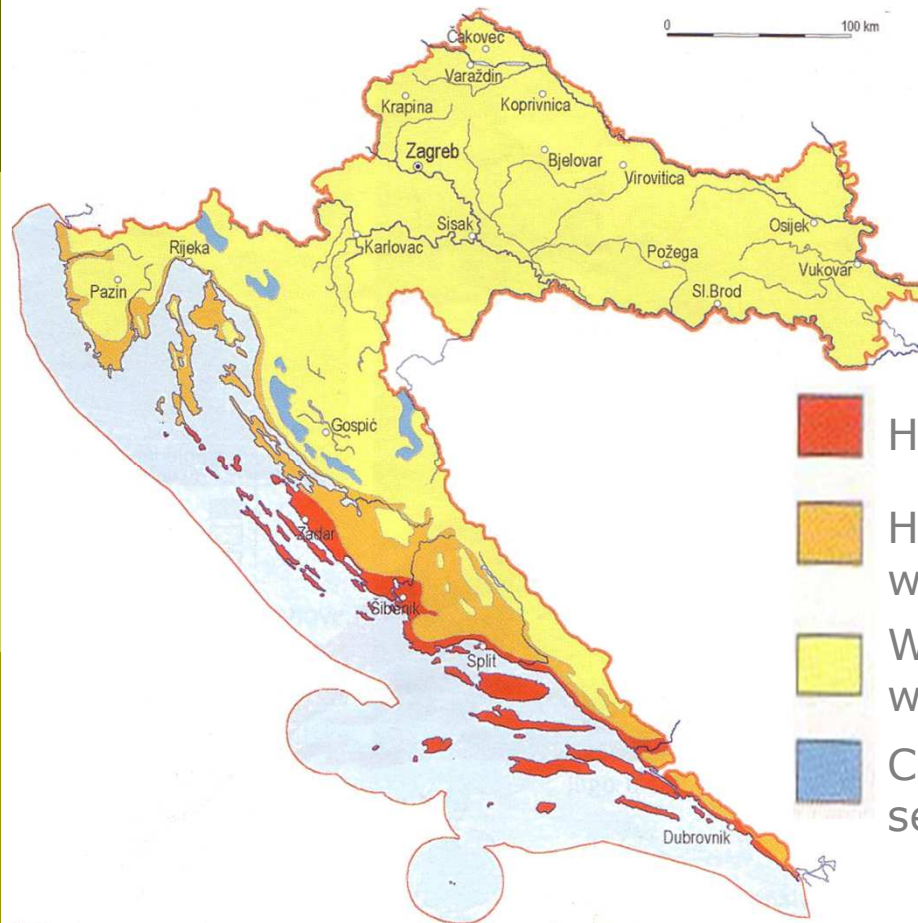


Climate Change in Croatia - *Grooming* Disasters





Climate Change Consequences in
Croatia

40

Climate in Croatia

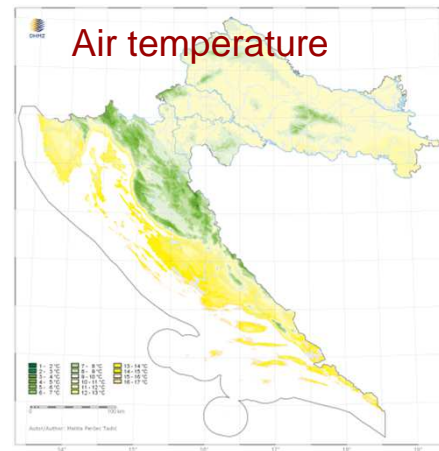
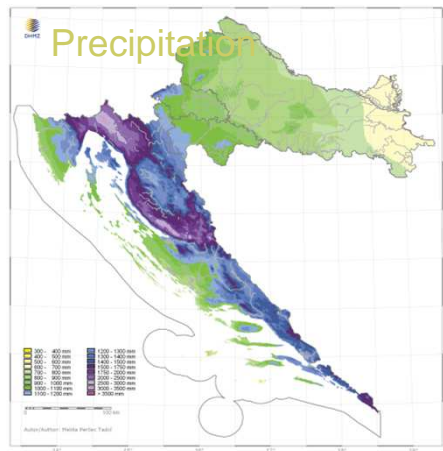
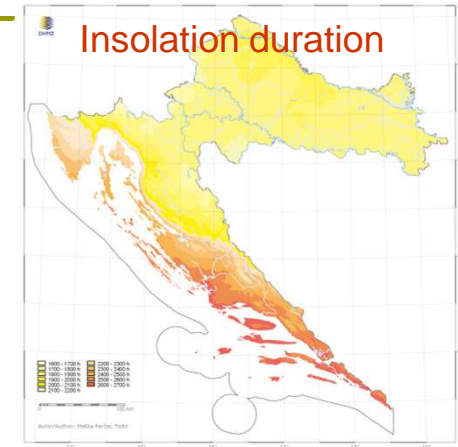


Köppen classification

-  Hot-summer Mediterranean climate (Csa)
-  Hot, humid summers and mild to cool winters (Cfa)
-  Warm, humid summers and mild to cool winters (Cfb)
-  Cold continental climate without dry season (Df)

Climatic Diversity in Croatia

Large spatial differences
between continental lowland,
transitional mountainous region
and Adriatic coast



Zaninović, K., Gajić-Čapka, M., Perčec Tadić, M. i dr., 2008:
*Klimatski atlas Hrvatske / Climate atlas of Croatia 1961-1990.,
1971-2000. Državni hidrometeorološki zavod, Zagreb, 200 str.*

Climate change in Croatia during 20th century and at the beginning of 21st century

Air temperature

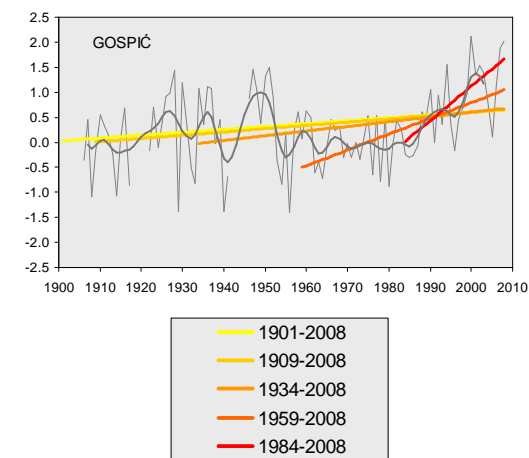
- Increase of mean annual air temperature, which in the 20th century was between $+0.02^{\circ}\text{C}$ per 10 years in Gospić up to $+0.07^{\circ}\text{C}$ per 10 years in Zagreb, continued and amplified by the beginning of the 21st century
- Prevailing positive trend has become particularly expressed within the last 50 years, even more within the last 25 years
- The positive temperature trends in the continental part of Croatia is mostly due to winter trends, while on the Adriatic to summer trends.
- Out of ten warmest years since the beginning of the 20th century, since 2000, there were 7 recorded in Zagreb, 6 in Gospić and Crikvenica, 5 in Hvar and 4 in Osijek.
- Within the whole analyzed period, a majority of warm temperature indices has a positive trend, while a majority of cold temperature indices has a negative trend
- Trends are much more expressed at the Adriatic, than in the inland, except in Zagreb, where they were probably partly a result of urban heat island impact.
- Almost all trends by 2008 have been amplified, and changes in trends of warm temperature indices are greater than changes in trends of cold indices.

