and extends to an outer boundary of territorial sea. The Croatian Parliament has declared an Exclusive Economic Zone (EEZ) in the Adriatic Sea on February 5, 2021. This EEZ is 23,870 km^2 and reaches an epicontinental border between the Republic of Croatian and Italy.[1] Croatia shares land borders with Slovenia, Hungary, Bosnia and Herzegovina, and Serbia.

The country has a population of nearly 4.1 million people (2019), with an annual growth rate of –0.5% (2019) **(Table 1)**. The country's Gross Domestic Product (GDP) was $60.4 billion in 2019, experiencing annual growth of 2.9%.[2] Croatia's population is projected to reach 3.8 million and 3.3 million people in 2030 and 2050, respectively. The urban population is expected to grow from 61.5% in 2030 to 71.3% in 2050.[3] The Croatian economy is dominated by the services sector (which includes, retail trade, transport, and government, financial, professional, and personal services such as education, health care, and real estate services), which accounts for 59% of GDP. Industry (including mining, manufacturing, construction, electricity, water, and gas) accounts for 26.3% of GDP and the agricultural sector, accounts for 3% of the country's GDP.[4]

TABLE 1. Data snapshot: Key development indicators[5]

Indicator	
Life Expectancy at Birth, Total (Years) (2019)	78.4
Population Density (People per sq. km Land Area) (2018)	73.0
% of Population with Access to Electricity (2018)	100%
GDP per Capita (Current US$) (2019)	$14,944.40

The ND-GAIN Index[6] ranks 181 countries using a score which calculates a country's vulnerability to climate change and other global challenges as well as their readiness to improve resilience. This Index aims to help businesses and the public sector better identify vulnerability and readiness in order to better prioritize investment for more efficient responses to global challenges. Due to a combination of political, geographic, and social factors, Croatia is

1 Ministry of Environment and Nature Protection (2018). Seventh National Communication (NC6) and Third Biennial Report of The Republic of Croatia Under The United Nations Framework Convention On Climate Change URL: https://unfccc.int/sites/default/files/resource/2671905483_Croatia-NC7-BR3-2-96481035_Croatia-NC7-BR3-2-7.%20NC%20i%203.%20BR_resubmission_IX_2018_0.pdf

2 World Bank Open Data (2021). Data Retrieved May 2021. Data Bank: World Development Indicators. URL: https://databank.worldbank.org/source/world-development-indicators

3 World Bank Open Data (2020). Data Retrieved May 2021. Data Bank: Population Estimates and Projections. URL: https://databank.worldbank.org/data/reports.aspx?source=health-nutrition-and-population-statistics:-population-estimates-and-projections

4 World Bank Data Bank (2021). Development Indicators: Croatia. URL: http://databank.worldbank.org/data/reports.aspx?source=2&country=UZB

5 World Bank (2021). DataBank – World Development Indicators. URL: https://databank.worldbank.org/source/world-development-indicators

6 University of Notre Dame (2020). Notre Dame Global Adaptation Initiative. URL: https://gain.nd.edu/our-work/country-index/

recognized as vulnerable to climate change impacts, ranked 51 out of 181 countries in the 2020 ND-GAIN Index. The more vulnerable a country is the lower their score, while the more ready a country is to improve its resilience the higher it will be. Norway has the highest score and is ranked 1st.

Croatia submitted its Seventh National Communication (NC7) and Third Biennial Report of The Republic of Croatia Under the UNFCCC in 2018. Croatia participated in the Updated Nationally Determined Contributions (NDC) submitted to the UNFCCC as an EU Member State in 2020.[7] The country's adaptation priorities include availability and accessibility of water for drinking and irrigation uses, coast and coastal zones, forestry and land use change, agriculture, biodiversity, and human health.[8]

Green, Inclusive and Resilient Recovery

The coronavirus disease (COVID-19) pandemic has led to unprecedented adverse social and economic impacts. Further, the pandemic has demonstrated the compounding impacts of adding yet another shock on top of the multiple challenges that vulnerable populations already face in day-to-day life, with the potential to create devastating health, social, economic and environmental crises that can leave a deep, long-lasting mark. However, as governments take urgent action and lay the foundations for their financial, economic, and social recovery, they have a unique opportunity to create economies that are more sustainable, inclusive and resilient. Short and long-term recovery efforts should prioritize investments that boost jobs and economic activity; have positive impacts on human, social and natural capital; protect biodiversity and ecosystems services; boost resilience; and advance the decarbonization of economies.

CLIMATOLOGY

Climate Baseline

Overview

The majority of Croatia experiences a moderately warm and rainy climate. Mean temperature in the lowland area of northern Croatia is 10°C–12°C, the mountain regions experience mean temperatures of 3°C–4°C, with coastal areas experiencing temperatures of 12–17°C. Most of the precipitation is recorded on the coastal slopes and peaks of the Dinarides from Gorski Kotar in the northwest to the southern Velebit in the southeast. Croatia is defined by three major geomorphological zones: the Pannonian basin, the mountain system of the Dinarides, and

[7] EU (2020). Updated Nationally Determined Contribution of the EU and its Member States. URL: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Croatia%20First/EU_NDC_Submission_December%202020.pdf

[8] Ministry of Environment and Nature Protection (2018). Seventh National Communication (NC6) and Third Biennial Report of The Republic of Croatia Under The United Nations Framework Convention On Climate Change URL: https://unfccc.int/sites/default/files/resource/2671905483_Croatia-NC7-BR3-2-96481035_Croatia-NC7-BR3-2-7.%20NC%20i%203.%20BR_resubmission_IX_2018_0.pdf

Adriatic basin. The Lowland areas, up to 200 m, represent 53% of area of the country, hills and sub-mountains from 200 up to 500 m represent 26%, and mountain areas above 500 m, equate to 21% of the country. As of 2011, 23% of land area was used by for agriculture and forests covered 39% of land area.[9]

Croatia is a climatically complex area and has experienced a large variability in precipitation trends across the country, over the last decades. Particularly, the mountainous region and the coastal zones are mostly affected by drying tendencies in precipitation, especially during the summer season (May to October), while the mainland is subjected to wetter precipitation conditions. The reduction in annual amounts of precipitation in the area north of the Sava River results from decline in spring and autumn precipitation. In the mountains and on the Dalmatian islands the fall season brings decline in winter and spring precipitation. On the northern Adriatic, the reduction in precipitation amount is evident in all seasons.[10] In the northeastern Mediterranean Region (or Adriatic-Ionian region, which encompasses Croatia), heat wave events have become more frequent, longer lasting, and more severe.[11] The country experiences a largely Mediterranean climate with hot, dry and sunny weather during the summer and relatively mild, yet rainy weather during the winter in the coastal area. In the mainland, a typical continental climate can be experienced with four distinguished seasons; warm summers and cold winters and more precipitation in spring and late autumn/early winter. However, due to climate change, usual climate patterns are changing towards more unpredictable seasons.

Analysis of data from the World Bank Group's Climate Change Knowledge Portal (CCKP) (**Table 2**) shows historical information for 1901–2020. Mean annual mean temperature for Croatia is 10.5°C, with average monthly temperatures ranging between 21°C (July, August) and 0°C (December and January). Mean annual precipitation is 1,082.7 mm. Precipitation levels increase from October to December. The largest rainfall occurs in November (117mm)[12]; shown in Croatia's latest climatology, 1991–2020, in **Figure 1**. **Figure 2** presents the spatial variation of observed average annual precipitation and temperature for 1991–2020.

TABLE 2. Data snapshot: Summary statistics

Climate Variables	1901–2020
Mean Annual Temperature (°C)	**+10.6°C**
Mean Annual Precipitation (mm)	**+1,082.7 mm**
Mean Maximum Annual Temperature (°C)	**15.4°C**
Mean Minimum Annual Temperature (°C)	**5.7°C**

[9] Ministry of Environment and Nature Protection (2018). Seventh National Communication (NC7) and Third Biennial Report of The Republic of Croatia Under The United Nations Framework Convention On Climate Change URL: https://unfccc.int/sites/default/files/resource/2671905483_Croatia-NC7-BR3-2-96481035_Croatia-NC7-BR3-2-7.%20NC%20i%203.%20BR_resubmission_IX_2018_0.pdf

[10] Ministry of Environmental Protection, Physical Planning and Construction (2010). Strategy for Sustainable Development of the Republic of Croatia. URL: http://extwprlegs1.fao.org/docs/pdf/cro105236.pdf

[11] Climate Adapt (2021). Adriatic-Ionian Area. URL: https://climate-adapt.eea.europa.eu/countries-regions/transnational-regions/adriatic-ionian

[12] WBG Climate Change Knowledge Portal (CCKP, 2021). Croatia. URL: https://climateknowledgeportal.worldbank.org/country/croatia/climate-data-historical

FIGURE 1. Average monthly temperature and rainfall for Croatia, 1991–2020[13]

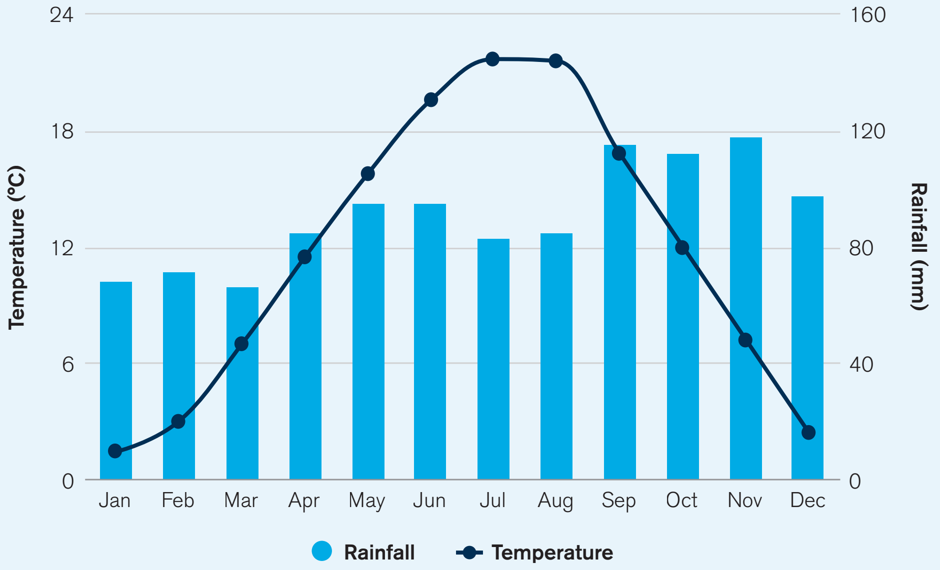
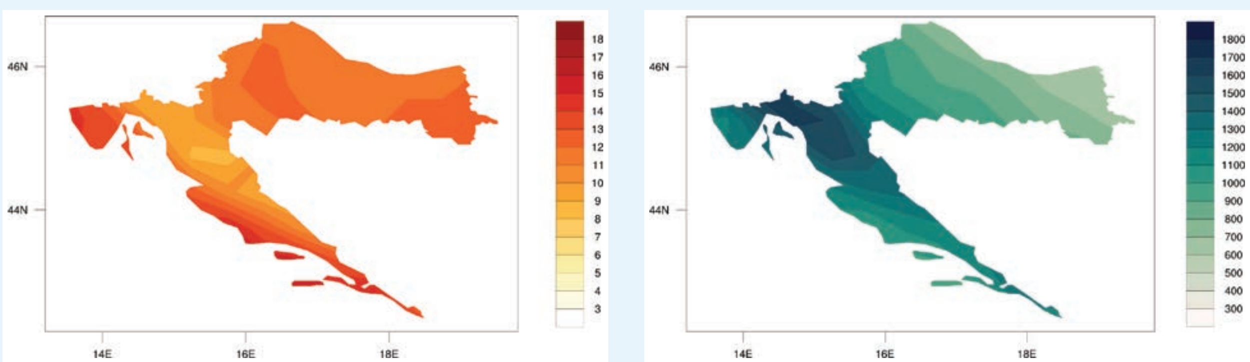


