6. CHAPTER SIX: METEOROLOGICAL, HYDROLOGICAL AND CLIMATE SERVICES TO SUPPORT DISASTER RISK REDUCTION AND EARLY WARNING SYSTEMS IN MONTENEGRO

Montenegro is prone to several natural hazards like floods, drought, heavy rainfall or snowfall, wind storms, heat waves, landslides, avalanches, forest fires, airborne sand from deserts and some epidemics which are directly or indirectly related to hydrology, meteorology and weather conditions. A number of hazards pose risks across borders in the region, especially floods, forest fires and dispersion of airborne pollutants.

This chapter presents all the findings related to the assessment of the DRR institutional framework and the technical capacities of the NMHS of Montenegro (HydroMeteorological Institute of Montenegro, hereafter referred to as HMI) to support Disaster Risk Reduction. It highlights that:

- The legal and technical status of the HMI has been significantly improved in 2010. However, the legal status, the technical and human capacity of HMI and ability to support national and regional DRR are still at much lower level than at the NHMSs in EU countries;
- There are urgent needs to enhance the institutional capacity of HMI for hazard mapping and risk assessment, production and dissemination of early warning and local scale analyses of climate change;
- It is necessary to strengthen the hydrometeorological observation network, including further automatization and establishment of weather radar network;
- It is necessary to enhance investments in climate modelling in cooperation with SEEVCCC and forecasting and analysis to support strategic and sectoral planning for at-risk sectors and investment plans of industry in order to promote economic development of the country;
- Development of Risk Assessment, MHEWS and other capacities to support national risk management could also benefit from regional coordination and cooperation, leveraging expertise, capacities, resources and information across the region among IPA beneficiaries and with various regional centers in Europe.

6.1. Montenegro's vulnerability to hydrometeorological disasters

6.1.1. General overview of country's economic sectors

Agriculture, tourism, industry and services are the top earners and priorities for economic development in Montenegro, with services and tourism carrying 49.6% and 20% of the GDP respectively. The energy sector is also essential for sustainable development but the challenges faced in Montenegro's energy sector are low efficiency, high losses in transmission/distribution systems, unfavorable consumption structures leading to high dependency on imports, minimal use of its own natural energy resources, etc. Natural and technological hazards including earthquakes, floods, landslides, forest fires and industrial incidents represent a considerable threat to the Republic of Montenegro. The recent urban sprawl and the industrial growth of the country have exposed an increasing number of people as well as infrastructure to the potential consequences of these hazards[12].

In 2008, the gross domestic product amounted to 3.09 billion Euros, i.e. 4.908 Euros per capita. For the same year, the service sector's share in GDP was 77.2%, the contribution of agriculture and industry (with mining) to the gross domestic product amounted to 9.3% and 13.5%, respectively. The electric power generation, mining, and metal processing make approximately 70% of industrial production[13].

Tourism is a significant branch of economy, which is regarded as one of the key development priorities. The number of tourists almost doubled during the period 2003 – 2007 (from approximately 0.6 to 1.1 million), while the number of overnight stays, during the same period, went up for more than 80%. In 2008, the country was visited by approximately 1.2 million tourists, with 7.8 million overnights. The visits/overnights realized in the coastal region prevail in the total tourism turnover.

The share of primary agricultural production in GDP for the period 2005 – 2008 remained on the level of approximately 9% to 10%. The agricultural land structure is predominated by pastures and meadows (approximately 87%), whereas arable land and gardens make up less than 10% of the total agricultural land. Animal husbandry is the most important branch of agriculture, with a share of 60% in the total new value.

6.1.2. Hydrometeorological hazards in Montenegro

Geographical position of Montenegro as a Mediterranean country makes it a disaster prone country which is exposed to several natural hazards like flood, drought, heavy rainfall or snowfall, wind storms, heat waves, landslides, avalanches, forest fires, airborne sand from deserts and some epidemics which are directly or indirectly related to hydrology, meteorology and weather conditions.

The most devastating impacts from hazards in Montenegro are caused by floods. According to the EM-DAT data since June 2006, four major floods have occurred affecting significantly almost 8,000 people. A summer heat wave in 2007 saw the highest European temperature of 43.3 degrees Celsius measured in the capital city Podgorica. The extreme heat and drought caused serious problems with water supply especially in coastal areas of Montenegro.

In Montenegro, fires of all scopes and levels are possible, from incident to disaster and very common in green and forest areas. Forests in coastal and central parts of Montenegro are most threatened due to high air temperatures and characteristics of vegetation in July and August, which also applies to February and March - periods of dry and warm winters.

[12] Igor Djuric, IPA Beneficiary National Needs Assessment: Montenegro. WMO – UNDP, 2010.
[13] First National Communication to the UNFCCC.

The northern and higher inland areas are prone to snowfalls and icing which may lead to long-term interruption of traffic on many roads and a complete breakdown of relations with many villages and some towns.

Weather conditions may occasionally lead to landslides and rock slides. Such disturbances most frequently occur following heavy long-lasting rains when intensively waterlogged grounds, with unfavourable physical and mechanical characteristics of the rocks they are composed of, break off and begin to slide, possibly threatening and damaging infrastructure facilities and neighbourhoods or some their parts. In Montenegro such disturbance are particularly prominent along highways and regional roads in northeast Montenegro, and to a lesser degree at the coast.