Five meteorological stations in different climatic regions:
Zagreb-Grič, Crikvenica, Osijek, Gospić, Hvar

Temperature trends ($^{\circ}\text{C}/10\text{yrs}$), 1901-2008

	OS	ZG	GO	CR	HV
DJF	0.60	1.25	1.33	0.76	0.39
MAM	0.50	1.09	0.46	0.40	0.52
JJA	0.55	0.92	0.39	1.34	0.71
SON	0.30	0.70	0.25	0.85	0.50
A	0.50	0.99	0.58	0.85	0.56

Trends in mean annual temperature



Fifth National Communication of the Republic of Croatia under the United Nation Framework Convention on the Climate Change, Ministry of Environmental Protection, Physical Planning and Construction, 137-143.

http://unfccc.int/national_reports/annex_i_natcom/submitted_natcom/items/4903.php

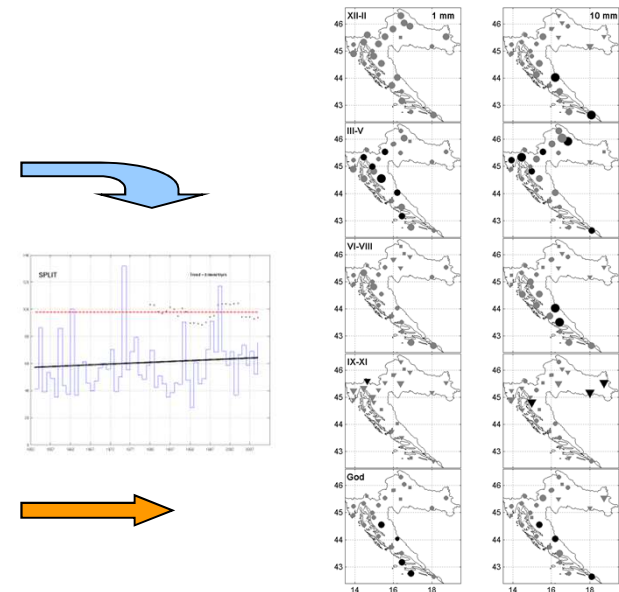
Climate change in Croatia during 20th century and at the beginning of 21st century

Precipitation

- There has been drying all over Croatia on annual scale
 - more pronounced at the coast than in the mainland
 - Primorje: in all seasons
 - Dalmacija: winter and spring
 - Lika: winter and spring
 - north from the Sava River: spring and autumn
- Decrease in interannual variability is mainly indicated
- In the area of drying such as Croatia there is no signal of major secular changes in extremes related to the high amounts of precipitation and frequency of rainy and very rainy days over the larger part of Croatia.
- The reduction in annual amounts of precipitation can be attributed to changes in the frequency of low-intensity rain days and significant increase in incidence of dry days all over Croatia.
- There is the predominant increase in dry spells in the Adriatic and poorly pronounced trend in the continental area

Precipitation trends (%/10yrs), 1901-2008

	OS	ZG	GO#	CR	HV
DJF	-0.0	-0.4	-2.9	-1.6	-2.9
MAM	-3.2	-0.9	-1.8	-1.9	-1.3
JJA	+1.3	+1.1	+0.1	-2.9	+2.9
SON	-2.0	-1.3	-0.2	-1.1	-0.5
A	-0.8	-0.3	-1.0	-1.7	-1.0

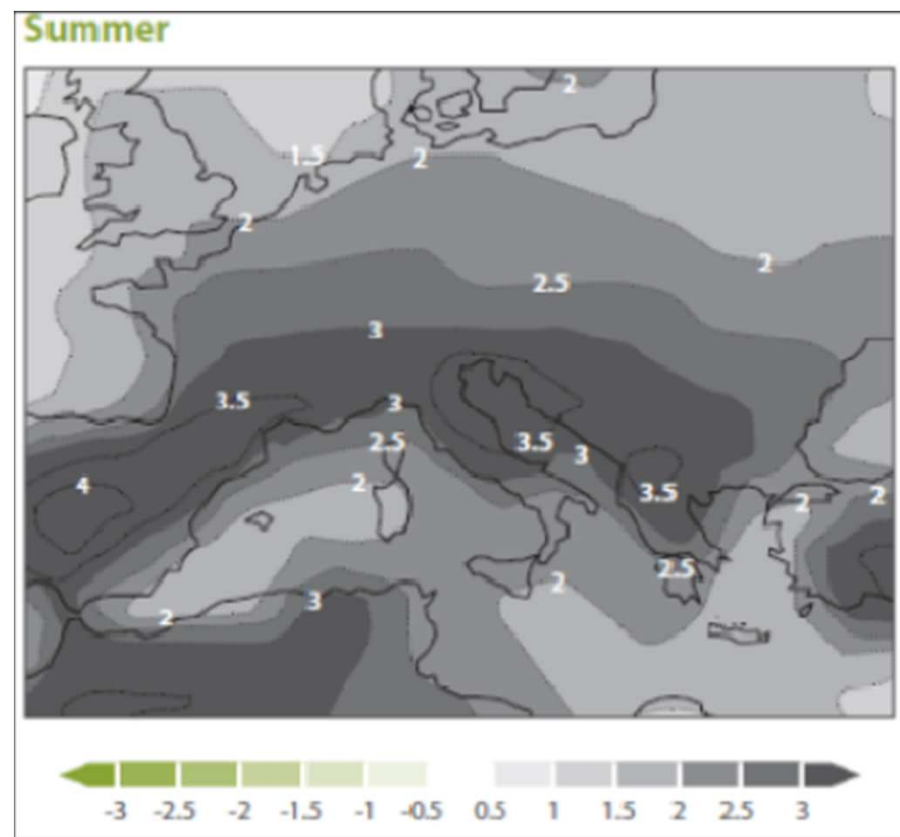


Fifth National Communication of the Republic of Croatia under the United Nation Framework Convention on the Climate Change, Ministry of Environmental Protection, Physical Planning and Construction, 137-143.

http://unfccc.int/national_reports/annex_i_natcom/submitted_natcom/items/4903.php

Climate Predictions

- ❑ In general, Croatia is predicted to get warmer and drier – especially during the summer.
- ❑ Surface snow in northern Croatia will become uncertain.
- ❑ Soil moisture in the spring is expected to drop.