FIGURE 2. Map of average annual temperature (°C) (left); annual precipitation (mm) (right) of Croatia, 1991–2020[14]



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[13] WBG Climate Change Knowledge Portal (CCKP, 2021). Croatia. URL: https://climateknowledgeportal.worldbank.org/country/croatia/climate-data-historical

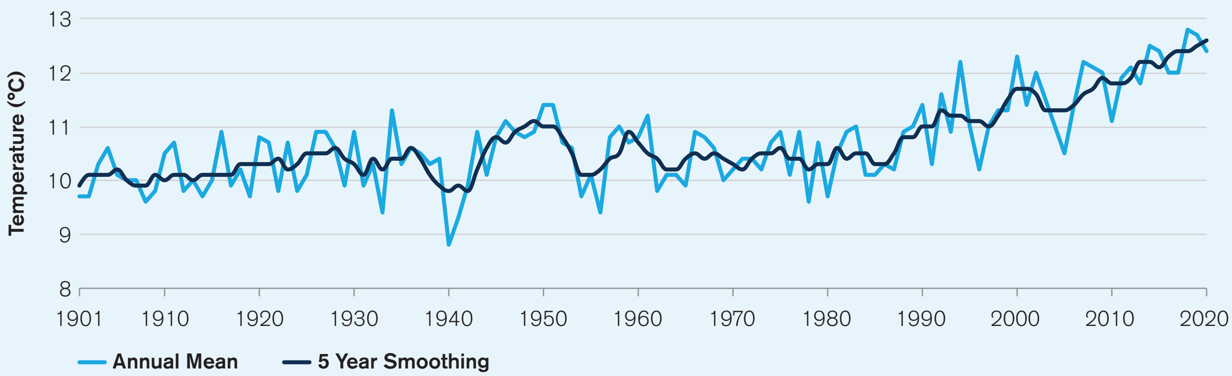
[14] WBG Climate Change Knowledge Portal (CCKP, 2021). Croatia. URL: https://climateknowledgeportal.worldbank.org/country/croatia

Key Trends

Temperature

In Croatia, January is the coldest month, with the temperature in the Pannonian region range from 0°C to –2°C. Along the Adriatic coast, winters are milder; January temperatures are 4°C–6°C. In the north and east of Croatia average July temperatures are 20°C–22°C and on the Adriatic coast 23°C–26°C. Since the 1960s, Croatia has experienced a general warming trend throughout the country (**Figure 3**), with higher temperatures experienced in the mainland as opposed to areas along the coast. Observed warming has been experienced in terms of both warmer daytime temperatures and warmer nights. Maximum temperatures have been observed to experience the most significant change at an increase of 0.3°C to 0.4°C per decade.[15]

FIGURE 3. Observed temperature for Croatia, 1901–2020[16]



Precipitation

Croatia's central Adriatic and eastern regions of Slavonia and Baranja experience the least amount of rainfall, with coastal zones experiencing the highest amounts of annual average rainfall. Typically, rainfall in Croatia decreases from the west towards the east. Since the 1960s, trends have shown that rainfall is increasing in the eastern lowlands but decreasing across the rest of the country, however future projections are inconclusive, and this might

[15] Ministry of Environment and Nature Protection (2018). Seventh National Communication (NC6) and Third Biennial Report of The Republic of Croatia Under The United Nations Framework Convention On Climate Change URL: https://unfccc.int/sites/default/files/resource/2671905483_Croatia-NC7-BR3-2-96481035_Croatia-NC7-BR3-2-7.%20NC%20i%203.%20BR_resubmission_IX_2018_0.pdf

[16] WB Climate Change Knowledge Portal (CCKP, 2021). Croatia URL: https://climateknowledgeportal.worldbank.org/country/croatia/climate-data-historical

not be the steady trend.[17] The country also experiences prominent dry spells, typically during the autumn months. Summer precipitation trends have decreased most significantly.[18]

Climate Future

Overview

The main data source for the World Bank Group's Climate Change Knowledge Portal (CCKP) is the CMIP5 (Coupled Inter-comparison Project No.5) data ensemble, which builds the database for the global climate change projections presented in the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC). Four Representative Concentration Pathways (i.e. RCP2.6, RCP4.5, RCP6.0, and RCP8.5) were selected and defined by their total radiative forcing (cumulative measure of GHG emissions from all sources) pathway and level by 2100. The RCP2.6 for example represents a very strong mitigation scenario, whereas the RCP8.5 assumes business-as-usual scenario. For more information, please refer to the RCP Database. For simplification, these scenarios are referred to as a low (RCP2.6); a medium (RCP4.5) and a high (RCP8.5) emission scenario in this profile. **Table 3** provides CMIP5 projections for essential climate variables under high emission scenario (RCP8.5) over 4 different time horizons. **Figure 4** presents the multi-model (CMIP5) ensemble of 32 Global Circulation Models (GCMs) showing the projected changes in annual precipitation and temperature for the periods 2040–2059 and 2080–2099.

TABLE 3. Data snapshot: CMIP5 ensemble projection

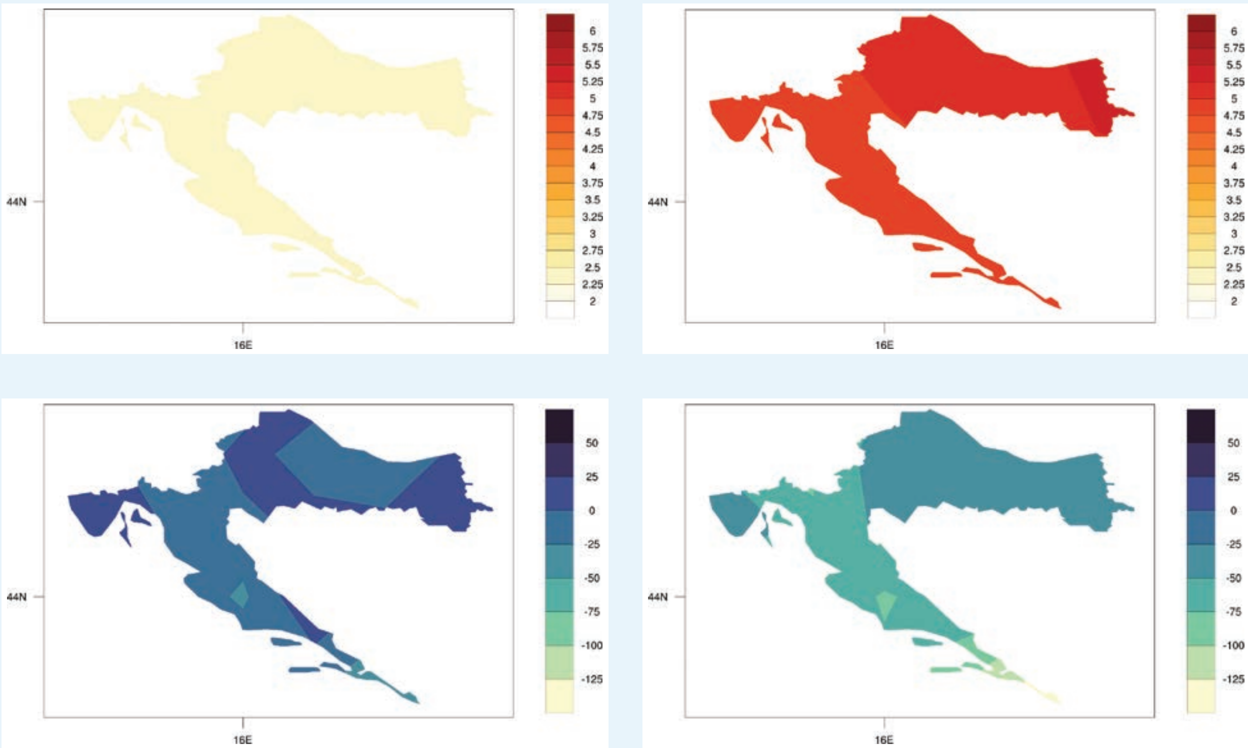
CMIP5 Ensemble Projection	2020–2039	2040–2059	2060–2079	2080–2099
Annual Temperature Anomaly (°C)	**+.33 to +2.36** (+1.36)	**+.958 to +3.48** (+2.29)	**+1.71 to +4.94** (+3.47)	**+2.66 to +6.4** (+4.56)
Annual Precipitation Anomaly (mm)	**–17.39 to + 13.07** (–1.21)	**–19.08 to +15.55** (–1.63)	**–22.87 to +14.83** (–2.48)	**–26.98 to +13.94** (–6.05)

Note: The table shows CMIP5 ensemble projection under RCP8.5. Bold value is the range (10th–90th Percentile) and values in parentheses show the median (or 50th Percentile).