6.1.3. Sectoral analysis of the vulnerability to hydrometeorological hazards

Heavy rain is very common and often results in flash floods, landslides and rock falls which are potentially very damaging for settlements and public infrastructure, especially the 7,000 km road network, much of which is located in mountain areas. Forest fires are even more frequent and widespread, especially in the rural coastline areas and in the central region. Marked increases in losses from property damage and lost revenue due to business interruption caused by extreme weather events translate into the increased volatility of earnings in the sectors exposed to weather. These include utilities, tourism, agriculture, transportation, aviation and forestry. And this in turn, means a higher cost of capital for businesses operating in the region. Besides the direct costs associated with physical damage, natural disasters typically lead to a worsening of the fiscal position, as governments pay for reconstruction and sources of revenue are disrupted. Therefore, the total impact on the budget widely exceeds the direct costs of relief and reconstruction from natural disasters.

Vulnerability to floods and droughts has not yet been fully analyzed in Montenegro till now. The effects of climate changes and the vulnerability of several sensitive sectors (water resources, coastal areas, agriculture, forestry, biodiversity and public health) were analyzed within the First National Communication on Climate Change of Montenegro.

In Montenegro, there are significant differences in the distribution and abundance of water resources, starting with arid karst areas to those that are rich in both surface and groundwater. The rivers drain into two basins: the Black Sea, with a total area of 7,260 km^2 (or 52.5% of the territory) and the Adriatic Sea with about 6,560 km^2 (or 47.5%). Rivers and streams in the coastal area, with the exception of the Bojana River, are characterized by short watercourses and a relatively low average flow. Some of these rivers are drying up during the summer season, while during the rainy period almost all have a torrential character, which contributes to landslides and erosion. Not counting the water used for electricity generation, the largest water consumer is the population. In 2005, about 102 million m^3 of water was extracted for the purpose of water supply to the settlements (of which about 90% came from groundwater and spring water sources). There are two most vulnerable areas to floods areas in Montenegro. The first is area of Skadar-lake basin with tributaries and Bojana river. The second is the upper flow of Lim (and also Tara) and confluent streams with torrential character.

Agriculture is an important economic sector for Montenegro. The structure of agricultural households is unfavorable from the standpoint of intensive and competitive production given the fact that small farms (less than 5 ha) dominate. In the last ten years, there was a slight decline in total surface of agricultural land (a decrease of about 3,000 hectares), while the structure remained approximately the same, with certain decreases in the arable land and gardens, and pastures categories, and with increased perennial plantations and meadows areas. Vulnerability to droughts is manifested primarily in the southern part of the country, also because of the karstic terrain.

6.2. Institutional Framework of Disaster Risk Reduction in Montenegro

6.2.1. Legal framework and policy supporting DRR in Montenegro

The National Strategy for Emergency Situations was adopted by the Government of the Republic of Montenegro (MNE) in December 2006 and can be considered as a foundation for the modern structure of Civil Protection in Montenegro. It gives authority to the Ministry of Interior Affairs and Public Administration through its Sector for Emergency Management for further development of this document as well as the development of the National Platform for DRR which the Sector for with the participation of other relevant institutions is currently working on.

The National Strategy analyses all the risks affecting the territory of Montenegro, providing a survey on the actual capacity of the Montenegrin structures to cope with them. The survey highlights the operational capabilities of Montenegro with reference to the major risks on its territory, emphasizing the importance of constant monitoring of the hazards and the need for an integrated approach to disaster risk reduction.

The following laws constitute the specific legal frameworks:

- The Law on protection and rescue (Official Gazette of Republic of Montenegro no 13/2007);
- The Law on water (Off.gazz. RM, no. 27/07);
- The Law on hydrometeorological services (Off.gazz. RM, no. 26/10);
- The Law on Hydrographic services (Off.gazz. RM, no. 26/10).

The Law on protection and rescue prescribes a set of measures and activities to prevent danger of natural disasters, technological accidents and other disasters. In order to effectively protect the population and the material heritage against possible disasters and preventing the spreading of risk, the law prescribes to conduct activities related to collection and processing of data on potential risks, establish information and early warning systems. The law mandates that these preventive activities include assessment of vulnerabilities (defined as “a qualitative and quantitative analysis of data on the possible hazards of the occurrence of natural disasters” “with predictions of their possible future course and consequences, the proposal of the level of protection against risk and proposal of preventive and other measures for protection and rescue”) as well as development of plans for protection and rescue, spatial development and building buildings, establishment of a protection and rescue system and provision of material resources, personnel and other resources necessary to carry out the planned activities. The Law enables the overall adequate functioning and gives to municipalities competencies to act in cases of disasters.

Pursuant to Article 34 of the Law on Protection and Rescue, the Ministry adopted two documents; the Rulebook on the Methodology for the Development of Threat Assessment Studies of Natural, Technical-technological and Other Disasters and the Rulebook on Methodology for the Development of Protection and Rescue Plans. The Rulebook on the Methodology for the Development of Threat Assessment Studies delegates responsibility to the Sector for Emergency Management and other Ministries for risk assessment for the territory of Montenegro; to the local governments in coordination with the Sector for Emergency Management for the vulnerability assessment of municipalities and in the case of the private sector, to companies with more than ten employees, again in coordination with the Sector. The threat assessment will include an assessment of hazards or causes that may lead to the occurrence of disasters and the consequences that may arise for people, material and cultural goods and the environment; determining the appropriate organization of protection and rescue in order to prevent the occurrence of disasters or for purposes of rescue of people; and an assessment of needs and possibilities in the provision of human and material potentials necessary for achieving the estimated protection and rescue organization. The law stipulates that the Sector for Emergency Management coordinates the development of National Plans of Protection and Rescue. The National plan for protection of extreme meteorological occurrences and the National plan for flood protection are in course of drafting.