Extreme weather conditions:

- ▣ Floods
- ▣ Droughts
- ▣ Heat waves (long-term)
- ▣ Thunderstorms

CC effect:

Tourism

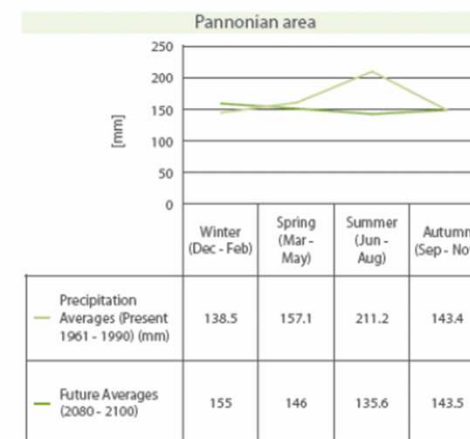
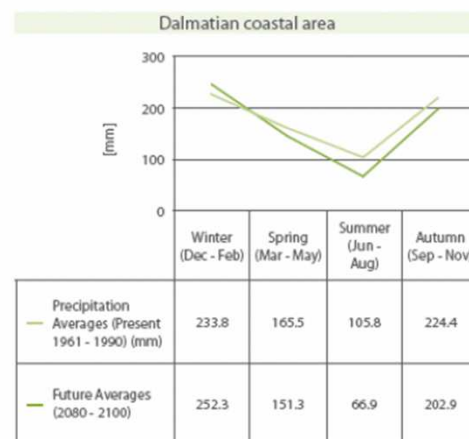
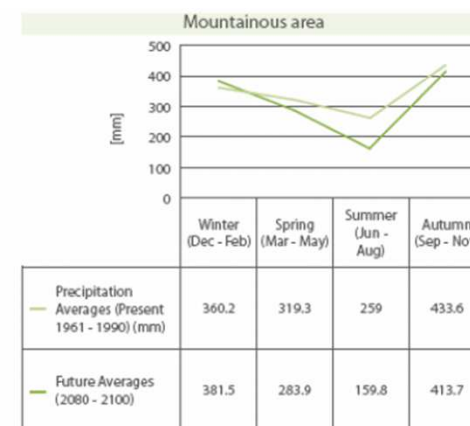
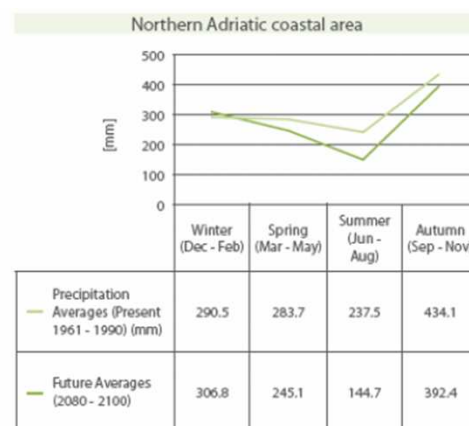
- ❑ Contributes significantly to human development in Croatia through the jobs and incomes that it creates for people.
- ❑ In Croatia, climate is especially important for tourism.
- ❑ The Adriatic is an ideal place for enjoying the sea during the summer months.
- ❑ Most tourism takes place outdoors.
- ❑ Hotter day-time temperatures along the Adriatic coast are expected to cause many beach tourists to avoid these destinations in favor of cooler locations to the north.
- ❑ Specific natural sites may also be at risk due to climate change – study is required into the probable physical impacts of climate change on specific areas (e.g. Plitvice)

Health Impacts

- ❑ Events such as heat waves – likely to increase in frequency due to climate change – have had an impact on Croatians. Every year during the summer there are several deaths caused by extreme temperatures.
- ❑ Therefore, it is very likely that climate change will have an impact on human health in Croatia both bad and good –

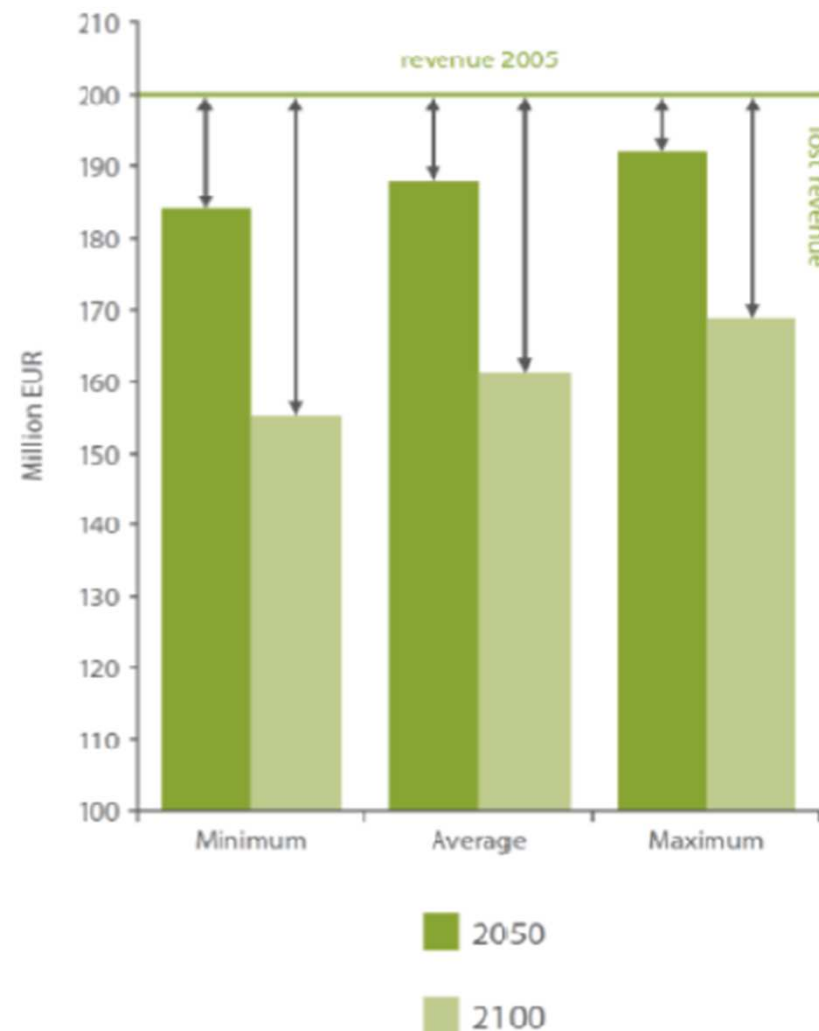
Fresh-water Resources

- ❑ During summer months, 30% less precipitation
- ❑ Dying of oak trees and other species in drought areas
- ❑ Generation from hydro lower for 20-50% until 2100



Agriculture

- Looking at the future effect of climate change on maize alone, the lost revenue due to climate change would be dramatic.
- Little information is available to aid in understanding or adapting to current climate variability or future climate change.





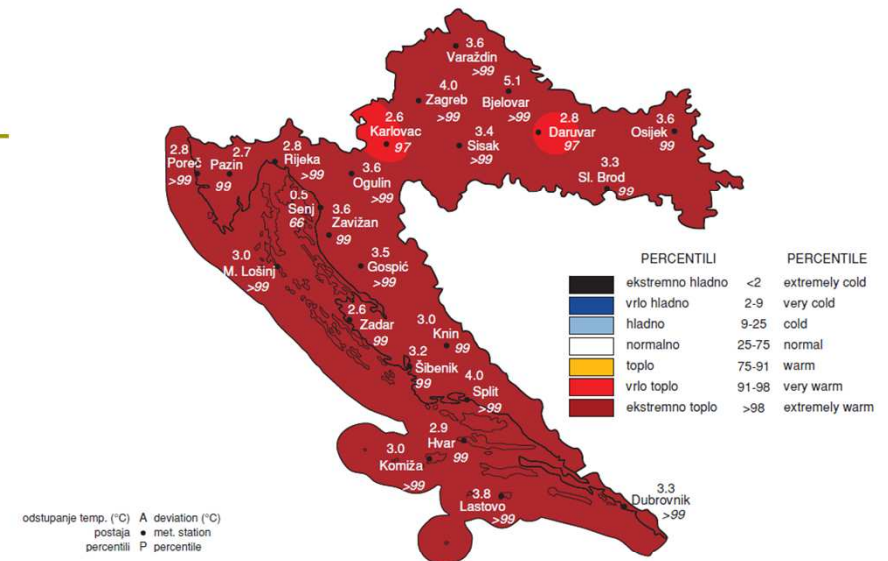
HEAT WAVE AND DROUGHT 2003.