[17] Kalinski, V. (2017). Results of Climate Modeling at the System HPC Velebit for the development of the NAS and NAP. URL: http://prilagodba-klimi.hr/wp-content/uploads/2017/11/Klimatsko-modeliranje.pdf

[18] Ministry of Environment and Nature Protection (2018). Seventh National Communication (NC6) and Third Biennial Report of The Republic of Croatia Under The United Nations Framework Convention On Climate Change URL: https://unfccc.int/sites/default/files/resource/2671905483_Croatia-NC7-BR3-2-96481035_Croatia-NC7-BR3-2-7.%20NC%20i%203.%20BR_resubmission_IX_2018_0.pdf

FIGURE 4. CMIP5 ensemble projected change (32 GCMs) in annual temperature (top) and precipitation (bottom) by 2040–2059 (left) and by 2080–2099 (right), relative to 1986–2005 baseline under RCP8.5[19]



[19] WBG Climate Change Knowledge Portal (CCKP, 2021). Croatia Climate Data - Projections. URL: https://climateknowledgeportal.worldbank.org/country/croatia/climate-data-projections

Key Trends

Temperature

Croatia is expected to become hotter and drier, especially in the summer. Climate change trends are projected to increase temperatures and decrease water availability across Croatia over this century.[20] Trends in temperature show warming throughout Croatia, with higher temperatures in the mainland than the coast or the Dalmatian areas. Maximum temperatures are expected to see the greatest degree of change, per decade. As demonstrated in **Table 3**, CCKP data analysis for high emission scenarios, show monthly mean temperature changes increasing by 1.36°C by the 2030s to more than 4°C by the 2090s. Temperature trends will see significant increase in summer months (May to September) as well as winter and spring seasons. Minimum temperatures are projected to experience the largest increase through mid-century. Specific 'new hot spots' are in the northern and western areas of Croatia, the northern regions in Gorski Kotar and the eastern part of Lika during its winter months. The coastal areas will experience the biggest change during summer seasons.[21]

Across all emission scenarios, temperatures will continue to increase for Croatia throughout the end of the century. As seen in **Figure 5**, under a high-emission scenario, average temperatures will increase rapidly by mid-century. Across the seasonal cycle (**Figure 5**), temperature increases will spike will be felt from April to June and again in September and October. Increased heat and extreme heat conditions will result in significant implications for public, the agricultural sector and water resources.

FIGURE 5. Projected average temperature for Croatia (Reference Period, 1986–2005)[22]

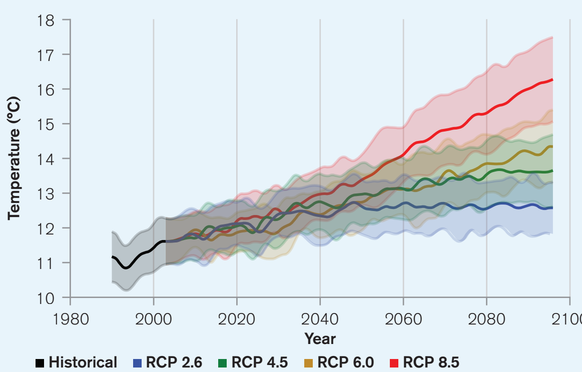
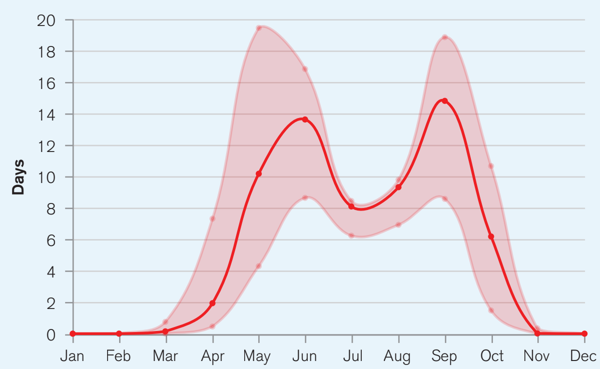


FIGURE 6. Projected change in Summer Days (Tmax >25°C) (RCP8.5, Ensemble, Reference Period, 1986-2005)[23]



[20] EU (2017). Draft Climate change Adaptation Strategy in the Republic of Croatia for the period to 2040 with a view to 2070 (White book). Croatia. URL: http://prilagodba-klimi.hr/wp-content/uploads/docs/Draft%20CC%20Adaptation%20Strategy.pdf

[21] Ministry of Environment and Nature Protection (2018). Seventh National Communication (NC6) and Third Biennial Report of The Republic of Croatia Under The United Nations Framework Convention On Climate Change URL: https://unfccc.int/sites/default/files/resource/2671905483_Croatia-NC7-BR3-2-96481035_Croatia-NC7-BR3-2-7.%20NC%20i%203.%20BR_resubmission_IX_2018_0.pdf

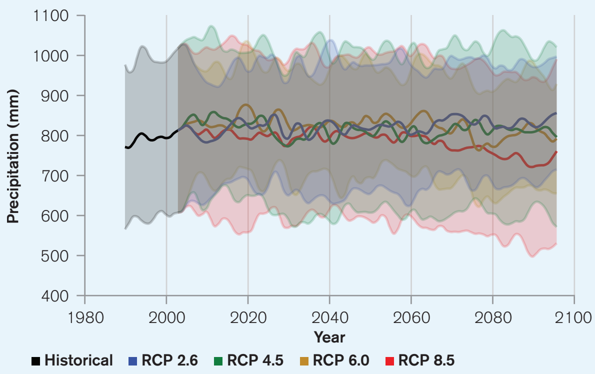
[22] WBG Climate Change Knowledge Portal (CCKP, 2021). Interactive Climate Indicator Dashboard - Agriculture. Croatia. URL https://climatedata.worldbank.org/CRMePortal/web/agriculture/crops-and-land-management?country=HRV&period=2080-2099

[23] WBG Climate Change Knowledge Portal (CCKP, 2021). Interactive Climate Indicator Dashboard - Agriculture. Croatia. URL https://climatedata.worldbank.org/CRMePortal/web/agriculture/crops-and-land-management?country=HRV&period=2080-2099

Precipitation

Future precipitation trends for the country are projected to decline steadily over the century, (eastern areas may experience increased rainfall), however these negative trends are primarily recognized in the summer months in the mountain regions as well as in the Adriatic areas. Annual decreases in precipitation are also expected in Istria and Gorski Kotar, due to reduced spring rainfall. An increased number of consecutive dry days are expected to be seen over the spring season for the northern Adriatic, with summer seasons seeing an extended number of dry days reach the southern coast of Croatia. Through the mid-century, the largest decrease (just over 10 %) will be in the spring in the southern areas of 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.[24] **Figure 7** shows the change in the projected annual average precipitation for Croatia.[25] At a nationally aggregated scale, mean annual precipitation for the country is expected to remain largely similar; however, at regional scales, western and specifically southern areas are expected to experience the most significant reduction in precipitation.

FIGURE 7. Projected annual average precipitation in Croatia (Reference Period, 1986–2005)[26]



CLIMATE CHANGE RELATED NATURAL HAZARDS

Overview

Croatia, and neighboring southeast European sub-region, are at risk to natural disasters, which primarily affect the region's agricultural, water and energy sectors, through seasonal flooding, aridity, and periods of drought. Temperatures are already observed to be increasing, precipitation is decreasing across key agricultural zones, and an increase in the intensity and frequency of extreme weather events — especially droughts and heat waves have been observed.[27] This also indicates scenarios for the increasing risk of wildfires. Croatia is at risk to earthquakes (Dinaric Arc, northwestern Croatia), flooding (Pannonia), landslides (northwestern Croatia), water scarcity (coastal area and islands) as well as extreme heat (throughout the country). This is expected to impact agriculture and water sectors as well as wider population health. Vulnerable groups, such as those with fewer economic opportunities

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[24] Ministry of Environment and Nature Protection (2018). Seventh National Communication (NC6) and Third Biennial Report of The Republic of Croatia Under The United Nations Framework Convention On Climate Change URL: https://unfccc.int/sites/default/files/resource/2671905483_Croatia-NC7-BR3-2-96481035_Croatia-NC7-BR3-2-7.%20NC%20i%203.%20BR_resubmission_IX_2018_0.pdf

[25] WBG Climate Change Knowledge Portal (CCKP, 2021). Croatia Water Dashboard. Data Description. URL: https://climateknowledgeportal.worldbank.org/country/croatia/climate-sector-water

[26] WBG Climate Change Knowledge Portal (CCKP, 2021). Climate Data-Projections. Croatia. URL: https://climateknowledgeportal.worldbank.org/country/croatia/climate-sector-water

[27] EU (2017). Draft Climate change Adaptation Strategy in the Republic of Croatia for the period to 2040 with a view to 2070 (White book). Croatia. URL: http://prilagodba-klimi.hr/wp-content/uploads/docs/Draft%20CC%20Adaptation%20Strategy.pdf

and the young and elderly are particularly at risk to natural hazards and the increasing impacts of climate change. Croatia has already endured various natural hazards, including droughts, floods, extreme temperatures, storms and wildfires. Croatia is also highly prone to earthquakes, and after relative quietness in the past 20 years,[28] Croatia was hit by two strong earthquakes: M5.5 on 22 March, 2020 (wider Zagreb capital area)[29] and M6.4 on 29 December, 2020 (Sisak-Moslavina County area, ca 40 km south of Zagreb)[30] killing several people, causing extensive damage to numerous homes and infrastructure as well as causing loss of livelihoods.[31]

Nearly a quarter of the Croatian economy is based on sectors potentially vulnerable to climate change and extreme weather, including agriculture and tourism. This accounts for €9.23 billion a year. Between 2000 and 2007, extreme weather including droughts and floods caused average annual losses in the agricultural sector of €173 million. The energy sector has also been affected by extreme weather: the 2003 drought cost the government €63–69 million in compensation for power outages caused by reduced river flow and hydropower production. Natural hazards resulting in these types of issues are likely to become more common over the coming century.[32,33]

Data from the Emergency Event Database: EM-Dat, presented in **Table 4**, shows the country has endured various natural hazards.

