Initiative on "Capacity Development to support National Drought Management Policy"
(WMO, UNCCD, FAO and UNW-DPC)

Drought conditions and management strategies in Montenegro

Background:

Institute of Hydrometeorology and Seismology, hereafter IHMS till 2010 did not have permanent drought monitoring. There were documentations about analyses of droughts mainly from meteorological point of view, published in public journals or scientific papers.

Before the project "Drought Management Centre in South East Europe" (DMCSEE) sparse information about the droughts could be found in IHMS's archive, such as : drought reports for specific towns, meteorological outputs that define onset and duration of drought made for the purpose of Conferences, Media and customers requests, outputs from the project "Extreme Atmospheric Conditions in Montenegro - AEN" based on the aridity index of De Morton.

Detailed vulnerability assessment did not exist before the project DMCSEE. An initiative in 2003 to calculate SPI index was unsuccessful as it was evident the lack of the staff and a great demand of disposable experts to be trained.

Those very important actions were implemented in IHMS through the project DMCSEE since 2010. The innovative approaches, tools, uniform data collection, risk assessment, online GIS and dissemination to end beneficiaries brought drought monitoring and reporting to a new level than before.

Based on electronic archive of newspapers, web sites of state institutions, local governments, enterprises as well as statistical yearbooks, data on the drought effects since 2000 were classified per years and selected in three categories: economic, environmental and social, with emphasis on those which according to available material most frequently affected society. Some of the consequences could be classified in more than one category (e.g. forest fires can be classified in each of these categories). Special attention was dedicated to the drought in 2000, 2003, 2007 and 2011 when its significant impact occurred. Identification and categorization of the drought impact show that the drought affected mostly economy with direct or indirect consequences in agriculture, forestry and water supply.

Table 1. Duration and impact of the drought in the period from 2000 to 2009

Year	Category	Drought impact
2000	Economic	Drought reduced yields of spring culture for 30%
2003	Economic	Reduced purchase of milk
1.6-10.9.2003	Economic	Long Forest fires season in coastal, karstic and Zeta-Bjelopavlici region (Ulcinj, Bar, Budva, Tivat, Kotor, Cetinje, H.Novi, Nikšič, Danilovgrad)
1.07-1.9.2003 1.7-5.9.2003	Social Economic	Water deficit; Restrictions and exclusions of water were applied mainly in the coastal region and in some area of central, northernmost and eastern region (i.e.Bar, Budva, Kotor, H.Novi, Cetinje, Nikšić, Plav, Pljevlja respectively) Forest fires
25.07-1.10.2003	Economic Environmental	Sand mining from the river Moraca and Cijevna was stopped Survival of animal species in river Moraca and Cijevna was affected
1.8-1.9.2003	Economic	Forest fires in National Park "Durmitor" (northern mountainous region)
do 26.08.2003 2004	Economic -	Sawing were affected in Kolasin, Bijelo Polje, Plav, Berane, Pljevlja, Cetinje Drought was not registered
20.6-21.6.2005	Economic	Forest fires affected grass and vegetation in vicinity of Podgorica town
29.6.2005	Economic	Forest fires in vicinity of Kotor (coastal region)
15.7.2005	Economic	Forest fires affected grass and vegetation in vicinity of Podgorica town
9.9.2005	Economic	Forest fires in vicinity of Herceg Novi (coastal region)
1.7-1.8.2006	Economic	Forest fires in coastal region, Zeta-Bjelopavlici region and karstic region
1.11-23.11.2006	Social	Water deficit in the middle of Autumn affected Niksic (karstic region).Restriction in water use.

28.11.2006	Ecological	Famous lake Biograsko Lake in Kolašin (northern mountainous region) was affected
1.6-1.9.2007	Economic	Numerous forest fires all over the country
1.7-10.9.2007	Social	Water shortage in the coastal area (Bar,Budva,Tivat,Kotor,H.Novi)
24.7-19.10.2007	Economic	Wide spread impact on crops
9.8.2007	Economic	Hydrological situation near minimum values
12.9.2007	Environmental	Low level of water in Biogradsko Lake.Hydrological drought
1.7-25.9.2008	Economic	Very active forest fire season with maximum in August
1.8-25.9.2008	Social	Water supply near critical conditions
20.8.2008	Economic	Reduced production of honey
17.8.2009	Economic	Summer without forest fires
20.8-2.10.2009	Economic	Forest fires in Septembar in surrounding of Podgorica
21.8-9.9.2009	Economic	Forest fires in the coastal region - Olives in Kotor and Herceg Novi in flame
2011	Economic	Hydrological drought – Hydrological conditions near the lowest values. November the driest in record from 1970. Production of electricity was affected. Montenegrin Academy of Science and Art together with IHMS and relevant Faculties addres the problem to the public. Temperature in greenhouses was around 60 degrees, while the limit upon the plants can grow and form a product is 36 degrees; Purchase of lambs was earlier due to the lack of water and food for the cattle.
2012	Economic/ Environmental / Social	Forest fires in 2012 had impacts on: Health – watery eyes, coughing and choking due to large amounts of dust particles in air; concentration of dust particles in the air in Podgorica was 4 times higher than is allowed; Forest – the loss of 6,500 hectars of forests because of the fire was estimated at about 6 milllion according to information from the Ministry of Agriculture and Rural Development; Traffic - the traffic on the main road Podgorica-Cetinje was periodically closed that fire trucks could came closer to the fire location.