CCiC

□ Situation - may

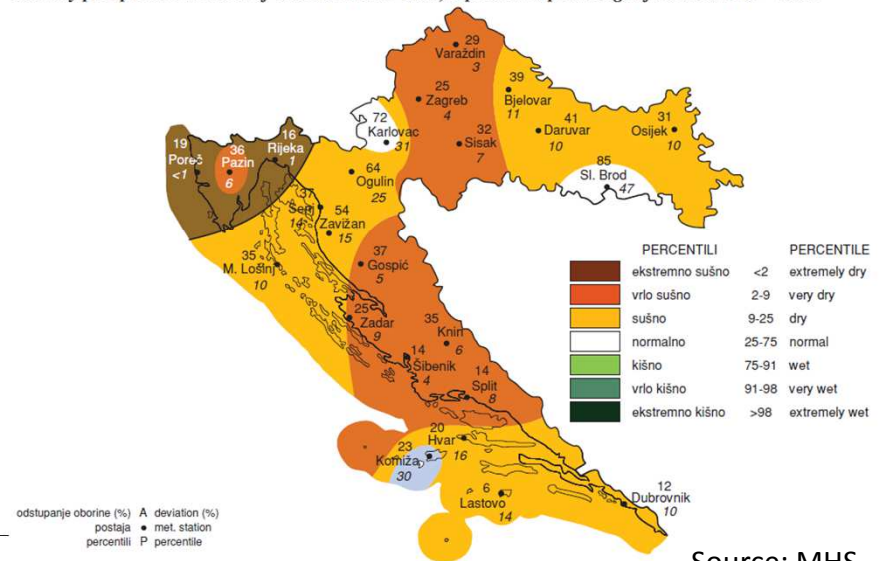
Odstupanje srednje mjesečne temperature zraka (°C) u SVIBNJU 2003. od prosječnih vrijednosti (1961—1990).

Monthly air temperature anomalies in Croatia in MAY 2003, from normals 1961—1990.



Mjesečne količine oborine u SVIBNJU 2003, u odnosu na prosječne vrijednosti (1961—1990), izražene u (%).

Monthly precipitation amounts of Croatia in MAY 2003, expressed as percentage of normals 1961—1990.



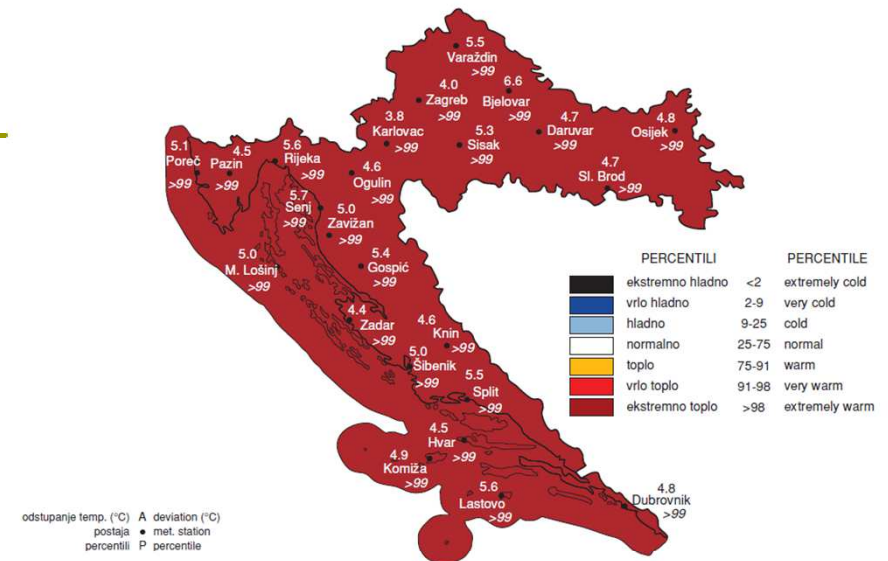
Source: MHS

CCiC

□ Situation - june

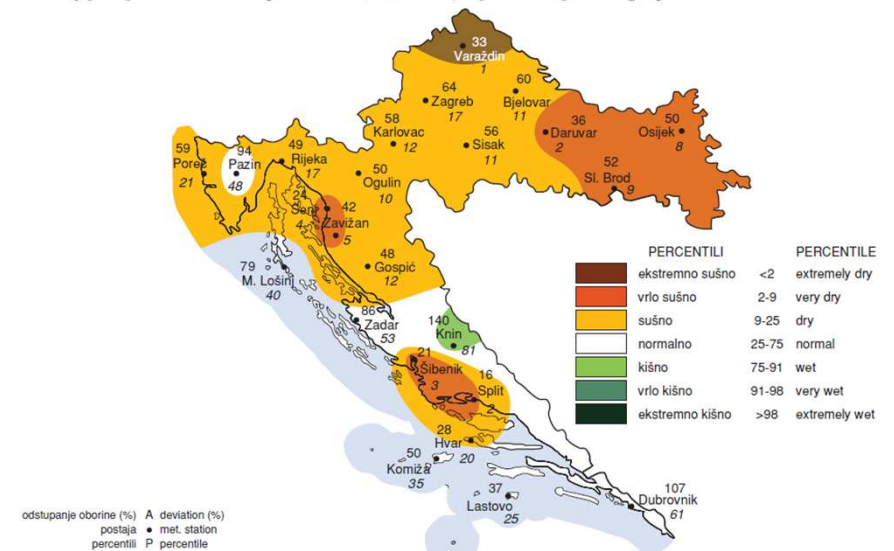
Odstupanje srednje mjesečne temperature zraka (°C) u LIPNJU 2003. od prosječnih vrijednosti (1961—1990).

Monthly air temperature anomalies in Croatia in JUNE 2003, from normals 1961—1990.



Mjesečne količine oborine u LIPNJU 2003, u odnosu na prosječne vrijednosti (1961—1990), izražene u (%).

Monthly precipitation amounts of Croatia in JUNE 2003, expressed as percentage of normals 1961—1990.