The Law on water defines the obligation of preparation of a General plan for protection from harmful effects of water. The current plan covers the period 2010-2016. It especially contains: works and measures which are undertaken preventively and in the period of high waters for protection from floods and erosion; method of institutional organization of defense; duties and responsibilities of the manager for protection; method for monitoring and recording data; method for early warning. The law foresees the preparation also of a yearly Operational Plan for the Protection of the harmful effects of water. At national level it should be prepared by the Water Department and the Ministry, while at local level it should be prepared by competent local authority, with the approval of the Ministry. The Operational Plans determine the names of managers of protection against the harmful effects of water, headquarters, bodies and names of companies and other entities that conduct legal protection against the harmful effects of water and means for operational implementation of protection.

The overall protection plan, provides that in case a major flood hazards (declaration of the fourth degree of danger of flooding), the management of protection and rescue of people, material and cultural goods is to be ensured by a Coordination Team for Emergency Management situations. In this case, further action regarding the protection and rescue operations are undertaken regulated by the National Plan for the Protection and Rescue of Flood, prepared by the Ministry of Internal Affairs and Public Administration, in accordance with the Law on Protection and Rescue. Ministry of Internal Affairs, through Department for Emergency situation and civil security coordinates the work of all segments of the system of protection and rescue, which are: Ministries, Police Directorate, other state bodies, Montenegrin Military, economic society, operative units for protection and rescue, Agency for environmental protection, Hydrometeorological Institute and Center for Eco-toxicological Researches.

The new laws on “Hydrometeorological services” and on “hydrographic services” established in April 2010, define the tasks of the Hydrometeorological Institute of Montenegro (HMI). It states that the HMI has duty to:

- Produce nonscheduled meteorological and hydrological information and warnings in situation before atmospheric and hydrospheric elementary disaster (emergency situation);
- Organize emergency observation and measurement of the hydrological stations profiles and emergency information shall be submitted;
- Monitor weather and waters;
- Collect and analyze data;
- Prepare forecast;
- Inform and alert responsible agencies.

The National Action Plan for the implementation of the National Strategy for Emergency Situations is in the process of development.

In April 2007, the Government adopted the National Strategy of Sustainable Development which recognizes climate changes and protection of ozone layer as a priority and the government is now in the process of developing the National Development Plan.

6.2.2. Institutional framework

6.2.2.1. List of agencies involved in DRR

The agencies that are responsible for management and implementation of different components of DRR are:

- Sector for Emergency Management (SEM), Department for Emergency Situations and civil security under the Ministry of Interior Affairs and Public Administration;
- HydroMeteorological Institute (HMI), under the Ministry of Sustainable Development and Tourism;
- Ministry of Rural Development and Agriculture;
- Directorate of Water, under the Ministry of Rural development and Agriculture;

- Local Authorities – Secretariats involved in water management.

The SEM with the participation of other relevant institutions is currently working on the establishment of a National Platform for DRR.

6.2.2.2. Sector for Emergency Management

The Sector for Emergency Management is situated within the Department for Emergency Situations and Civil Security under the Ministry of Interior Affairs and Public Administration. Based on the Law on protection and rescue, Department for Emergency Situations and Civil Security has obligation, in sense of preventive, operational activities of elimination of consequences. Also SEM obligation is to develop vulnerability assessment, plans for protection and rescue, establish and coordinating the system for protection and rescue (including the 112 center) and provide material means and other resources for conducting of planned activities. The duties of the Department include also risk and vulnerability assessment and planning for emergency responses. The process of risk assessment for drought and floods is performed by the Department for Risk Management. It is also responsible for the management of the national database of the risks as reported by the National Strategy for Emergency Situations. The duties of the Department encompass the drafting and development of strategic documents and plans at national or inter-municipal levels, cooperation with scientific bodies (universities), laboratories and other research institutions. As indicated by the National Strategy for Emergency Situations, line ministries and relevant agencies are involved in the preparation of specific plans, participating in the ad-hoc working groups and are responsible for providing specific data and analysis to the department of Risk Assessment. SEM relies also on operational units: Municipal services for protection and rescue, units for civil protection, units for protection and rescue of economic societies and other legal persons, aeronautic-helicopter unit, as well as voluntary units for protection and rescue.

6.2.2.3. HydroMeteorological Institute – HMI

The Hydrometeorological Institute of Montenegro (HMI) is the main actor related to hydrological, meteorological, environmental and marine observations, monitoring and services. TV stations and other media are also proposing meteorological services.

The HydroMeteorological Institute of Montenegro is under the Ministry of Tourism and Sustainable Development (previously was under the Ministry for Environment and Spatial Planning). According to the law on Hydrometeorological activity, HMI have mandate for the following activities:

- monitoring weather and waters;
- collecting and analyzing hydro-meteorological data and data on water and air quality ;
- preparing forecasts;
- informing and alerting responsible agencies.