TABLE 4. Natural disasters in Croatia, 1900–2020[34]

Natural Hazard 1900–2020	Subtype	Events Count	Total Deaths	Total Affected	Total Damage ('000 USD)
Drought	Drought	1	0	0	330,000
Earthquake	Ground Movement	3	8	indirectly over 1.5 million	~ $19.2 billion USD (2020 earthquakes)
Extreme Temperatures	Cold Wave	3	7	0	0
	Heat Wave	2	828	200	240,000
	Severe Winter Conditions	1	5	0	0
Flood	Flash Flood	2	0	3,200	0
	Riverine Flood	7	3	10,576	80,000
Storm	Convective Storm	2	2	3,500	161,000
Wildfire	Forest Fire	6	13	106	37,750

[28] Hadzima-Nyarko, M. and Sipos, T. (2017). Insights from existing earthquake loss assessment research in Croatia. Earthquakes and structures. 13(4). pp. 401–411. URL: http://www.techno-press.org/content/?page=article&journal=eas&volume=13&num=4&ordernum=3

[29] World Bank Group (2020). Overlooked: Examining the impact of disasters and climate shocks on poverty in the Europe and Central Asia Region. Washington, DC: World Bank. URL: http://documents1.worldbank.org/curated/en/493181607687673440/pdf/Overlooked-Examining-the-Impact-of-Disasters-and-Climate-Shocks-on-Poverty-in-the-Europe-and-Central-Asia-Region.pdf

[30] Croatian Geological Society (2021). Petrinja Area Earthquake Report: URL: https://www.hgi-cgs.hr/press-release-of-the-croatian-geological-survey-hgi-cgs/

[31] Uhlir, Z., Ivos, S., Orsanic, D., Bogaerts, V. R., Stanton-Geddes, Z., Katic, K. (2020). Croatia Earthquake – Rapid Damage and Needs Assessment 2020. Washington, D.C.; World Bank Group. URL: http://documents1.worldbank.org/curated/en/311901608097332728/pdf/Croatia-Earthquake-Rapid-Damage-and-Needs-Assessment-2020.pdf

[32] EU (2017). Report on the Estimated Climate Change Impacts and Vulnerability of Individual Sectors. URL: https://climate-adapt.eea.europa.eu/countries-regions/countries/croatia

[33] EU (2012). Climate Vulnerability Assessment: Croatia. URL: http://www.seeclimateforum.org/upload/document/cva_croatia_-_english_final_print2.pdf

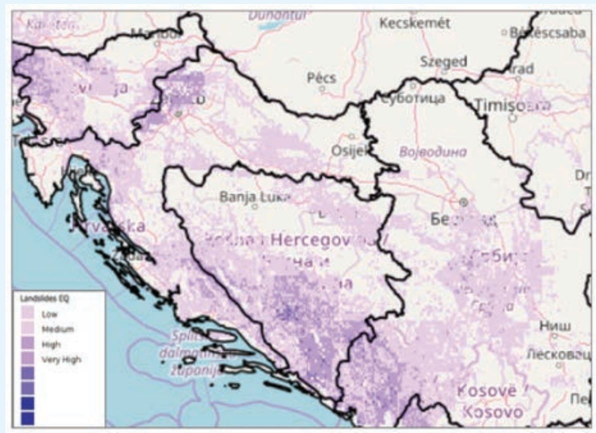
[34] EM-DAT: The Emergency Events Database – Universite catholique de Louvain (UCL) – CRED, D. Guha-Sapir, Brussels, Belgium. URL: http://emdat.be/emdat_db/. Updated by the 2020 earthquakes data from various sources.

Key Trends

While many sectors in Croatia do have risk assessments,[35] Croatia has yet to establish a functional data flow mechanism in order to have comprehensive understanding of natural hazards in all sectors. Additionally, Croatia does not have a central database which would systematically collect and analyze disaster loss data. The country depends upon tourism and an increase in natural disasters in the coastal area are expected to cause significant economic losses for the sector. Croatia's population density and urban development greatly varies throughout the country, and the urban coastal areas have experienced greater impacts from disasters.[36]

Flooding, including coastal and riverine, are particular hazards for Croatia and damaging and potentially life-threatening river floods are expected to occur at least once in the next 10 years. Flooding along river areas is considered an immediate as well as long-term hazard for both rural and urban areas. Surface flood hazards in urban and rural areas are also expected to occur. Croatia is at risk to sea level rise and resulting coastal area flooding, which will impact coastal cities.[37] **Figure 8** demonstrates Croatia's current risk of landslides, which can be seen to be particularly pronounced in the center of the country, in the northwest area and along the coast.

FIGURE 8. Croatia landslide risk[38]



Implications for DRM

To increase its resilience to natural hazards and climate change impacts, Croatia has plans, procedures and resources to deal with a major disaster. However, it is still lacking in good coordination and disaster risk management, especially in human capacity. At an operational level, the Croatian Red Cross (CRC) has contingency plans and procedures which are in permanent upgrading process. Support to the most vulnerable population remains the CRC's priority and mandate. Croatian Waters has developed a well-organized flood defense structure at the national level and activities are implemented in accordance with EU flood risk management directives. Croatia's flood risk management is coordinated through the national and local level as well as on the trans-boundary level, supported by flood forecast modelling and early warning responses. Croatia have also implemented strong landslide risk management mechanisms, which are measured and undertaken by the Ministry of Construction and Physical Planning. These institutions oversee landslide risk assessments as well as programs for landslide disaster recovery.[39]

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35 Croatian Government (N.D). Disaster risk assessment for the Republic of Croatia/Procjena rizika od katastrofa za Republiku Hrvatsku. URL: https://civilna-zastita.gov.hr/UserDocsImages/DOKUMENTI_PREBACIVANJE/PLANSKI%20DOKUMENTI%20I%20UREDBE/Procjena%20rizika%20od%20katastrofa%20za%20RH.pdf

36 GFDRR (2018). Croatia – Landslide Risk URL: https://www.gfdrr.org/sites/default/files/Croatia.pdf

37 ThinkHazard! (2020). Croatia. URL: http://thinkhazard.org/en/report/62-croatia

38 Global Risk Data Platform (2019). Croatia. URL: http://preview.grid.unep.ch/index.php?preview=map&lang=eng

39 Arbanas, S. *et al.* (2019). Landslide risk management in Croatia: Current state. Proceedings of the 4th Symposium on Landslides in the Adriatic-Balkan Region, Sarajevo, 2019. DOI: doi.org/10.35123/ReSyLAB_2019_40

Overall, Croatia is working to improve its resilience to increased risk of natural hazards and reduce vulnerability of local communities and institutions to better prepare for and mitigate and respond to natural hazards and climate change. It has incorporated disaster risk reduction strategies in all sector strategies. Additional cross-sector coordination and collaboration as well as the development of early warning systems can improve the country's preparedness and resilience.[40] Wider adoption and implementation of the planning tools such as the European Flood Awareness System (EFAS) can also help to improve planning towards major risks, such as floods.[41] Following its recent earthquakes, Croatia is working to assess its DRM processes, specifically in response to earthquakes and increase its ability to prepare for disasters as well as mitigate future impacts. This includes the allocation of resources and for establishing the necessary legal framework covering all aspects of material and social recovery. The implementation of measures to strengthen existing buildings and to mitigate earthquake risks is a key factor in improving the resilience of the community in the future.[42]

CLIMATE CHANGE IMPACTS TO KEY SECTORS

Croatia is expected to experience a range of adverse impacts of climate change throughout the country and across all sectors, the most significant impacts being more frequent and intense droughts, changing precipitation patterns, prevalence of new disease vectors, increases in air and sea surface temperature, and increasing number of consecutive dry and hot days. Visible signs of climate change include annual variation in crop yields, sea level rise, a longer tourism season and the potential development of new tourism destinations due to changes in local climates.[43] Variable precipitation and increasing temperatures are resulting in an increasingly riskier agricultural and water availability environment. Furthermore, climate change and global temperature increases are impacting sea level rise, which will also have an impact in the country. Climate change is expected to impact major economic sectors of the country such as tourism and agriculture. Financial constraints and limited institutional capacity have limited adaptation capabilities and effective response to climatic hazards in the country. This further threatens future sustainable agricultural production as well as the opportunity to expand and sustain tourism.

Gender

An increasing body of research has shown that climate-related disasters have impacted human populations in many areas including agricultural production, food security, water management and public health. The level of impacts and coping strategies of populations depends heavily on their socio-economic status, socio-cultural norms, access to resources, poverty as well as gender. Research has also provided more evidence that the effects are not gender neutral, as women and children are among the highest risk groups. Key factors that account for the differences

[40] Holcinger, (2015). National progress report on the implementation of the Hyogo Framework for Action (2013–2015)-Croatia. URL: https://www.preventionweb.net/files/40137_HRV_NationalHFAprogress_2013-15.pdf

[41] Dottori, F., et al. (2017). An operational procedure for rapid flood risk assessment in Europe. *Nat. Hazards Earth Syst. Sci.*, 17, pp. 1111–1126.

[42] Government of Croatia. (2020). Croatia Earthquake – Rapid Damage and Needs Assessment 2020. World Bank Group. URL: http://documents1.worldbank.org/curated/en/311901608097332728/pdf/Croatia-Earthquake-Rapid-Damage-and-Needs-Assessment-2020.pdf

[43] EU (2017). Report on the Estimated Climate Change Impacts and Vulnerability of Individual Sectors. URL: https://climate-adapt.eea.europa.eu/countries-regions/countries/croatia

between women's and men's vulnerability to climate change risks include: gender-based differences in time use; access to assets and credit, treatment by formal institutions, which can constrain women's opportunities, limited access to policy discussions and decision making, and a lack of sex-disaggregated data for policy change.[44]

Agriculture

Overview

Agriculture in Croatia is divided into crop production, livestock production, and fishing. Crop production includes arable land and gardens, kitchen gardens, orchards, olive groves, vineyards, meadows and pastures, nurseries and land with osier willows. Utilized agricultural areas comprised 23.4% of the country's total land area. Agricultural cultivation includes cereals (maize, wheat and barley), dried pulses, root and tuber crops, industrial plants (soy-bean, sugar beet, sunflower, rape seed), vegetables, green fodder from arable land as well as other arable crops, flowers and ornamental plants, seed crops and seedlings and fallow land.[45] Croatia's fishing sector is divided into maritime and freshwater fishing. Maritime fishing occurs in the Croatian sea and freshwater fishing in ponds and open freshwater. The majority of catch is blue fish but also includes other fish, crustaceans and oysters, other mollusks and shellfish. Mari-culture includes fish farms for white fish (mostly sea bass and sea bream), blue fish (tuna) and shellfish (mussels, oysters).[46]

Climate Change Impacts

The agricultural sector is particularly vulnerable to climate change, due to its weather dependence.[47,48] Extreme weather events such as droughts and hail have resulted in average losses of €76 million per year from 2000–2007; 0.6% of national GDP.[49] Changing climate conditions for the country may impact the annual number of days of active vegetation (with temperature above 5°C) increases in the lowland parts the country. This may result in cultivation of individual plants being moved depending on culture needs for heat, light and water and will result in changing the crop rotation in farming areas, suitable areas for orchards, vineyards and olive groves are likely to move, areas currently unsuitable for agriculture may become attractive. Increased temperatures coupled with capability to provide adequate water (irrigation) could bring a positive effect on the increase in yields, especially winter crops which will be cultivated under mild winter conditions. Adverse impacts i.e. drought risk,

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44 World Bank Group (2016). Gender Equality, Poverty Reduction, and Inclusive Growth. URL: http://documents1.worldbank.org/curated/en/820851467992505410/pdf/102114-REVISED-PUBLIC-WBG-Gender-Strategy.pdf