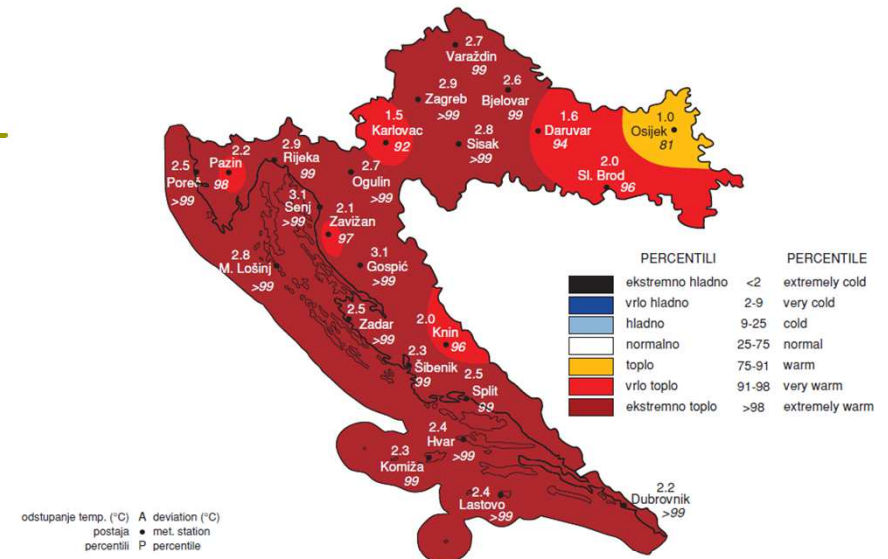
Source: MHS

CCiC

□ Situation - july

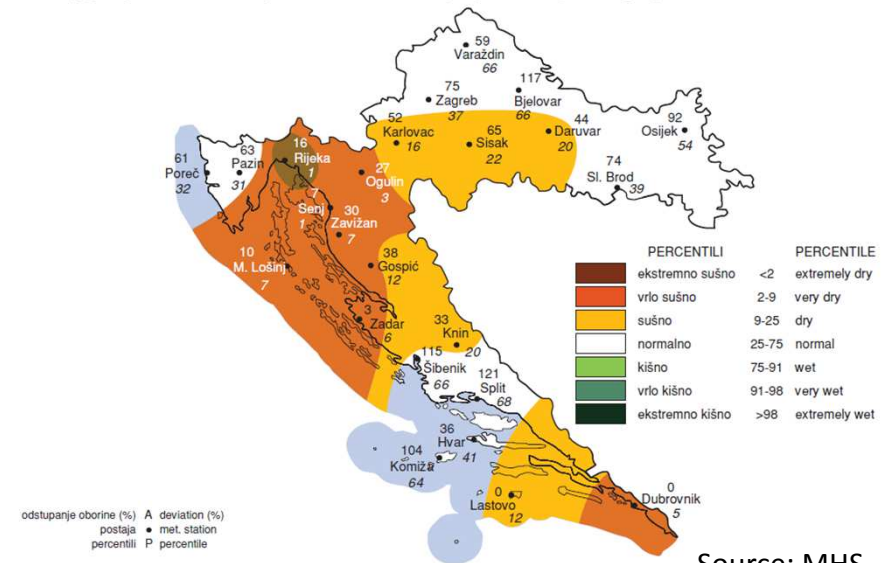
Odstupanje srednje mjesečne temperature zraka (°C) u SRPNJU 2003. od prosječnih vrijednosti (1961—1990).

Monthly air temperature anomalies in Croatia in JULY 2003, from normals 1961—1990.



Mjesečne količine oborine u SRPNJU 2003. u odnosu na prosječne vrijednosti (1961—1990), izražene u (%).

Monthly precipitation amounts of Croatia in JULY 2003, expressed as percentage of normals 1961—1990.



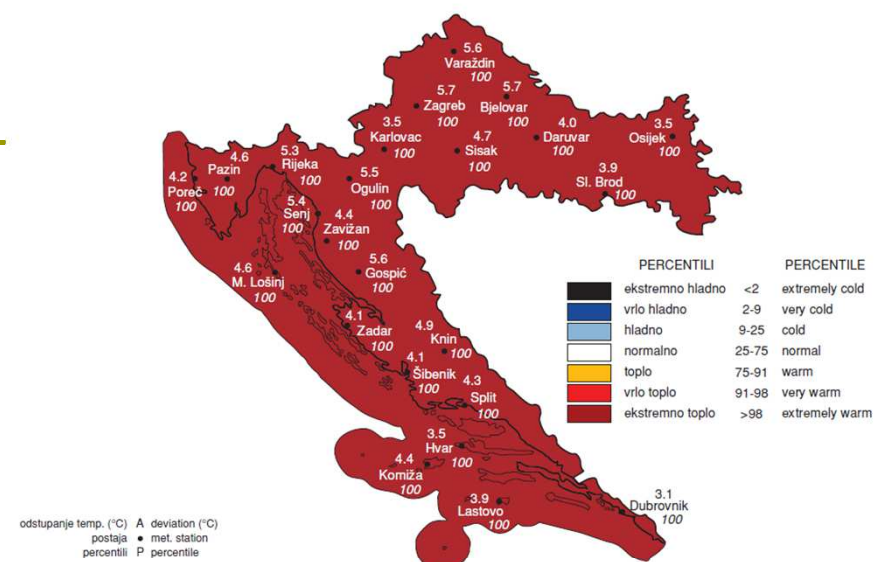
Source: MHS

CCiC

□ Situation - august

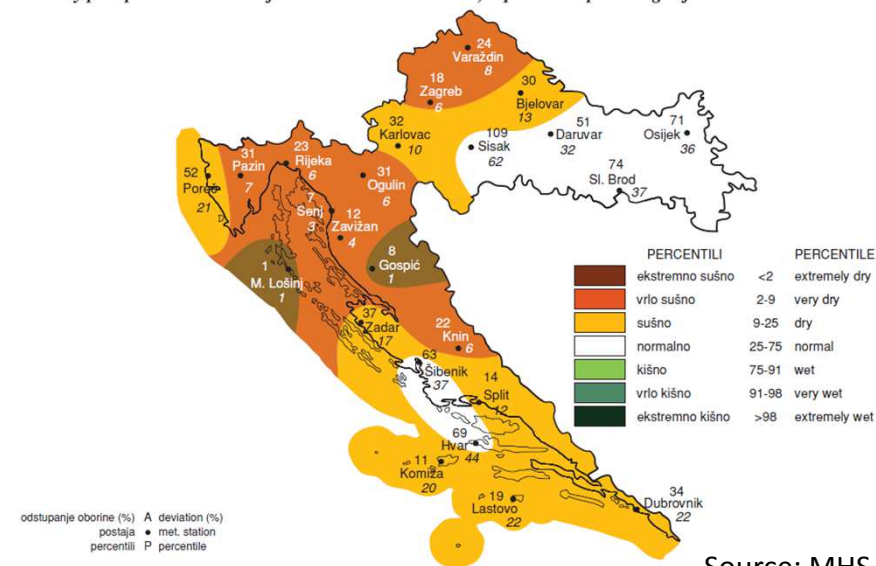
Odstupanje srednje mjesečne temperature zraka (°C) u KOLOVOZU 2003. od prosječnih vrijednosti (1961—1990).

Monthly air temperature anomalies in Croatia in AUGUST 2003, from normals 1961—1990.



Mjesečne količine oborine u KOLOVOZU 2003, u odnosu na prosječne vrijednosti (1961—1990), izražene u (%).

Monthly precipitation amounts of Croatia in AUGUST 2003, expressed as percentage of normals 1961—1990.