The Hydrometeorological Institute (HMI) is responsible for tasks relating to: observation and measurement of meteorological, hydrological, hydrographical, environmental and agrometeorological parameters; analysing, processing and archiving of measured and observed parameters, making studies, surveys, analysis and information on climate, soil condition, air, surface and underground waters and coastal sea; forecasting and presentation of data in the field of meteorology, hydrology, hydrography, environment and agrometeorology, establishment of information systems with the bank of climate, hydrological, hydrographic, environmental and agrometeorological research, the establishment and maintenance of meteorological, hydrological and agrometeorological stations for monitoring weather, water, and air, construction and cadastre sources, springs and water facilities, testing sediment in rivers, control and evaluation of the quality of surface and ground water, rainfall, air and soil on the basis of analysis of physical, chemical, biochemical and radiological parameters; providing data, information and study for the maritime, air and road transport, electricity, water, agriculture, construction, tourism, military, security of property and persons and other interested parties; aero-radiosounding measurements and higher layers of the atmosphere, phenological observations; indirect provision of air navigation; implementation and

maintenance of standards of meteorological and hydrological instruments and calibration of instruments in meteorological and hydrological stations, carrying out international obligations in the field of meteorology and hydrology and quality control of air, water, and other activities within its competency.

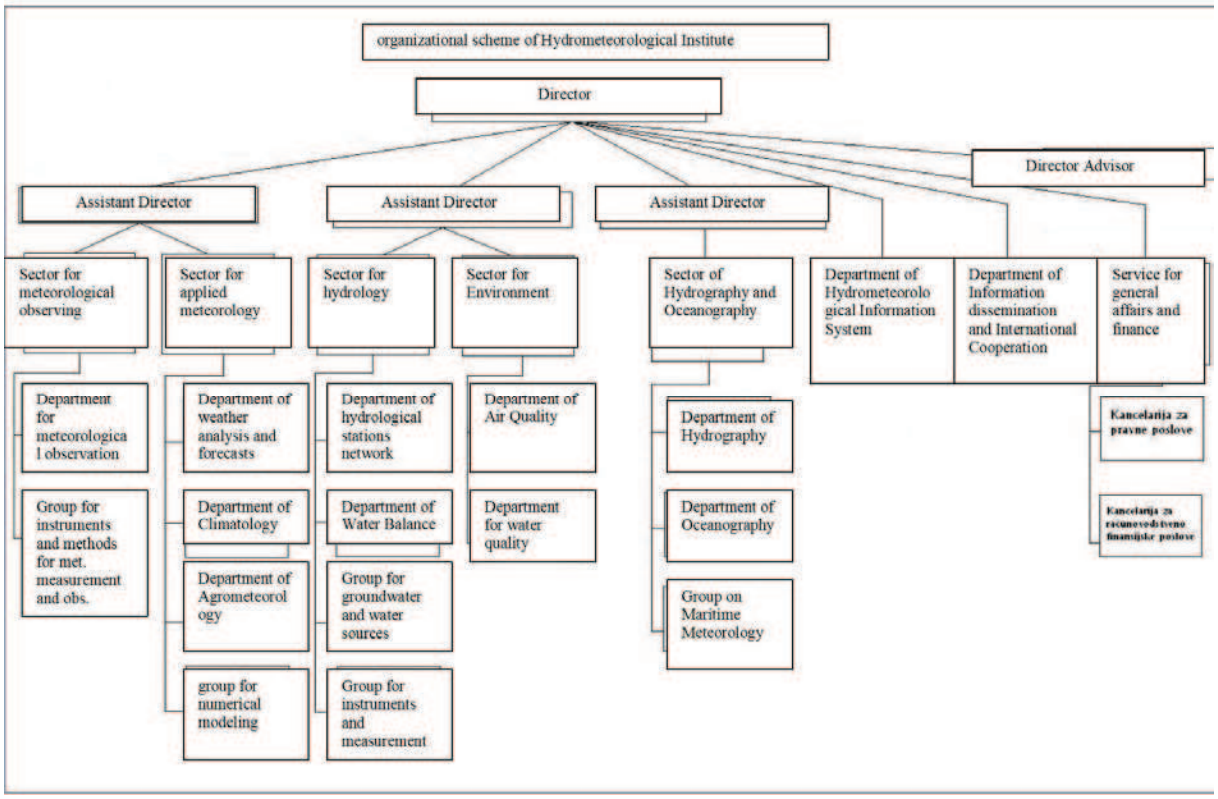

Figure 32. Structure of HMI

Regarding the Meteorological Services for the Aviation sector, the Serbian-Montenegro Air Transport Service Agency (SMATSA) provides air traffic services in the airspace of the Republic of Serbia, Montenegro, a part of international waters of the Adriatic Sea, as well as for 55% of the Upper Airspace of Bosnia and Herzegovina. SMATSA, which is a Serbian company partially owned by the Montenegrin government, produces warnings for the civil aviation sector using (free of charge) data, analyses and forecasts produced by HMI.

HMI has also the duty to produce nonscheduled meteorological and hydrological information and warnings in situation of hydrometeorological disaster (emergency situation). The structure of HMI and its various departments is described in the Figure 32.

6.2.2.4. Ministry of Agriculture and Rural Development

The Ministry of Agriculture and Rural Development (MARD) is also in charge of water management. The Ministry is mandated to prepare the General Plan for protection from harmful effects of water each 6 years and the yearly Operational Plan. Within the Ministry, the Water Directorate is an organizational body dealing with Water Management. Water Directorate is responsible for planning and implementation of protection measures and infrastructures. WD is charged to prepare plans of water management for each river basin on the basis of floods risk assessment. According to the law on water, the WD is responsible for the implementation of the European Framework Directive on Water and the Directive for Floods Protection. In this context WD should prepare the Preliminary Flood Risk Assessment by 2011. Full employment in the administration of directorate is 8 people, including 3 engineers. The technical capacity of the Directorate is actually quite low. WD activities are carried out principally on project basis using external resources.