Drought monitoring and early warning systems: 350

The available drought monitoring system is based on analysis of percentiles and SPI index. Following set of indicators that are most in use to characterize drought magnitude are as follows:

Temperature	Temperature anomalies with respect to the 1961-1990 base period (in ^{0}C) or expressed as percentiles, Heat Wave Duration Index (HWDI), number of days with temperature over 75th percentile and precipitation below 25th percentile
Water	Consecutive Dry Days (CDD), SPI12, anomalies of water level
Soil	-
Socioeconomic	Air quality assessment, losses in agriculture, losses in electrodistribution

Network of meteorological stations are presented in the figure 1. The density of the stations was 6.88/1000 km2 up to 2010. The network was consisted of 94 active stations. From them 9 are main, 18 were climatological while 67 were rainfall stations. From 2011 rapid decrease of precipitation stations is evident mainly due to financial problems. About 20 precipitation stations are currently in use.

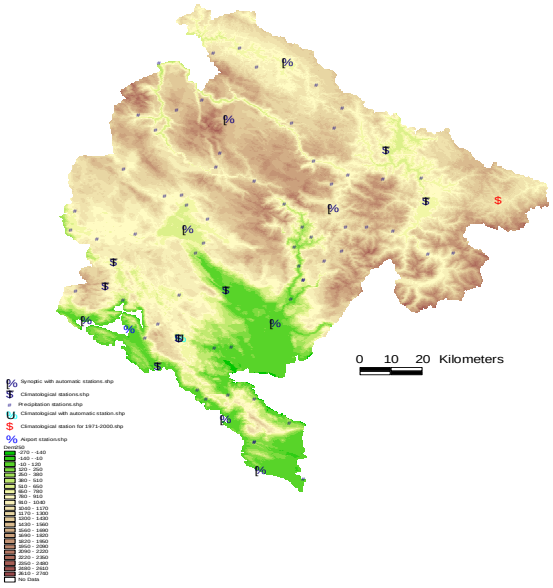

Figure 1. Network of meteorological stations

Table 2 presents the number of all active stations till 2011 sorted by altitude and assessed by categories from bad to very good.

Table 2.

Altitude categories*	Number of all active meteorological stations	Representativity of the category (very good, good, acceptable, bad)
0-200	***22***	***very good***
200-500	***4***	***acceptable***
500-1000	***45***	***good***
1000-1500	***24***	***acceptable***

Network of hydrological stations has 51 stations that measures water level. Certain number of them are automatic for the main rivers in the Adriatic and Black Sea catchment. Data are available on-line over the web site of IHMS (www.meteo.co.me).