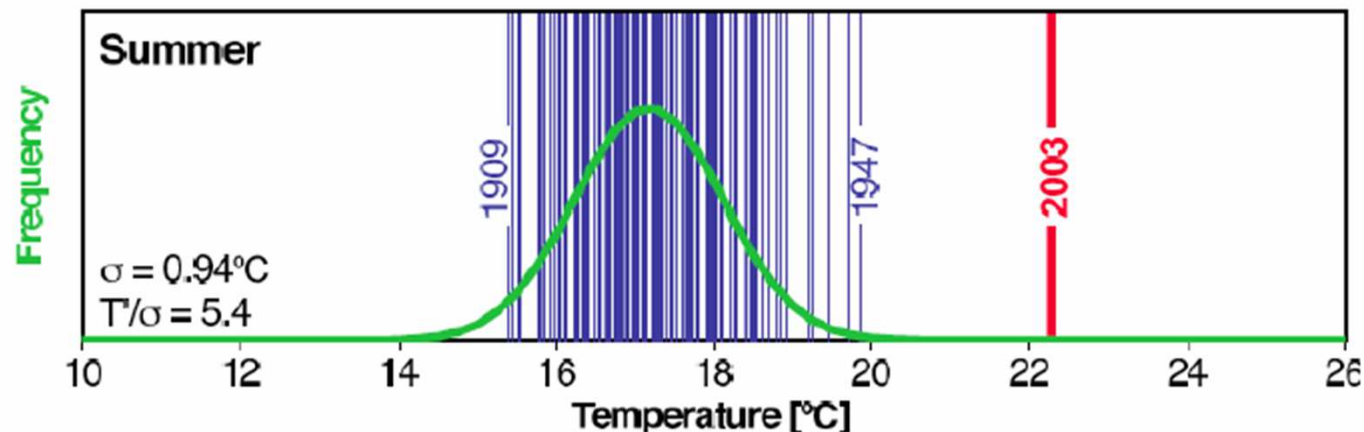


Source: MHS

CCiC

Already perceived climate change

- ❑ The same year, electricity production from hydro power plant's in Croatia dropped 20 % – cost was 96 mil EUR to compensate losses
- ❑ Extreme weather events in period 2000 – 2007 resulted in an average annual costs of 176 mil EUR for agriculture – amount higher than amount paid for incentives in agriculture within that period



Aftermath

- ▣ US\$ 330 000 000 economic damage (2003.)
- ▣ 30-50 % decrease crop output
- ▣ Unspecified damage to freshwater fish industry
- ▣ Widening of the forest fires area from the coast to the inland (central Istria, Lika region, inland part of Dalmatia)
- ▣ Extension of the wildfires season (in 1990-es from the end of May to the end of August, now from February to the end of September)

CCiC

Actions taken

- ▣ US\$ 50 000 000 (2003.)
- ▣ Croatian waters and local communities starts to work on modernizing old and build new irrigation systems
- ▣ Every day medical advices



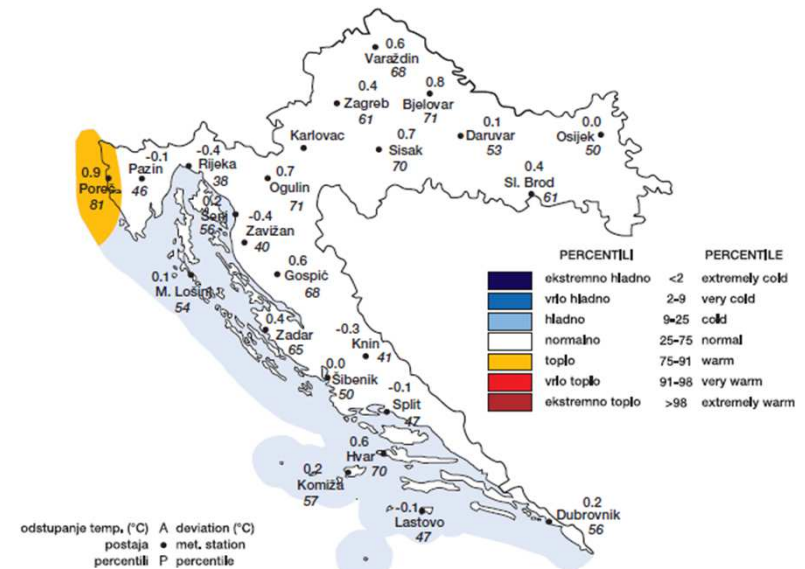
FLOODS CENTRAL AND EASTERN CROATIA 2010.

CCiC

□ Situation - may

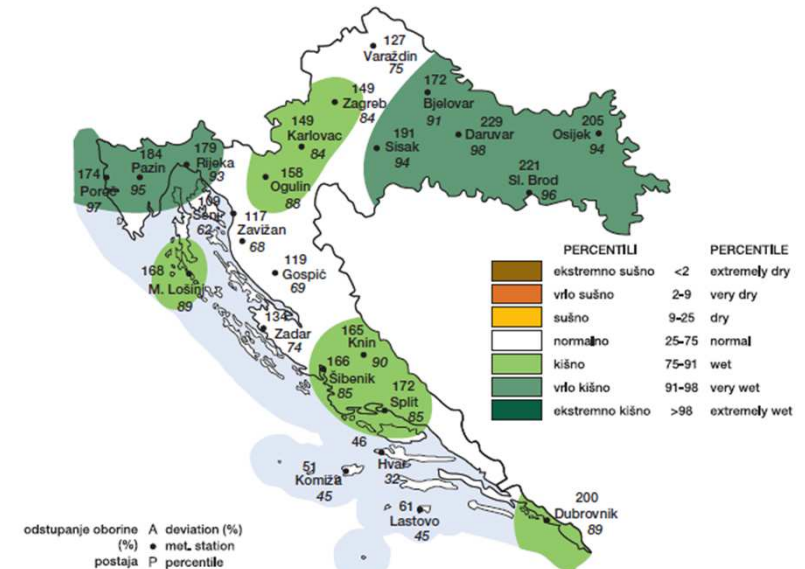
Odstupanje srednje mjesečne temperature zraka (°C) u SVIBNJU 2010., od prosječnih vrijednosti 1961—1990.

Monthly air temperature anomalies in Croatia in MAY 2010, from normals 1961—1990.



Mjesečne količine oborine u SVIBNJU 2010., u odnosu na prosječne vrijednosti 1961—1990, izražene u percentilima.

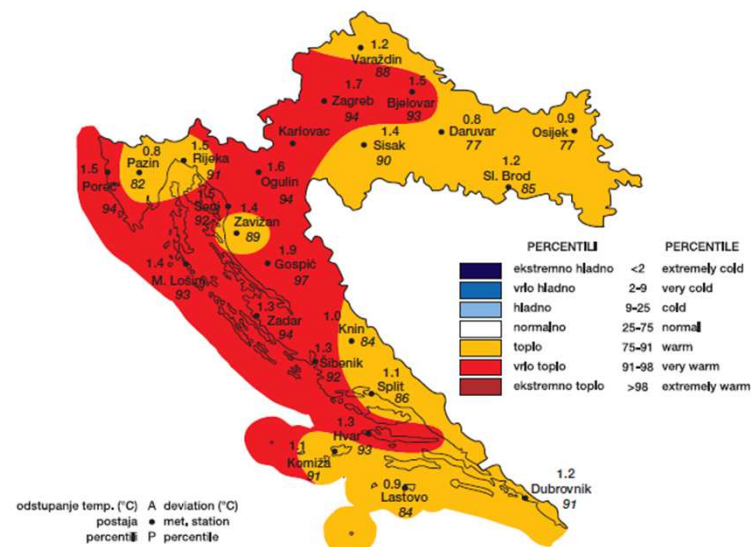
Monthly precipitation amounts of Croatia in MAY 2010, expressed as percentage of normals 1961—1990.