6.2.3. Operational relationship with Disaster Risk Management and other Technical agencies

In Montenegro, there is a disaster management system in place, which is predominantly disaster response oriented. The system of protection and rescue is realized through organized activities and reactions of preventive and operative character conducted by state bodies, local government units, business organizations, entrepreneurs and other legal and natural persons.

SEM is the unique body to coordinate Civil Protection in Montenegro. Currently most of the structures related to DRR activities are built into the system of management in emergency situations led by Coordinating Management Team for Emergency Situations. At the local level there are structured municipal teams responsible for the management of emergency situations, which are managed by the Governor.

The early warning system is currently in the process of being developed. Currently the system is located with the Coordinating Body for emergency situations, and each relevant ministry and institution has their place within it. The HMI has a role of providing information but it is not the focal point of the EWS. Currently the cooperation with the SEM and other Montenegrin technical agencies concerns mainly the disaster management, while very little cooperation exist for risk assessment and planning. HMI mainly releases data by request and the cooperation with DRR management is mainly on ad-hoc bases. Standard Operating Procedures (SOP) and Quality Management Systems (QMS) between the HMI and the DRM sector have not been developed.

6.2.4. Roles and responsibilities in flood and drought risk assessment

At national level, the institutional framework of drought/floods risk assessment is currently in the process to be defined. The process of drought/floods risk assessment at national level in Montenegro is organized upon different fields of activity and different administrative levels and could be strengthened by improving coordinations among these entities. Concerning floods, the legal framework attributes to:

- SEM the duty to perform flood risk assessment for planning emergency management;
- Ministry of Agriculture and Rural Development the duty to perform floods risk assessment for planning protection against the harmful effects of water;
- WD the duty to prepare Plans for water management of each river basin, including relative flood risk assessments (and the preliminary flood risk assessment according to the EC Directive for floods protection);
- Local authorities the duty to perform flood risk assessment for disaster prevention and for local spatial planning.

None of these four levels is actually fully operational according to international standards of Risk Assessment. Only WD performed ad-hoc floods risk analysis for some segment of rivers on project basis using external technical resources. Moreover some overlaps of competencies still exist, for example concerning floods between SEM and Ministry of Agriculture and Rural Development in planning for floods protection. In other cases, roles and responsibilities are becoming clearer.

Concerning drought, as per the law on protection and rescue, drought risk assessment is included in the meteorological extreme event risk assessment for planning emergency management. But as well as for floods, drought risk assessment is not implemented yet. HMI, even if in its mandate drought risk assessment is not clearly expressed, is approaching the issue on project basis.

SEM is responsible for the production of the National Plan for protection of extreme meteorological occurrences and the National Plan for flood protection. In order to produce this plan, SEM coordinates working groups composed by experts representing involved line ministries. Line ministries provide specific data and analysis for the analysis of threats and risks related to specific hazards as indicated by the Rulebook on the Methodology for the Development of Threat

Assessment Studies. These studies are not supported by spatial analysis on historical time series of data on hazards and impacts, rather they are qualitative evaluation of the threats.