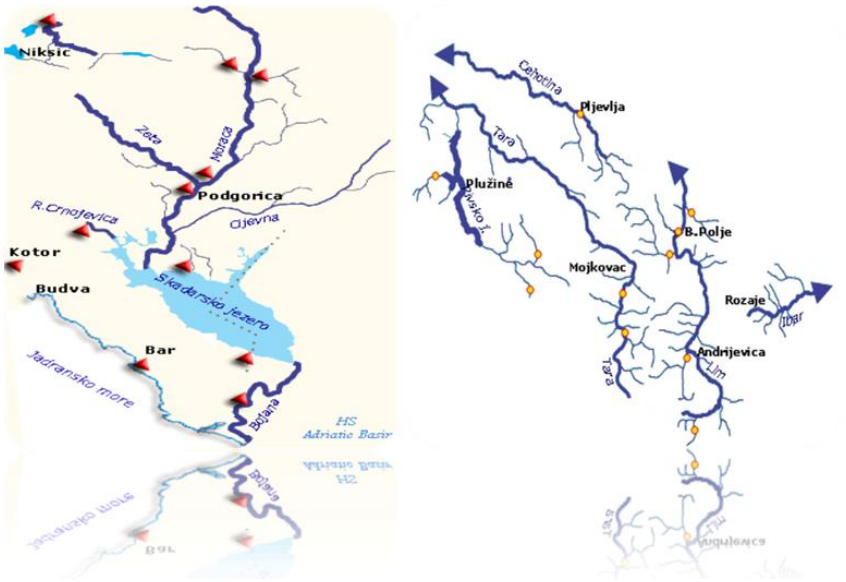

Figure 2. Network of automatic hydrological stations on Adriatic (left) and Black Sea (right) catchment

Considering the fact that drought was not permanently monitored in the past, still the role of IHMS becomes crucial when the drought develops into agricultural and hydrological drought. Although the Academy of Science and Art of Montenegro together with IHMS and relevant Faculties addres to the public on drought developing in 2011, results of dissemination activities during and after the project DMCSEE showed that drought monitoring in Montenegro should be more integrated and coordinated between final beneficiaries and IHMS, focusing on mutual teamwork as well.

Table 3 presents mitigation practices applied in drought periods in Montenegro (project IPA DMCSEE). It is evident the lack of drought management and drought master plan.

Table 3. Synoptic table on mitigation practices in drought period in Montenegro

Mitigation Practices in agricultural sector	Mitigation Practices in hydrological sector	Drought management	Drought Master plan
Irrigation - fragmented	Drainage system, reservoirs, dams	no	no

It is important to note that in nowadays IHMS faces the problems of rapid reduce of precipitation stations with decrease in density less than 6 /1000 km^2.

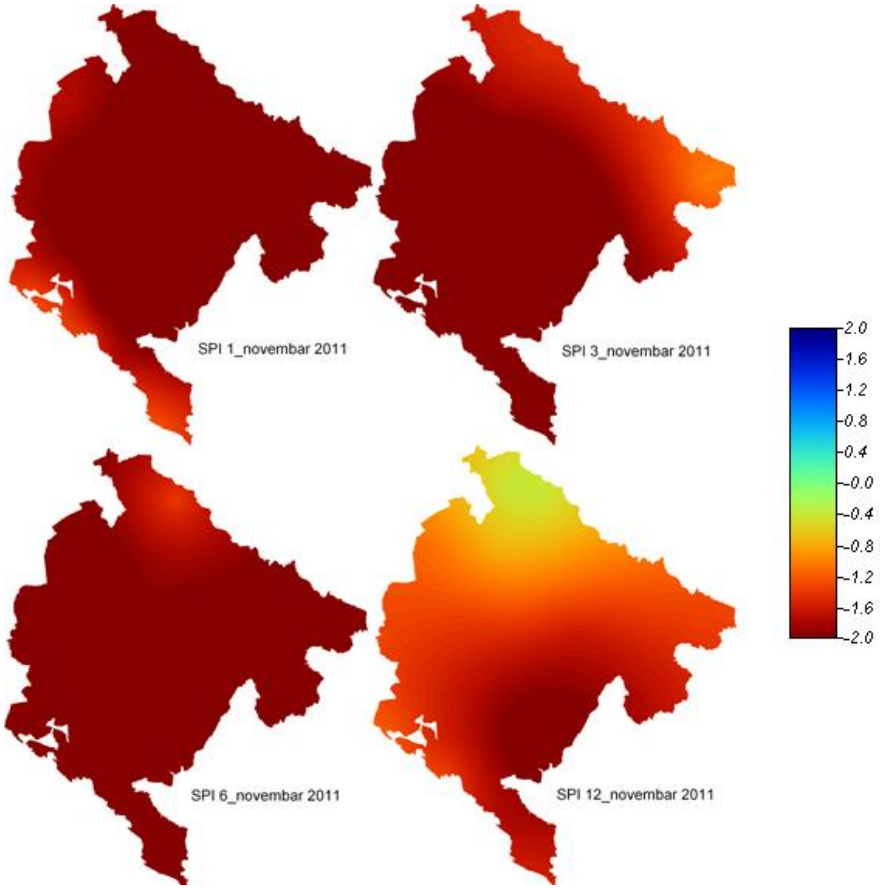

Figure 3. Example of SPI 1, 3, 6 and 12 for November 2011

Vulnerability assessment:

Focusing on water resources shortage and their impacts, the most vulnerable sectors in economy are:

- agriculture, food and milk production
- water supply
- electricity production
- environment

what is also reported in the table 1.