□ Situation - june

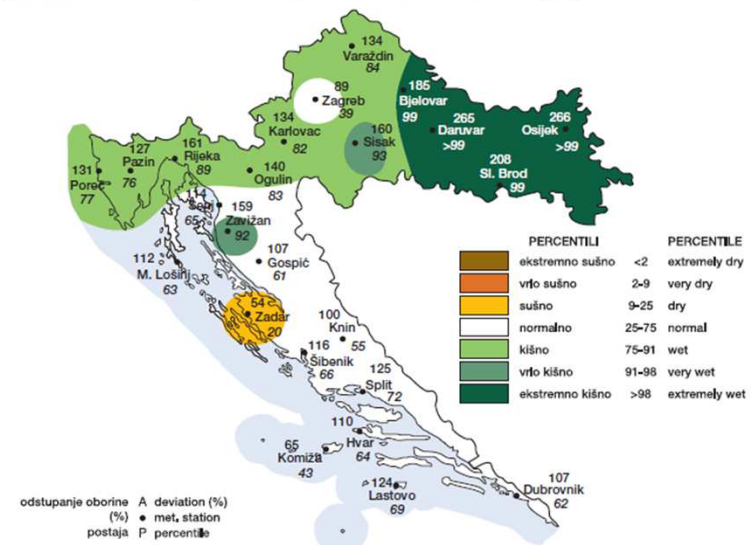
Odstupanje srednje mjesečne temperature zraka (°C) u LIPNJU 2010., od prosječnih vrijednosti 1961—1990.

Monthly air temperature anomalies in Croatia in JUNE 2010, from normals 1961—1990.



Mjesečne količine oborine u LIPNJU 2010., u odnosu na prosječne vrijednosti 1961—1990, izražene u percentilima.

Monthly precipitation amounts of Croatia in JUNE 2010, expressed as percentage of normals 1961—1990.



Situation

- ❑ from 30 May 2010 to 26 June 2010
- ❑ very high water waves of regional proportions in the river basins of international rivers Drava, Sava and the Danube
- ❑ extremely high inflow of rivers from the Republic of Hungary and the area of Bosnia and Herzegovina coincided with extremely high precipitation in the area of Eastern Croatia that, in a short amount of time, reached the quantity of 180 mm/m²,
- ❑ the Baranja region had more than 710 mm/m² of precipitation.

Aftermath

- ❑ great damage to agriculture, fruit and vegetable growing, animal husbandry, infrastructure, property of the populations and property of local self-government units
- ❑ 427 houses, cellars and yards have been flooded
- ❑ 682 houses have been directly threatened and damaged
- ❑ 112 families have been evacuated
- ❑ 7 counties

Economic loss and expenses (Damages)

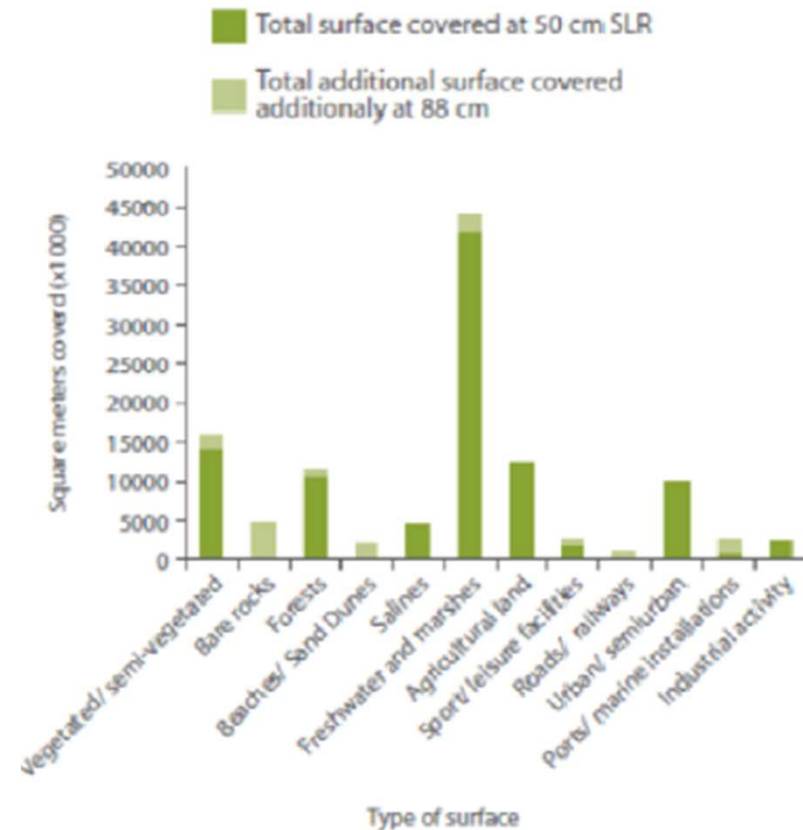
- ❑ **EUR 153.039.302,69 (66% of the original income of the affected counties)**
- ❑ Agriculture, animal husbandry, fruit growing, single construction buildings
 - EUR 141.368.441,69
- ❑ Temporary accommodation
 - EUR 2.851,39
- ❑ Rescue teams
 - EUR 136.335,78
- ❑ Cleaning potable water wells, cellars, yards etc.
 - EUR 209.472,54
- ❑ Energy, water and waste water infrastructure, transport and preventive infrastructures
 - EUR 11.322.201,29

Actions taken

- ▣ Irrigations system
- ▣ Drainage system
- ▣ 23,69% damages verified by the Government
- ▣ Amount form the EUSF: EUR 3 825 983

Coastal Zone and Sea Level Rise

- Global sea level is expected to rise between 9 and 88 cm by 2100 but there is significant uncertainty.
- The analysis suggests that the amount of land under water would be over 100 million m² with a sea-level rise of 50 cm.
- While the impacts could be very costly, they are uncertain and will occur over a fairly long time span.





COSTAL CITIES FLOODING

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Pula – 2009.