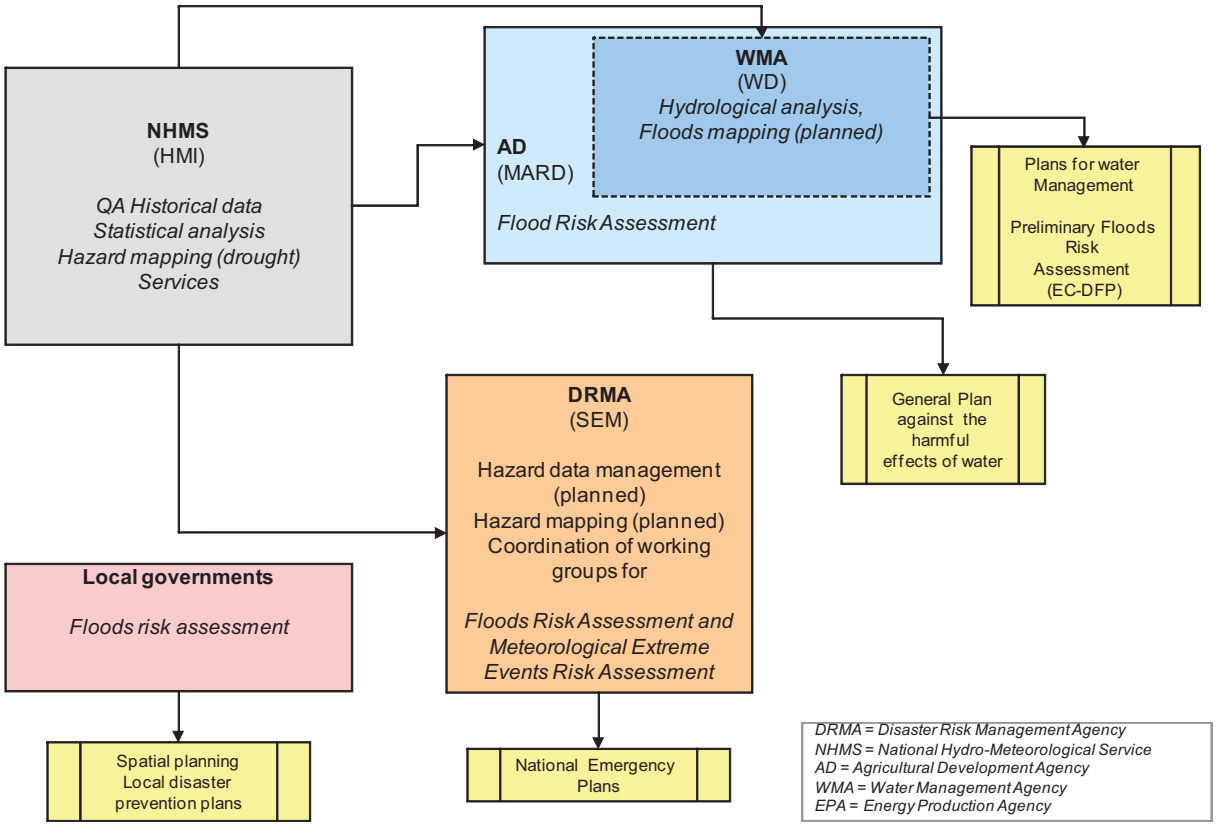

Figure 33. Workflow for drought and floods risk assessment in Montenegro

Currently the role of HMI is to provide basic statistics and analyses of extremes and climate variability to be used for strategical planning of DRR. HMI provides such information to SEM and also to Water Directorate. Flood risk assessment and analysis is still not implemented in HMI, while the drought risk assessment and analysis is actually supported within the project DMC-SEE. HMI is included in the National team for risk assessment formed on the state level and coordinated by SEM.

The WD is responsible for the planning of preventive works and measures to protect against the harmful effects of water. WD should ensure the identification of areas for which there is a risk of flooding, the production of maps of flood zones and their integration into the physical planning, the development of a Water Information Systems, the design, the construction and routine maintenance of facilities for protection against the harmful effects of water. Operationally, the WD operated some studies on project basis assigning the technical work to external service providers because WD didn't have yet strong technical capacity. But at least the IT component, including databases and GIS, would be managed in-house.

MARD is currently not involved in any activity aiming to analyze drought or to assess drought impacts on Montenegrin agriculture. The approach of MARD seems to be simply pushing toward irrigation for risk reduction in general.

6.2.5. Budget and funding for DRR

Protection and rescue is funded from the budget of the government, municipal budgets, voluntary contributions, international assistance, funds of business organizations, other legal persons and entrepreneurs and other sources. As the SEM does not have its own budget, it is financed from the

budget of the Ministry of Interior; however, there are no budget allocation mechanisms to earmark funding for DRR. Furthermore, within other ministries, annual planning needs do not include specific programs oriented towards risk reduction so budgets can not be allocated for them. At the municipal level, spending on developing or implementing DRR measures is on ad hoc basis. HMI is severely under-financed for essential parts concerning DRR and it does not have resources to operate a 24/7 analyzing and forecasting system.

A window of opportunity exists to allocate resources if such programs and projects are created by the Ministries by September (date when plans are submitted to Ministry of Finance). Sources of international funding are mainly focused on ECO funds and it can be expected that if adequate DRR program/projects are prepared by Ministries there could be possibility of funding from EC funds. UNDP has also channelled activities through the Bureau of Crisis Prevention and Recovery, which could be directed at capacity development and improving risk assessment practices.

6.3. Technical Capacities of Hydrometeorological Services to support Disaster Risk Reduction

6.3.1. Monitoring and observations networks and data exchange

The meteorological and hydrological observations are the base for climatological studies and for global, regional and local weather forecasting. Main input for numerical weather prediction models are upper air soundings, which give the temperature, humidity and wind profiles from the ground to upper level of the atmosphere. Long-time historical time series of accurate quality controlled observations are required for hazard mapping and analyses of climatological trends. Real-time observations are critical for:

- prompt reaction in meteorological, hydrological and air quality emergency situations;
- reduction of vulnerability to the risks of hydrometeorological and environmental hazards;
- short term forecasts;
- validation of forecasting models;
- improved data assimilation, which will benefit the global, regional, local and mesoscale NWP modelling.

The meteorological observation network in Montenegro (Table 33) consists mainly of 9 AWS (plus 2 aviation meteorological stations) communicating via GTS, 20 climatic stations and 60 rainfall stations. Data from automatic weather stations are available in the center of Podgorica every 10-min on HMI servers and on web-page. Data from hydrological automatic stations are collected in the centre once per day, and they are available on web-pages. Data from other hydrological and meteorological stations are measured with classical instruments. For hydrological parameters water stage from limnigraphs and discharges are available with some time delay. Data from meteorological stations: depending of type of stations measurements are taken every hour on main and air stations and climatological measurements are taken three times per day (07, 14, and 21) and every 10 minutes from automatic stations. These data are available with time delay.

HMI has no own calibration facilities for meteorological sensors. The Serbian hydrometeorological servcie assists with calibration of HMI meteorological sensors by request. Due to lack of national calibration system of hydrometeorological sensors and data acquisition systems, the quality of HMI measurements and data produced is questionable.

Weather radars are powerful tools in flood prone countries to forecast floods, and in general to provide basis for nowcasting and location of precipitation areas during hazard events and rescue operations. However, weather radars are very expensive investments. Currently there are no weather radars, lightning observations or upper air observations available. HMI does not have access to radar data from neighbouring countries.