45 Igor, B., Josip, T. and Paulo, P. (2020). Agriculture Management Impacts on soil Properties and Hydrological Response in Istris. Agronomy. 10(2). DOI: https://doi.org/10.3390/agronomy10020282

46 Ministry of Environment and Nature Protection (2018). Seventh National Communication (NC6) and Third Biennial Report of The Republic of Croatia Under The United Nations Framework Convention On Climate Change URL: https://unfccc.int/sites/default/files/resource/2671905483_Croatia-NC7-BR3-2-96481035_Croatia-NC7-BR3-2-7.%20NC%20i%203.%20BR_resubmission_IX_2018_0.pdf

47 EU (2017). Report on the Estimated Climate Change Impacts and Vulnerability of Individual Sectors. URL: https://climate-adapt.eea.europa.eu/countries-regions/countries/croatia

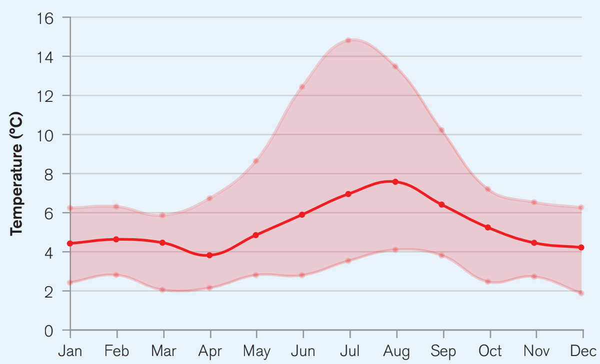
48 EU (2012). Climate Vulnerability Assessment: Croatia. URL: http://www.seeclimateforum.org/upload/document/cva_croatia_-_english_final_print2.pdf

49 EU (2017). Draft Climate change Adaptation Strategy in the Republic of Croatia for the period to 2040 with a view to 2070 (White book). Croatia. URL: http://prilagodba-klimi.hr/wp-content/uploads/docs/Draft%20CC%20Adaptation%20Strategy.pdf

hail, flood, frost, etc., may impact production of key staple crops, such as winter wheat and maize.[50] Warmer sea temperatures are likely to impact the fishing industry, potentially through an increased number of invasive species and changing locations of shoals, which will in turn affect the economy of coastal provinces and islands. Diminished surface runoff may also affect groundwater levels, affecting drinking water supplies as well as water availability for irrigation needs.

The projected increased heat will increase stress on crops and is also likely to alter the length of the growing seasons. Decreased water availability is likely to further reduce yields and the reduction in soil moisture may alter suitable areas for agriculture or the production of specific crops. Increased heat and water scarcity conditions are likely to increase evapotranspiration, expected to contribute to crop failure and overall yield reductions.[51] **Figure 9** shows the average daily maximum-temperature across seasonal cycles. These higher temperatures, occurring throughout the year, have implications for soil moisture and crop growth; summer spikes in temperature will have impacts for harvest seasons as well as the country's tourism industry and energy production and distribution.

FIGURE 9. Projected average daily max temperature for Croatia (RCP8.5, Ensemble, Reference Period, 1986-2005)[52]



Adaptation Options

Expanded irrigation is one measure which can prevent or minimize the effects of climate change, in particular for areas experiencing decreased precipitation. The reduction in crop cultures without irrigation, in average climate conditions, can vary from 10% to 60 %, while in extreme dry conditions, it can be up to 90% depending on culture, soil and area. Increasing the irrigated area of arable land in Croatia is likely to be necessary to maintain crop yields. In the long term, investment in further research is required to develop detailed, economically sound adaptation measures in this area, including the development of the agricultural education sector. Potential measures include promoting crop rotation and encouraging farmers to use new crop varieties, including drought resistant and faster-growing varieties.[53,54] Capacity building programs are also necessary to develop educational programs for farmers,

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50 Ministry of Environment and Nature Protection (2014). Seventh National Communication (NC6) and Third Biennial Report of The Republic of Croatia Under the United Nations Framework Convention On Climate Change URL: https://unfccc.int/sites/default/files/resource/2671905483_Croatia-NC7-BR3-2-96481035_Croatia-NC7-BR3-2-7.%20NC%20i%203.%20BR_resubmission_IX_2018_0.pdf

51 Ministry of Environment and Nature Protection (2018). Seventh National Communication (NC6) and Third Biennial Report of The Republic of Croatia Under the United Nations Framework Convention On Climate Change URL: https://unfccc.int/sites/default/files/resource/2671905483_Croatia-NC7-BR3-2-96481035_Croatia-NC7-BR3-2-7.%20NC%20i%203.%20BR_resubmission_IX_2018_0.pdf

52 WBG Climate Change Knowledge Portal (CCKP, 2020). Croatia Agriculture. Dashboard URL: https://climatedata.worldbank.org/CRMePortal/web/agriculture/crops-and-land-management?country=HRV&period=2080-2099

53 EU (2017). Report on the Estimated Climate Change Impacts and Vulnerability of Individual Sectors. URL: https://climate-adapt.eea.europa.eu/countries-regions/countries/croatia

54 EU (2012). Climate Vulnerability Assessment: Croatia. URL: http://www.seeclimateforum.org/upload/document/cva_croatia_-_english_final_print2.pdf

advising services, administrative staff, scientists, teachers and community stakeholders. Scientific agricultural research is necessary to:

- initiate (finance) improvement projects focused on the development of populations and varieties adapted to soil types and climate conditions in Croatia's agricultural regions that will meet new requirements in the future,
- initiate permanent research into existing agricultural crops (maize, wheat, potato, apple, wine grape) in the areas of Croatia or abroad (through international cooperation) containing already elements of the model predicted,
- investigate new systems of tillage, sowing (planting), sowing density, cultivation.[55]

Water

Overview

Croatia is characterized by significant wetland areas, especially in typically flooded areas of Drava, Danube, Sava and Neretva catchments. While the country has a positive average water balance, the interannual distribution of water quantities is not favorable due to the significant spatial and time difference across the country's water resource distribution. Croatia has a wide allocation of surface (rivers, lakes, transitional and coastal waters) and ground waters, which are part of either Black Sea or Adriatic catchment area with watersheds running along the mountain and alpine area. Large watercourses such as Sava, Drava and Danube with many smaller sub-catchments dominate the Black Sea catchment area. In the Adriatic catchment area, the abundance and the length of surface watercourses are significantly lower, but there are significant groundwater flows through karst systems. The River of Danube, the largest and richest in water, flows through the eastern borderland of the Republic of Croatia. The largest rivers in Istria are Mirna, Dragonja and Raša, and in Dalmatia these are Zrmanja, Krka, Cetina, and Neretva. The Mediterranean, including the Croatian Adriatic coastline, is affected by global sea-level rises caused by thermal expansion of the oceans and melting of the polar ice caps. Particularly at-risk from sea level rise are Croatia's low islands such as Krapanj (only 1.5 m above sea level) and river deltas (i.e. the Neretva river delta) which includes large areas of agricultural land) which are vulnerable to coastal flooding as well as salinization.[56,57]

Climate Change Impacts

Climate change will impact Croatia's water supply, impacting demand from the agricultural sector as well as increasing drinking requirements. Annual distribution (and changing patterns) of rainfall is of great interest to the water industry as the distribution of water throughout the year is critical for planning of resources as well as for safety against disasters. Infrastructure and water management strategies are closely tuned to the annual cycle of supply and demand. In Croatia, projected temperature and precipitation trends are likely to result in hydrological

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55 Ministry of Environment and Nature Protection (2018). Seventh National Communication (NC6) and Third Biennial Report of The Republic of Croatia Under The United Nations Framework Convention On Climate Change URL: https://unfccc.int/sites/default/files/resource/2671905483_Croatia-NC7-BR3-2-96481035_Croatia-NC7-BR3-2-7.%20NC%20i%203.%20BR_resubmission_IX_2018_0.pdf

56 EU (2017). Report on the Estimated Climate Change Impacts and Vulnerability of Individual Sectors. URL: https://climate-adapt.eea.europa.eu/countries-regions/countries/croatia

57 EU (2012). Climate Vulnerability Assessment: Croatia. URL: http://www.seeclimateforum.org/upload/document/cva_croatia_-_english_final_print2.pdf

impacts of the country's watercourses, such as catchments, rivers and coastlines. Increasing temperatures will also play an adverse role in evapotranspiration, changes in groundwater inflow, water level in rivers and lakes, and water temperatures. Changes in precipitation will influence not only the discharge, but the intensity, time period and frequency of floods and droughts as well as soil humidity, ground water recharge and the amount of water flowing through rivers.[58] Some estimates expect discharges in the largest watercourses to decrease by 10% to 20%, although in eastern parts of the country such change could be less than 10%.[59] Additional natural resources such as wetlands services (flood protection, water filtration, etc.) could also be at risk in a drier future.

Rainfall and evaporation changes also impact rates of surface water infiltration and the recharge rates for groundwater. Low-water storage capacity increases the country's dependence on unreliable rainfall patterns. Changes in rainfall and evaporation for Croatia are expected to translate directly to changes in surface water infiltration and groundwater re-charge. This has the potential for further decreased reliability of unimproved groundwater sources and surface water sources during droughts or prolonged dry seasons. Increased strain on pumping mechanisms leading to breakdowns if maintenance is neglected and the potential for falling water levels in the immediate vicinity of well or borehole, particularly in areas of high demand.[60] Additionally, temperature increases have the potential to result in increased soil moisture deficits even under conditions of increasing rainfall.

FIGURE 10. Projected annual SPEI Drought Index in Croatia for the period, 2080–2099 (Reference Period, 1986–2005)[61]

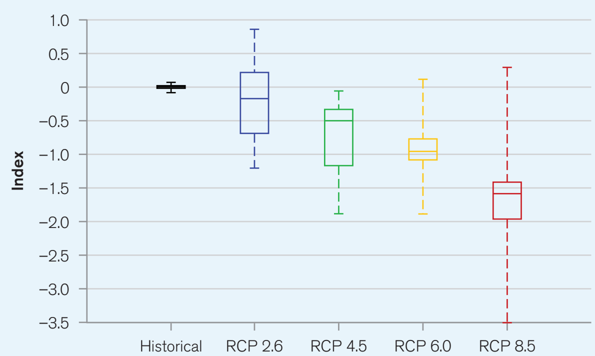

Figure 10 shows the projected annual *Standardized Precipitation Evapotranspiration Index* (SPEI) through the end of the century. The SPEI is an index which represents the measure of the given water deficit in a specific location, accounting for contributions of temperature-dependent evapotranspiration and providing insight into increasing or decreasing pressure on water resources. Negative values for SPEI represent dry conditions, with values below –2 indicating severe drought conditions, likewise positive values indicate increased wet conditions. This is an important understanding for the water sector in regard to quantity and quality of supply for human consumption and agriculture use as well as for the energy sector as reductions in water availability impacts river flow and the hydropower generating capabilities. At a nationally aggregated scale, Croatia is projected to experience heightened dry conditions and drought severity, which will likely increase pressure on water resources for the country and region by mid-century and by end of the century.