The most vulnerable groups of the society are small farmers (wheat, ray, barley, oats and maize producers), producers of fruits and vegetables (olives, figs, citrus, raspberries and grapes, potatoes, cabbage and pepper), ranchers and milk producers.

Regarding the public health, the most vulnerable groups are those with respiratory problems, heart disease as well as children who suffer the most effects of forest fires smoke.

Emergency relief and drought response:

There is insufficient data and information on drought and damages caused by drought in previous years. Drought in Montenegro were not permanently analyzed and monitored in the past. There is no archive on the damages dedicated particularly to the drought.

Drought impact archive was created during the project DMCSEE. Collected data on economic impact of the drought on annual basis show that during the dry years maximum losses in electricity production are in range from 3 – 3.5 million Euros. Total hydropower potential of Montenegro is about 9900GWh annually. In the period 1999-2008. deficit was 14121GWh or 620million EUR.

Collected data on water supply show that in Podgorica, capital town of Montenegro, water supply uses about 2.000lit/s, with a daily injection into water supply system of about 130.000m^3 . The daily loss of profit during the drought ranges from 15.000EUR to 85.000EUR.

Impact of the drought in december 2011 reflected in unprecedented lowest water level in Montenegro. In agricultural sector during the, crop production was suffered the greatest damage (the damages are estimated from 30 to 60 percent of expected yield). Throughout the crop production great impact was on livestock.

Milk production was second ranked as extremely affected by the drought. An urgent measures such as subsidies for the import of cattles' food necessary for production of milk, was sought by the Agriculture Union of Montenegro. They addresed to the Government with the strong need for support of the milk production.

The need for knowledge and skills on drought management:

There is an urgent need for skills in drought management both on individual and institutional levels, establishment of drought authority and organized drought management, implementation of irrigation scheduling system (e.g. WINISAREG which was applied in IPA DMCSEE resulted in Montenegro as an efficient and very precise tool in agricultural water management).

.

Regarding the irrigation, higher portions of water required each year, comparing to the past. The intensity of this problem is evident not only in southern part of Montenegro but also in the hilly and mountainous region under cold continental climate where irrigation traditionally was not used in the past.

In Montenegro does not exist a national policy or strategy related to the drought. There are only a few strategic documents such as: **Montenegro Spatial Plan until 2020. (**http://www.gov.me/files/117498935.pdf**), and Montenegro Water Law, 2007.**

Montenegro Water Law from 2007 is an important document in combat the drought and its mitigation (http://www.gov.me/files/1246958897.pdf). This Law regulates the water management.

Montenegro ratified in 2007 the EU Convention to Combat Desertification (UNCCD) (http://www.ncsa-montenegro.com/index.php?jezik=0&opcija=0&id=5). By approaching to UNCCD and adopting obligations, it is expected to produce own national strategies directly involved in combating the droughts. Ratifying and approaching the Convention Montenegro has the obligation of **Development and implementation of programs for sustainable irrigation**, like necessary condition for agricultural development in rural and arid areas. Program has to be a part of existing and future agro-ecological programmes on local and national level. Realization of this plan is expected to have numerous positive effects on agricultural production, in combating the drought and drought mitigation.

M.I. Author[1], V.A. Author[2], N.P. Author[3], S.M. Author[4], M.K. Author[5]

[1]Department of applied meteorology, Podgorica, Montenegro, mirjana.ivanov@meteo.co.me

[2]Data base management, Podgorica, Montenegro, vera.andrijasevic@meteo.co.me

[3]Department of applied meteorology, Podgorica, Montenegro, natasa.pazin@meteo.co.me

[4]Climatological Department, Podgorica, Montenegro, slavica.micev@meteo.co.me

[5]Biotechnical Faculty, Podgorica, Montenegro, knez@t-com.me

References:

Institute of Hydrometeorology and Seismology www.meteo.co.me

Statistical Office of the Republic of Montenegro - MONSTAT www.monstat.org

Statistical Yearbook 2006

Statistical Yearbook 2007

Statistical Yearbook 2008

Statistical Yearbook 2009

Statistical Yearbook 2010

Montenegrin Electric Enterprise- Niksic http://www.epcg.co.me/01_05.html

Products and reports of DMCSEE project:

dmcsee.eu/index.php?option=com_docman&task=doc...gid=35...

www.dmcsee.org/en/drought_monitor/

www.dmcsee.org/GISapp

Media / (www.pobjeda.co.me)

Ministry of Agriculture, Forestry and Water management