Hydrology is a significant field of activity of HMI under two departments. HMI has a good coverage of Montenegro with 51 hydrological stations (31 in Black Sea basin and 20 in Adriatic sea basin) of

which 31 are automatic and connected with the center in Podgorica. Lack of funds is HMI main problem in finishing automatization of remaining stations in the network.

Table 33: Observation stations operated by HMI

Types of observation station	Number		Connected to WMO GTS	Comments of 2010 network
	2007	2010		
Atmospheric domain				
Surface synoptic stations (> 8 obs./day)	18			
Manned stations	8	9	4	2 stations operate 03-21 UTC
AWS or AWOS	7	9	9	all AWS and GTS
Aviation weather stations		2		Automatic
Agrometeorological stations	0	0		
Ordinary climate station (3 obs./d)	20	20		2 automatic
Rainfall station (2 obs./d)	69	65		
Rainfall station – automatic	0	0		
Meteorological towers	0	0		
Upper air radio sond stations	0	0		
Pilot balloon stations	0	0		
SODAR/RASS	0	0		
Wind profiler stations	0	0		
Lidar	0	0		
Access to AMDAR data	No	No		
Weather radars	0	0		
Hale radars	0	0		
Lightning detection stations	0	0		1 station planned
Lightning detection hub station	0	0		
Satellite MSG ground station	0	1		
Hydrological domain				
Hydrometric stations	41	51		31 in Black Sea and 20 in Adriatic Sea
Stream gauge station – manual				
Stream gauge station – automatic				
Water level post – manual				
Water level station – automatic		31		
Maritime domain				
Offshore synoptic stations - manned	0	0		
Offshore synoptic stations - automatic	0	0		
Buoys	0	0		
Buoys with meteorological observations	0	0		
Tidal stations	0	0		
Tidal stations with met. observations	0	0		
Sea temperature	6	6		
Environmental domain				
Air quality	17	17		SO2, NOx, smoke, precipitation quality
Water quality-surface and sea waters	36			
Nuclear deposition				
Ozone – near surface				
Ozone – upper air				
UV radiation				
EMEP		1		on Zabljak mountain
UNEP/MEDPOL		1		

HMI operated some 15 air quality stations with 24 hour sampling, while the main responsibility of air quality monitoring in Montenegro was transformed to CETI in 2010.

In 2010, HMI installed a satellite weather station MSG 2nd generation DAWBEE drawn from the EU grant through the IPA Disaster Risk Reduction project conducted by WMO. The first meteorological images were received on 7 October 2010 from EUMETSAT meteorological satellites.

The number of stations from which the data is communicated to international data exchange trough the WMO GTS is very low (4 stations).

6.3.2. Hydrometeorological data management systems

Data management is the core of successful operation of an NHMS, data communication, use of NWP and other numerical models, commercial weather service and dissemination of data and products.

Synoptic and climate data are available since 1948 and agrometeorological data from 1951 to 2003. Some of the data is still in form of manual archives and needs urgently to be digitalized. In HMI, the data management used to be decentralized and based on PCs and servers. However, in 2009 a new CLIDATA database system was installed (replacing the CLICOM system), and a new hydrological database WISKI was taken in use. Meteorological sector has special staff working with meteorological data, while the hydrological data is managed directly by experts.

HMI collects hydrological, meteorological, hydrographical, oceanographic, air quality and water quality data from its official national networks. HMI has a sector of hydrography and oceanography which leads bathymetric measurements and surveys the sea and inland navigation paths. The oceanographic data consists only of sea temperature measurements near the coast, as well as of quality water at the beaches. The data is stored in a digital Oracle database. Part of data also available in excel data base. Archive of meteorological and limnigraph charts are in paper form.

For quality control and validation, the process is organized on three levels: (i) observers make an evaluation of measurements quality; (ii) meteorological technicians make logical consistency of data from paper documentation; (iii) Quality Control procedures and validation are performed within the database, i.e. CLIDATA for meteorological data and WISKI for hydrology.

Still in 2010 there were difficulties with operation of the database and sharing of data to different users within HMI. However, these problems were solved recently by purchasing a sufficient number of licenses. The technical data management systems, operation of data bases and sharing of data within HMI have been significantly improved in 2010.

The process of linking separate databases into a single database and their transfer to GIS is time-consuming and requires financial means and appropriate information technology equipment and well-trained personnel. In Montenegro there have been some attempts to produce a common database, but it has failed as the terms user access to the database was not properly defined.

Near real-time data are available on web-pages, and historical data are available only on demand.

According to international obligation for data exchange HMI shares in GTS data from 4 stations. HMI provides also data to meteorological services for aviation and maritime navigation. Furthermore HMI provides data to neighbouring countries (Serbia, FYROM, Croatia, and Republic of Srpska) with specific MoUs (in preparation phase for Slovenia, Bosnia and Turkey). Hydrological data are provided to the ICPDR and the Sava Commission.

Information about data (metadata) is scarce, nevertheless station documentation about geographical location (lat, lon, alt), observation practices and data about instruments are available

in digital format. Metadata needs to include observation station specific information of sensors used, their transfer functions, siting of the sensors, description of masts, towers and booms, detailed description of the surroundings of the measurement site with special interest in nearby obstacles (type, size, height, distance, relevant angles) rather shown by photos (including a fisheye photo), etc.

6.3.3. Hazard analysis and mapping to support risk assessment

In Montenegro there is no inventory nor list or database of past floods or droughts. Some information on flood extent exists for the floods of 2009/10 at WD. Concerning droughts, some information is available from 2000, but it is not organized.