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58 EU (2017). Draft Climate change Adaptation Strategy in the Republic of Croatia for the period to 2040 with a view to 2070 (White book). Croatia. URL: http://prilagodba-klimi.hr/wp-content/uploads/docs/Draft%20CC%20Adaptation%20Strategy.pdf

59 EU (2017). Report on the Estimated Climate Change Impacts and Vulnerability of Individual Sectors. URL: https://climate-adapt.eea.europa.eu/countries-regions/countries/croatia

60 Oresic, D. and Canjevac, I. (2019). Groundwater resources in Croatia. *Water Resources Management in Balkan Countries*. URL: https://link.springer.com/chapter/10.1007/978-3-030-22468-4_5

61 WBG Climate Change Knowledge Portal (CCKP, 2020). Croatia Water Sector Dashboard. URL: https://climatedata.worldbank.org/CRMePortal/web/water/land-use-/-watershed-management?country=HGV&period=2080-2099

Adaptation Options

Climate change adaptation for the water sector in Croatia requires further investments in flood defense and a more integrated approach to water resources management. Shortage of water is expected in the long run during the vegetation period and the tourist season, when water requirements reach peak demand. Additional research should be undertaken as well as enhanced cooperation with other countries where positive experiences in combating drought could be applied. Capacity can be developed to simulate the physical impacts of climate on the supply, distribution and quality of freshwater resources. An improved ability to downscale global climate model results to the level of catchments, can improve monitoring through identification of results suitable for correlation with data from existing runoff gauges and weather stations used for monitoring. Improved management of groundwater extraction can aid to sustainability of Croatia's water resources and its sustainable recharge.[62] Within Croatia's water sector, several adaptation objectives should be prioritized:

- strengthening monitoring, research, education and management capacities at various levels and domains for climate change impact analysis and adaptation measures,
- strengthening the capacity for construction, reconstruction and upgrading of existing systems for protection against harmful effects of water, systems for water use and for protection of waters in a new (future) climate conditions,
- strengthening the resilience of coastal water and communal infrastructure to the possible impacts of climate change,
- strengthening the capacity to protect natural water and marine systems, and especially protected areas, from the negative effects of climate change as well as for their adaptation.[63]

Croatia would benefit from the establishment of a national database and system of rainfall-runoff models to project the effects of rainfall changes (for climate variability and climate change) on runoff and discharges (including peak and low flows). This should be done in important river basins and catchments and linked to an expanded national runoff and flooding reporting system. As such, Croatia's Water Sector should undertake a program to map existing groundwater resources in a comprehensive fashion, and then develop the databases and models needed to simulate the effects of climate variability and climate change on groundwater recharge, storage and water quality.[64]

[62] Oresic, D. and Canjevac, I. (2019). Groundwater resources in Croatia. *Water Resources Management in Balkan Countries*. URL: https://link.springer.com/chapter/10.1007/978-3-030-22468-4_5

[63] Ministry of Environment and Nature Protection (2018). Seventh National Communication (NC6) and Third Biennial Report of The Republic of Croatia Under The United Nations Framework Convention On Climate Change URL: https://unfccc.int/sites/default/files/resource/2671905483_Croatia-NC7-BR3-2-96481035_Croatia-NC7-BR3-2-7.%20NC%20i%203.%20BR_resubmission_IX_2018_0.pdf

[64] Holcinger, (2015). National progress report on the implementation of the Hyogo Framework for Action (2013–2015)- Croatia. URL: https://www.preventionweb.net/files/40137_HRV_NationalHFAprogress_2013-15.pdf

Energy

Overview

Croatia's energy sector is sensitive to changes in seasonal weather patterns and extremes that can affect the supply of energy, impact transmission capacity, disrupt oil and gas production, and impact the integrity of transmission pipelines and power distribution. Due to the country's existing hydropower plants and the recent additions of wind and solar generating capabilities, Croatia is exceeding the EU renewable energy target of 20% in final energy consumption by 2020. However, wind and solar capacity accounted for just 11% of total generation capacity in 2018.[65] The production of natural gas, crude oil and heat generated by use of heat pumps also decreased. Natural gas production has also decreased, while production of fuel wood and biomass and of other renewables has increased over the past decade.[66] Other renewable energy sources such as geothermal energy, biodiesel and biogas, while contributing minimal amounts to overall generation, are important prospects.

Climate Change Impacts

In Croatia, hydro-electric power generation makes up half of all electricity production. Decreased river flow would lead to a reduction of hydro-electric power production resulting in significant extra costs, estimated at tens of millions of Euros, to replace the generating capacity if river flow is reduced. This is likely to occur due to reduction in rainfall and river flow disruptions. The projected decrease in precipitation, especially for key hydrologic zones as well as change in seasonal rainfall patterns are likely to reduce hydropower potential and revenue losses. Increased evaporation rates from existing water storage facilities may also increase production costs; costs that will inevitably be transferred to the consumer.

Cooling Degree Days show the relationship between daily heat and cooling demand, typically sourced through a form of active cooling or an evaporative process. The change in cooling degree days provides insight into the potential for extended seasons of power demand or periods in which cooling demand (power demands) might increase. As seen in **Figure 11**, seasonal increases for cooling demands are expected to increase over an extended summer period (May to September). The Warm Spell Duration Index represents the number of days in a sequence of at least six days in which the daily maximum temperature is greater than the 90th percentile of daily maximum temperature. As shown in **Figure 12**, warm spells are expected to sharply increase in the second half of the century.

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65 World Bank (2018). Croatia Energy Sector Note. Energy and Extractives, Poverty and Equity Global Practices Europe and Central Asia Region (ECA). URL: http://documents1.worldbank.org/curated/en/126131551124308323/pdf/AUS0000353-WP-REVISED-P166022-PUBLIC.pdf

66 Ministry of Environment and Nature Protection (2018). Seventh National Communication (NC6) and Third Biennial Report of The Republic of Croatia Under The United Nations Framework Convention On Climate Change URL: https://unfccc.int/sites/default/files/resource/2671905483_Croatia-NC7-BR3-2-96481035_Croatia-NC7-BR3-2-7.%20NC%20i%203.%20BR_resubmission_IX_2018_0.pdf

FIGURE 11. Projected change in Cooling Degree Days (65°F) in Croatia for the period 2040–2059 (Reference Period, 1986–2005)[67]

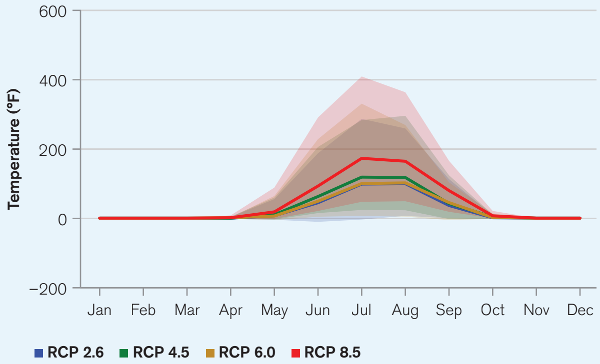
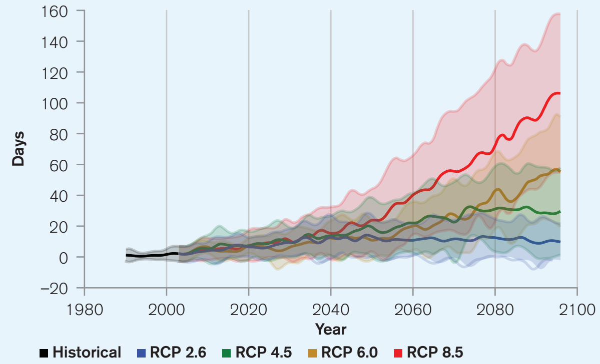


FIGURE 12. Projectd Warm Spell Duration Index in Croatia (Reference Period, 1986–2005)[68]



Adaptation Options

To ensure the resilience of energy infrastructure to current climate variability and projected future climate change, the continued provision of basic services to the public and industry needs to be provided to enhance the quality of decision making. The Croatian Government and individual departments should understand the inherent vulnerabilities in this energy sector and develop flexible adaptation strategies for existing and planned infrastructure. Consideration should be given to the capacity of energy systems to sustain cumulative impacts; the redundancy at peak periods; the sensitivity of regulators to climate change pressures on infrastructure and the possible need for redundant capacity; demand management and energy conservation strategies. Institutionalized measures for energy saving will allow decreasing consumption of primary energy, mainly natural gas. Additional investments can be made in energy efficiency and renewable energy sources; a high priority for both economic (decrease in costs for energy generation) and climate mitigation (decrease in volumes of greenhouse gas emissions). Croatia is also actively promoting biofuel production and building capacitates for green hydrogen production and use. Adaptation measures in Croatia's energy sector should also aim to:

- Strengthening the capacity of all relevant institutions and major energy entities, and the community, to assess the impact of climate caused hazards, risk prevention, preparedness measures and responses to emergencies.
- Increasing security of energy supply.
- Increasing the resilience of existing hydropower, thermal power, transmission and distribution networks.
- Providing an incentive legal framework, i.e. preconditions for encouraging the construction of RES capacities with the aim of diversifying sources and increasing decentralized production.[69]

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[67] WBG Climate Change Knowledge Portal (CCKP, 2021). Croatia – Energy. URL: https://climateknowledgeportal.worldbank.org/country/croatia/climate-sector-energy

[68] WBG Climate Change Knowledge Portal (CCKP, 2021). Croatia Energy Sector Dashboard. URL: https://climatedata.worldbank.org/CRMePortal/web/agriculture/crops-and-land-management?country=HRV&period=2080-2099

[69] Ministry of Environment and Nature Protection (2018). Seventh National Communication (NC6) and Third Biennial Report of The Republic of Croatia Under The United Nations Framework Convention On Climate Change URL: https://unfccc.int/sites/default/files/resource/2671905483_Croatia-NC7-BR3-2-96481035_Croatia-NC7-BR3-2-7.%20NC%20i%203.%20BR_resubmission_IX_2018_0.pdf