- ❑ Precipitation – 50 mm/2h
- ❑ Spatial planning – concrete, asphalt but no green areas
- ❑ Development– 400 l/s, collection and purification system could not manage that kind amount of water, old sewerage system
- ❑ Adriatic coast



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Dubrovnik

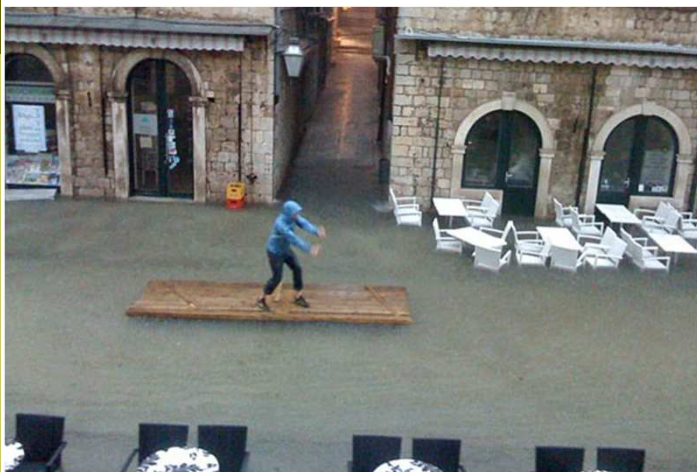


Foto: Željko Tutunjević

CCA – Ministry of Environmental Protection, Physical Planning and Construction

CCA responsible bodies:

- ❑ Ministry of Environmental Protection, Physical Planning and Construction
- ❑ Environmental Protection and Energy Efficiency Fund
- ❑ Croatian Environment Agency
- ❑ Croatian Chamber of Economy
- ❑ Ministry of Agriculture, Fisheries and Rural Development
- ❑ Ministry of Economy, Labor and Entrepreneurship
- ❑ Ekonerg - Energy and Environmental Protection Institute
- ❑ Energy Institute Hrvoje Požar
- ❑ Faculty of Agriculture
- ❑ Faculty of Mechanical Engineering and Naval Architecture
- ❑ Meteorological and Hydrological Service

CCA – Ministry of Environmental Protection, Physical Planning and Construction

Legislation:

- ❑ Air Protection Act
- ❑ Regulation on the quality of biofuels
- ❑ Regulation on the quality of petroleum-derived liquid fuels
- ❑ Regulation on the monitoring of greenhouse gas emissions in the Republic of Croatia
- ❑ Regulation on limit values for pollutant emissions from stationary sources into the air
- ❑ Guide for the implementation of the Regulation on limit values of pollutant emissions from stationary sources into the air, Chapter VI
- ❑ Regulation on emission quotas for certain pollutants in the Republic of Croatia
- ❑ Regulation on implementation of the Kyoto Protocol flexible mechanisms
- ❑ Regulation on greenhouse gas emission quotas and the method of emission allowance trading
- ❑ Regulation on amendments to the Regulation on greenhouse gas emission allowances and emissions trading
- ❑ Decision on the adoption of the National Plan for the implementation of Stockholm Convention on Persistent Organic Pollutants
- ❑ Decision on adopting the Plan on reduction of emissions of sulphur dioxide, nitrogen oxides and particulate matter from major combustion plants and gas turbines in the territory of the Republic of Croatia
- ❑ Plan on allocation of greenhouse gas emission quotas in the Republic of Croatia (National Allocation Plan)
- ❑ Programme for gradual emission reduction of certain pollutants in the Republic of Croatia for the period until the end of 2010, with emission projections for the period 2010-2020

CCA – Ministry of Environmental Protection, Physical Planning and Construction

Reports:

- ❑ The First National Communication of the Republic of Croatia to the United Nations Framework Convention on Climate Change (UNFCCC)
- ❑ Croatian GHG Projections for the period 1990-2020
- ❑ Second, Third and Fourth National Communication of the Republic of Croatia under the United Nations Framework Convention on Climate Change
- ❑ National Inventory Report 2007 on Greenhouse Gas Emissions in the period 1990-2005
- ❑ Fifth National Communication of the Republic of Croatia under the United Nation Framework Convention on the Climate Change
- ❑ Preparation of the Impact, Vulnerability and Adaptation Strategy (IVAS) to Climate Change
- ❑ **Croatia does not yet have a CCA Strategy**

CCA – National Protection and Rescue Directorate

National Platform for Disaster Risk Reduction supporting CCA

▣ 2009.

Early Warning System and the Role of Meteorological and Hydrological Service, dr.sc. Branka Ivančan-Picek - Meteorological and hydrological service of Croatia

Possibilities and Restrictions of the Severe Weather Forecast, Dr sc Vlasta Tutiš - Meteorological and hydrological service of Croatia

Water as Natural Disaster Generator, dr.sc. Dušan Trninić - Meteorological and hydrological service of Croatia

Project of Risk Identification and Land-Use Planning for Disaster Mitigation of Landslides and Floods in Croatia, Prof.dr.sc. Ognjen Bonacci, Prof.dr.sc. Ivica Kisić, Prof.dr.sc. Nevenka Ožanić, Faculty of Civil Engineering, Faculty of Agriculture

Functions of Ecological management in Risk Control, Dr. sc. Sanja Kalambura, Alen Stranjik, dipl.ing., University of Applied Sciences Velika Gorica

Flooding forecast for the Croatian Coast – Task of the Operational Oceanology, Nenad Leder, Nenad Domijan, Zvonko Gržetić, Hydrographic Institute of the Republic of Croatia

CCA - NPRD

▣ 2010.

Gale-Force Wind in Croatia, Alica Bajić, Meteorological and hydrological service of Croatia

Forecasting and following thunderstorms by means of satellite and other remote sensing data, Nataša Strelec Mahović - Meteorological and hydrological service of Croatia

The Influence of meteorological parameters on the acute neurovegetative disability, Ksenija Zaninović, Meteorological and Hydrological Service

Precipitations risk assessment in Croatia, Marjana Gajić-Čapka (Ksenija Cindrić), Meteorological and Hydrological Service

Holistic Model for Forest Fire Protection in the Adriatic Area, Darko Stipaničev (Ranko Vujčić, Branimir Hrasnik, Tomislav Vuko), University of Split Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture; Department for Economy, Development and Reconstruction of Splitsko-dalmatinska County; UZOR – Sustainable Development Association; National Protection and Rescue Directorate

Changes in Extreme Climate Parameters of Future Climate Resulting from Climate Simulations Using Regional Climate Model, Mirta Patarčić (C. Branković, L. Srnec, I. Güttler), Meteorological and Hydrological Service

CCA - NPRD

NP Conference Conclusion:

- In order to adapt to climate change, which the Republic of Croatia and the region is exposed to, it is necessary to increase investment in climate modeling, forecasting and analysis to support the sectoral planning in the sectors facing this risk.

CCA - NPRD

Action:

NPRD

- ▣ Informing the Public
- ▣ Supporting the RC CCA Network

Tasks:

- Advocating and influencing decision makers on the necessity of climate change adaptation through different ways of communication.
- Raising awareness of decision making level and general public level about necessity of Climate Change Adaptation and damage control of Climate Changes through public campaigns, press releases and other activities in order to reduce vulnerability.
- Coordination and cooperation between Civil Society Organizations, governmental institutions on all levels of local and regional self-government in the Climate Change Adaptation field, technological consulting and indicating best practices examples.
- Information exchange between Network members on practical and expert level
- Information exchange between Network members about activities on Climate Change Adaptation on regional and international level.

NP

- ▣ Committee for CCA formed in 2011.



CCA - NPRD

A way to go?

- ▣ National Risk Assessment
- ▣ National DRR Strategy (Accepted by the Government, and with obligatory assignments)
- ▣ National CC Assessment
- ▣ National CCA Strategy (Accepted by the Government, and with obligatory assignments)