Health

Overview

Croatia's health sector was heavily impacted by the economic crisis, which resulted in a significant increase in non-standard or precarious employment, which has added to the country's health burden.[70] More recently, access to public health services have been improved in response to more frequent heat-wave events. General practitioners, public health workers and homecare nurses have been given specific training in preparation for heat-waves, including risk communication.[71]

Climate Change Impacts

Climate change will pose numerous direct impacts and increasing risks to the country's population health. Higher incidence of hot and dry summers with increased night and day temperatures is expected and more frequent occurrences of heat waves will pose a serious threat to human health, particularly for highly vulnerable groups: elderly and chronically ill. In winter, vascular patients suffer most from situations of low air pressure. Low air temperatures adversely affect the respiratory diseases and asthmatic attacks are more frequent in winter due to cold high-pressure periods and in summer seasons are also associated with the movements of a cold front. Predicted decline in frequency of winter cold weather is also expected to result in a reduction in the number of coronary failures, cerebrovascular insults and asthmatic attacks in winter. The projected increasing temperatures and the projected change in number of heat days through the 2050s, are expected to impact human and animal health, as well as present more conducive environments for bacteria, pathogens and vector borne diseases.[72] While heat related health problems may occur, deaths due to cold weather may decrease during the winter time.[73] Additionally, tick-borne viral encephalitis, which is transmitted by forest ticks (*Ixodes ricinus*), typically occurs from spring to autumn in Croatia. Warmer and longer autumns will contribute to the extension of tick activities, and mild winters will favor strengthened and prolonged tick survival. As annual mean temperature rise, ticks are also likely to spread to higher altitudes; a warmer and longer autumn time contributes to extension of tick prevalence.[74]

Warmer and drier conditions as projected by climate scenarios may favor the spread of diseases borne by food or water, such as diarrhea and dysentery. A consequence of warmer summers and an extended vegetation season may also see the number of patients becoming sensitized to and affected by respiratory allergies such as seasonal allergic rhinitis and allergic asthma caused by pollen from the trees, grasses and weeds. A warmer and drier climate will favor the spread of allergenic plants and an increase in the number of patients suffering from allergic respiratory diseases.[75]

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70 WHO (2019). Croatia: Health and Employment. URL: https://apps.who.int/iris/bitstream/handle/10665/324928/9789289054034-eng.pdf?sequence=1&isAllowed=y

71 WHO (2020). Croatia. URL: http://www.euro.who.int/__data/assets/pdf_file/0006/82293/croatia_protect_health_factsheets.pdf?ua=1

72 Ministry of Environment and Nature Protection (2014). Sixth National Communication (NC6) and First Biennial Report of The Republic of Croatia Under The United Nations Framework Convention On Climate Change UR: https://unfccc.int/files/national_reports/annex_i_natcom_/application/pdf/hrv_nc6.pdf

73 EU (2017). Draft Climate change Adaptation Strategy in the Republic of Croatia for the period to 2040 with a view to 2070 (White book). Croatia. URL: http://prilagodba-klimi.hr/wp-content/uploads/docs/Draft%20CC%20Adaptation%20Strategy.pdf

74 Ministry of Environment and Nature Protection (2018). Seventh National Communication (NC6) and Third Biennial Report of The Republic of Croatia Under The United Nations Framework Convention On Climate Change URL: https://unfccc.int/sites/default/files/resource/2671905483_Croatia-NC7-BR3-2-96481035_Croatia-NC7-BR3-2-7.%20NC%20i%203.%20BR_resubmission_IX_2018_0.pdf

75 WHO (2010). Croatia. URL: http://www.euro.who.int/__data/assets/pdf_file/0006/82293/croatia_protect_health_factsheets.pdf?ua=1

Higher temperatures, heat waves and heat extremes are a major concern for Croatia. The annual distribution of days with a high-heat index provides insight into the health hazard of heat. **Figure 13** shows the expected Number of Days with a Heat Index >35°C through the 2090s. Heat indices in Croatia accelerate by mid-century and continuing to sharply increase under a high-emission scenario by end of the century. Increased health threats can be projected and monitored through the frequency of tropical nights. Tropical Nights (>20°C) (**Figure 14**) represents the projected increase in tropical nights for different emission scenarios to demonstrate the difference in expected numbers of tropical nights; expected to rapidly increase in a high-emission scenario.

FIGURE 13. Projected days with a Heat Index >35°C (Reference Period, 1986–2005)[76]

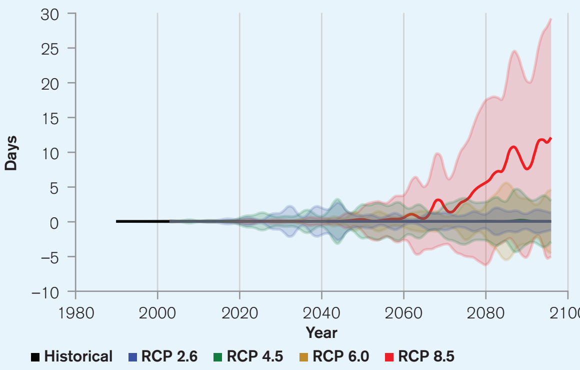
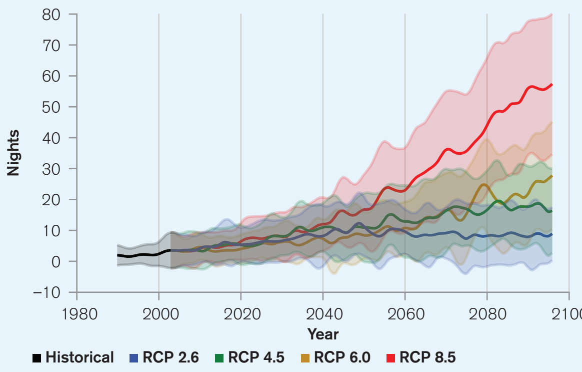


FIGURE 14. Projected number of Tropical Nights (Tmin >20°C) (Reference Period, 1986–2005)[77]



Adaptation Options

Croatia's healthcare system personnel should be trained to be more fully aware of the relationship between climate change and variability and health impacts. There has been no specific training of the personnel in regard to adaptation to climate change and mitigating its negative health impacts. Increases in training and capacity can improve the level of knowledge and skills to prevent diseases connected with climatic factors, however this knowledge remains relatively limited among the general population. Adaptation measures in health sector should meet several specific objectives:

- To strengthen the competencies of the health system on the effects of climate change on health.
- To strengthen the competencies of the health system to respond during future adaptation.
- Identify sectoral priorities for action related to climate change.
- Expansion of the system of monitoring health and environmental indicators related to climate change and the risk assessment system.
- Influence on the epidemiology of diseases related to climatological factors.[78]

[76] WBG Climate Change Knowledge Portal (CCKP, 2021). Croatia Health Sector Dashboard. URL: https://climatedata.worldbank.org/CRMePortal/web/health/systems-and-service?country=HRV&period=2080-2099

[77] WBG Climate Change Knowledge Portal (CCKP, 2021). Croatia Health Sector Dashboard. URL: https://climatedata.worldbank.org/CRMePortal/web/health/systems-and-service?country=HRV&period=2080-2099

[78] Ministry of Environment and Nature Protection (2018). Seventh National Communication (NC6) and Third Biennial Report of The Republic of Croatia Under The United Nations Framework Convention On Climate Change URL: https://unfccc.int/sites/default/files/resource/2671905483_Croatia-NC7-BR3-2-96481035_Croatia-NC7-BR3-2-7.%20NC%20i%203.%20BR_resubmission_IX_2018_0.pdf

Early warning systems can also be developed to improve the country's resilience by providing timely information on the atmospheric state and effects of such a state on the organism. Additionally, biometeorological forecasts can impact human health through daily public informing on expected meteorological conditions in order to give certain advice on health protection and symptoms prevention. Similar information, such as Croatia's bio-forecasts such as Pollen-calendars regularly appear in daily press and radio and television news broadcasts.[79] General awareness campaigns regarding climate change and its impact to human health is critical, especially for most vulnerable groups such as children and the elderly. The expansion of studied on the assessment of climate change impacts on population health have been requested.

Tourism

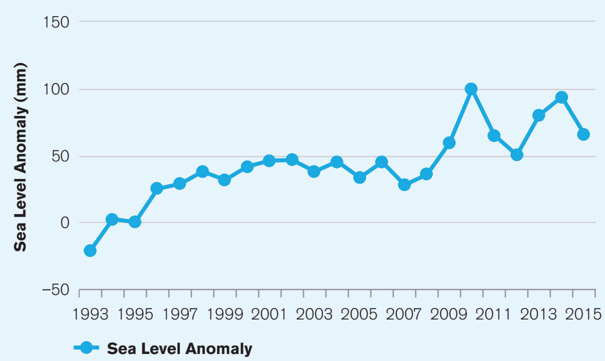
Climate Change Impacts

The tourism sector is a critical piece of the Croatian economy and has long played a central role in the country. The sector generates approximately 20% GDP and 28% of total employment. Hotter daytime temperatures along the Adriatic coast may cause many beach tourists to avoid these destinations in favor of cooler locations to the north. This could have serious economic consequences on many local communities, given the important role of beach tourism, also for the national economy. Alternatively, climate change may benefit other areas of Croatia's burgeoning tourism sector by lengthening the tourist season or creating two seasons for visitors—the spring and the autumn.[80]

Climate Change Impacts

Climate change impacts on Croatia's tourism industry are expected to be significant. Given the projected increases in temperatures and prolonged hot-seasons, climate change impacts are expected to create uncomfortably hot summers (specifically July and August) along the Adriatic coast which may impact visitors and especially beach tourism. Spring and autumn seasons are expected to increase in attractiveness for tourists at the Croatian coast.[81] Tourism infrastructure may also be at risk due to coastal flooding. The tourism sector is being included in the development of future adaptation strategies. **Figure 15** shows the change in sea level rise for Croatia's coast line since 1993.

FIGURE 15. Sea level rise in Croatia, 1993–2015[82]



[79] UNDP (2009). Climate Change in Croatia: New Human Development Report launched. [16 February, 2009]. URL: https://www.undp.org/content/undp/en/home/presscenter/pressreleases/2009/02/16/climate-change-in-croatia-new-human-development-report-launched.html#:~:text=Climate%20change%20in%20Croatia%20could,the%20groundwater%20used%20for%20drinking.

[80] EU (2017). Draft Climate change Adaptation Strategy in the Republic of Croatia for the period to 2040 with a view to 2070 (White book). Croatia. URL: http://prilagodba-klimi.hr/wp-content/uploads/docs/Draft%20CC%20Adaptation%20Strategy.pdf

[81] WBG Climate Change Knowledge Portal (CCKP, 2020). Croatia Impacts- Sea Level Rise. URL: https://climateknowledgeportal.worldbank.org/country/croatia/impacts-sea-level-rise

[82] Ministry of Environment and Nature Protection (2018). Seventh National Communication (NC6) and Third Biennial Report of The Republic of Croatia Under The United Nations Framework Convention On Climate Change URL: https://unfccc.int/sites/default/files/resource/2671905483_Croatia-NC7-BR3-2-96481035_Croatia-NC7-BR3-2-7.%20NC%20i%203.%20BR_resubmission_IX_2018_0.pdf

Adaptation Options

Much of the country's current tourism infrastructure is situated along the coast, it will be important to consider future changes in sea level and sea surface temperature, when planning future development in the area. Plans to extend the main tourism season to April, May, and September should be made. The past few years have indicated that June and September have a favorable sea and air temperature, both for swimming and sunbathing, while July and August are becoming more unstable, both in temperature and in precipitation extremes.[83] Adaptation measures in the tourism sector should include:

- Adequate flexibility of the tourism sector for the impact of climate change and the possibility of adaptation;
- Inclusion of adaptation to climate change in all segments of sustainable development of Croatian tourism;
- Compliance of tourism planning with forecasted climate change; and
- Strengthening climate change adaptation competencies of all persons engaged in the tourism sector

The Croatian government has the potential to support the tourism sector in adapting to climate change, however, it is necessary to conduct a thorough overview to establish the most effective ways for the local and national government structures. This would involve an examination of the direct and indirect ways in which the government at each level is currently involved in the tourism sector, which should indicate possible ways forward for the government to support the industry in the future.[84]

ADAPTATION

Institutional Framework for Adaptation

Croatia has confirmed its commitment to fighting climate change as a signatory to agreements and treaties dealing with climate change, global warming, CO2 emissions, reduction of greenhouse gases and incorporated these into its own policies and strategies.[85] Croatia has been ratified as an Annex 1 country to the UNFCCC. In 2015, Croatia ratified the Hyogo Framework for Action and has established a National Platform for Disaster Risk Reduction. Climate change related activities are overseen by the Ministry of Economy and Sustainable Development, with the Climate Change Directorate. Rescue Directorate, which is responsible for coordinating

[83] Kalinski, V. (2017). Results of Climate Modeling at the System HPC Velebit for the development of the NAS and NAP. URL: http://prilagodba-klimi.hr/wp-content/uploads/2017/11/Klimatsko-modeliranje.pdf

[84] EU (2012). Climate Vulnerability Assessment: Croatia. URL: http://www.seeclimateforum.org/upload/document/cva_croatia_-_english_final_print2.pdf

[85] Ministry of Environment and Nature Protection (2018). Seventh National Communication (NC6) and Third Biennial Report of The Republic of Croatia Under The United Nations Framework Convention On Climate Change URL: https://unfccc.int/sites/default/files/resource/2671905483_Croatia-NC7-BR3-2-96481035_Croatia-NC7-BR3-2-7.%20NC%20i%203.%20BR_resubmission_IX_2018_0.pdf

disaster response, is placed within the Ministry of Interior. Croatia is also engaged regionally through initiatives such as the South East European Climate Change Framework Action Plan for Adaptation to encourage cooperation.[86] These are not legally binding agreements, however, and therefore not enforceable.

Policy Framework for Adaptation

The country's climate change adaptation strategy is guided by its Seventh National Communication and Third Biennial report for the UN Framework Convention on Climate Change (2018). Croatia is also a signatory to the European Union's Updated Nationally Determined Contributions (NDC), submitted in 2020.[87] The capacity of the Croatian state and society to adapt to climate change can be improved through the development of sectoral adaptation strategies, which are mainstreamed across government planning. Current government strategies relating to climate change in Croatia emphasize mitigation, and there is little mention of the concept of adaptation. Government ministries and national bodies will need to take into account the future effects of climate change when developing their strategic plans for the coming years and decades, including ministries and agencies responsible for the agricultural, energy, tourism and water sectors. Additional evidence to inform policy and adaptation strategies is needed for the development of a more comprehensive adaptation framework.

There is potential for the country to develop a low-carbon economy and to begin to actively adapt to climate change.[88] This reality, along with mainstreamed adaptation and resilience planning needs to be driven by concerted government effort, in coordination to the development of effective cooperation and collaboration between relevant government departments to adequately integrate climate change adaptation in existing policies, foster the elaboration of a national climate change adaptation strategy, and national climate change adaptation plan.

Croatia has made a firm commitment to reducing emissions by introducing a carbon fee, promoting renewable energy, encouraging energy efficiency, and committing to GHG reductions under the Kyoto Protocol. There exists a significant amount of technological and intellectual capacity in Croatia to reduce emissions. Various businesses, NGOs and expert organizations are already engaged. Engagement and information sharing across sectors would improve the country's adaptation and resilience capabilities. This is especially true among state actors that are not already heavily engaged such as the Ministry of Agriculture, Ministry or Regional Development and EU Funds, the Ministry of the Sea, Transport and Infrastructure, and the Ministry of Tourism.[89]

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86 EU (2017). Draft Climate change Adaptation Strategy in the Republic of Croatia for the period to 2040 with a view to 2070 (White book). Croatia. URL: http://prilagodba-klimi.hr/wp-content/uploads/docs/Draft%20CC%20Adaptation%20Strategy.pdf

87 EU (2016). Nationally Determined Contribution of the EU and its Member States. URL: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Austria%20First/LV-03-06-EU%20INDC.pdf

88 Republic of Croatia (2019). Integrated National Energy and Climate Plan for the Republic of Croatia for the period 2021–2030. Ministry of Environment and Energy. URL: https://mingor.gov.hr/UserDocsImages/UPRAVA%20ZA%20ENERGETIKU/Strategije,%20planovi%20i%20programi/hr%20necp/Integrated%20Nacional%20Energy%20and%20Climate%20Plan%20for%20the%20Republic%20of_Croatia.pdf

89 EU (2017). Draft Climate change Adaptation Strategy in the Republic of Croatia for the period to 2040 with a view to 2070 (White book). Croatia. URL: http://prilagodba-klimi.hr/wp-content/uploads/docs/Draft%20CC%20Adaptation%20Strategy.pdf

National Frameworks and Plans

- Law on Climate Change and Protection of Ozone Layer (2019) (Croatian)
- Integrated National Energy and Climate Plan for the Republic of Croatia for the period 2021–2030 (2019)
- Environmental Protection Act (2019) (includes Plan for Air Protection)
- Air Protection Act (2019)
- Seventh National Communication and Third Biennial Update Report (2018)
- Draft Action Plan for Implementing The Strategy on Adaptation to Climate Change in The Republic Of Croatia for the Period From 2019 to 2023 (2017)
- National Adaptation Strategy until 2040 with an outlook on 2070 (2017, ratified 2020)
- Nationally Determined Contributions (2016)
- Sixth National Communication (2014)
- The Environmental Protection Act (2013)
- Plan for the Protection of the Air, the Ozone Layer and Climate Change Mitigation in the Republic of Croatia (2013)
- South East European Forum on Climate Change Adaptation (2012)

Recommendations

Research Gaps

- Improve science-based understanding of the nature and magnitude of physical and biophysical climate change impacts under differing scenarios, specifically for Croatia's health sector
- Widen the participation of the public and scientific institutions, under the coordination of the Croatian Science of Foundation and the Meteorological and Hydrological Service for improved adaptation response coordination and effectiveness of community participation
- Continue to build on improvements from recent investments to national hydrometeorological observation equipment, networks and technical modeling capacities, specifically regarding the Adriatic Decadal and Interannual Oscillations[90]
- Integrate data obtained from meteorological stations to support the monitoring and evaluation of long-range transboundary pollutions across the EU
- Determine potential risks to human health due to exposure to air pollution, particularly for sensitive populations

[90] Ministry of Environment and Nature Protection (2018). Seventh National Communication (NC6) and Third Biennial Report of The Republic of Croatia Under The United Nations Framework Convention On Climate Change URL: https://unfccc.int/sites/default/files/resource/2671905483_Croatia-NC7-BR3-2-96481035_Croatia-NC7-BR3-2-7.%20NC%20i%203.%20BR_resubmission_IX_2018_0.pdf

Data and Information Gaps

- Modernization of existing surface and upper air meteorological network that includes updates to existing and installation of new equipment
- Improved data availability — In many sectors such as agriculture, tourism, water resources, the data is still not available (or limited) to estimate the impacts of future climate change for Croatia's economy. Many of the data needed to estimate the future damages from climate change and avoid them through adaptation would also help with existing climate variability and help better target existing policies/programs
- Improved modelling of environmental and economic systems — Models of the Croatian economy, the climate, and various sectors can be very helpful in understanding the causal relationships within the Croatian economy. This is important for climate change and for economic development in general. The link between climate and economic systems still needs to be made within Croatia
- Continued improvement of technical capacity to analyze hydro-met data and project impacts across sectors
- Develop an early warning system about dangerous hydrometeorological phenomena and climate risk management

Institutional Gaps

- Coordination of the activities across sectors and actors, including Croatia's government ministries and private entities/ firms in order to engage with discussion on what Croatia does in addressing vulnerability to climate and in mitigating Croatia's emissions
- Integrate climate into the development of physical plans on the coast to minimize the risk from sea-level rise, targeting subsidies in the agriculture sector to reduce climate vulnerability, physical planning and energy planning that will reduce emissions but also take into account changing environmental conditions, being prepared to deal with health problems which may arise from heat waves, and many other areas[91]
- Increase mechanisms for knowledge and technology transfers between Croatia and the EU regarding environmental protections and adaptation planning
- Involve and engage the Croatian public to increase awareness of climate change impacts and the adaptation efforts undertaken by the Croatian Government[92]

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[91] EU (2017). National Adaptation Strategy until 2040 with an outlook on 2070 (2017, ratified 2020). URL: http://prilagodba-klimi.hr/wp-content/uploads/docs/Draft%20CC%20Adaptation%20Strategy.pdf

[92] Republic of Croatia (2019). Integrated National Energy and Climate Plan for the Republic of Croatia for the period 2021–2030. Ministry of Environment and Energy. URL: https://mingor.gov.hr/UserDocsImages/UPRAVA%20ZA%20ENERGETIKU/Strategije,%20planovi%20i%20programi/hr%20necp/Integrated%20Nacional%20Energy%20and%20Climate%20Plan%20for%20the%20Republic%20of_Croatia.pdf

CLIMATE RISK COUNTRY PROFILE

CROATIA

WORLD BANK GROUP