HMI collects hydrological data on flood events, which could be useful for hazard mapping, particularly water levels and discharges. Such data are collected using standard protocols for hydrological data, but no other specific protocols for hazard data collection or management is used. These data are managed within the WISKI database. HMI does not keep any separate hazards statistics, but statistics for high wind, heavy precipitation and extreme temperatures can be produced for each synoptic observation station. HMI collects phenological data, which are actually stored in excel for a time series of about 10 years.

Based on available hydrological and meteorological data HMI produces statistical analysis on flood frequency and probability. HMI has adequate tools for statistical analysis (Statistica, StartGraphics, Climdex), interpolation (Surfer), hydrological analysis (Hydras 3, Hyprom) and geographical and geomatics (Geomedia, Autocad, ArcView). WD has some technical capacity in terms of hydrological analysis and mapping, but they are not really exploited as the technical work is usually done by external service providers. They lack completely of tools for analysis and GIS.

Drought indices, analysis and early warning products are in preparation phase within the project DMCSEE. It is planned to make SPI available on a near real-time basis to relevant users in participating countries and broader SEE region.

In general there is no systematic process for flood and drought hazard analysis nor mapping. At the exception of the inundation of 2009/10 for which WD is preparing some maps of flooded areas and few inundations maps produced by HMI, most of the existing hazard analysis and mapping available in Montenegro have or are being produced on a project basis. These projects include:

- EWCM (Extreme Weather Conditions in Montenegro) project, which aims among other to determine criteria for the definition of weather related disasters in Montenegro and map the areas where certain types of disasters occur in order to determine the vulnerability level and assess possible damages of such disasters;
- the project Adricosm Star during which some tools for the understanding and simulation of the state of surface and underground waters have been developed, as hydrological forecasting model HYPROM (based on MIKE11), which has been implemented in Skadar lake basin. But this model still is not completely operative;
- The hydrological model HBV has been used in the framework of a collaboration with the Norwegian company Startcraft for modelling a tributary of the Lim river. HMI has provided the input data and the company has run the model. It is foreseen that HBV is installed at HMI and that hydrologist are trained in its use.

Main gaps consist in a lack of connection among various institutions, which are responsible for specific components of floods or drought risk assessment, but also the lack of specific capacities within the organizations.

Concerning disaster impact data, the practice in Montenegro is that relevant organizations collect data pertaining to their sector and hazards that impact them. Unfortunately no formal mechanisms have been developed for collecting, storing and accessing this data, which is currently scattered around different institutions acting at different levels. HMI, WD and SEM don't collect impact data.

SEM has an inventory of information about some past floods, but the data are not organized nor harmonized. MARD collects through the extension services some data on damages caused by floods at Municipal level. These surveys are performed when farmers claim for indemnities to the Municipalities. But this information is not organized and refers only to samples and not exhaustive inventories. Drought impact data are not collected by MARD. Concerning floods, local commissions make damages assessment after the floods. The information about damages exists in form of reports for the floods occurred in 2009/10, but for the previous years probably not. There is an extensive belief expressed by the stakeholders that a standardized methodology for impacts/damages assessment is needed. Thus, the establishment of a database or at list a meta-database of impact data per hazard is crucial in order to facilitate data access.

From an operational point of view, the process needs to be improved strengthening the analytical capacities of different actors, by introducing modern technologies of analysis, such as numerical modelling and GIS. Also the availability of data for the analysis should be improved through strengthening the observation network (density, automatization, and communication), improving the quality of databases (QC, software, data rescue) and the interoperability of different sources of data.

All the actors convene also that there is a need of standardized and specific methodologies for risk analysis and assessment according to the different types of event. Cooperation between Institutions should also be improved in the sense of data and information exchange and better organization of multidisciplinary meetings and working groups.

6.3.4. Forecasting

HMI publishes twice a day short-range +24h and +48h and daily weather forecasts +72 h, wave forecasts for the Adriatic Sea +72h and +72 h forecasts for dry and wet deposition for a domain covering South Europe and North Africa. HMI is preparing to produce weather forecasts also for longer period. The forecasts are available on the HMI home page. Currently nowcasting forecasts are not produced. HMI does not produce hydrological forecasts. HMI produces also special forecasts on contractual bases:

- every day 2-4 days forecasts to Agriculture sector;
- every day 2-days forecasts to road transport sector;
- twice a day 24 h forecast to water transport sector;
- every day 5-days forecast to energy production sector.

Global models cover entire planet, while regional models cover a limited area. In order to present processes in lower atmosphere, it is necessary to use ultra-fine resolution models i.e. a higher density grid of points where calculation is performed. Given that computer resources and time period are limited, fine resolution numerical models are used for smaller and limited areas, while initial and lateral conditions are provided from low resolution global models.

The weather forecasting is based on use of global NWP model products produced by international centers (ECMWF and GFS/USA), NWP modelling done by HMI and use of 3-hourly satellite data. Currently the forecasters do not have access to real-time data from the HMI observation network. HMI has in use several regional and local scale nested numerical models: ETA-MN (33 and 17 km horizontal resolution) and freely available models WRF (7 km) and NMM-MN (5 km). Data from global models of AVN GFS (USA) and ECMWF (Europe) are used as initial and lateral boundary conditions. As ECMWF is going to run global models on 8 km horizontal resolution it is vital to use this data for 1-10 days forecasts, and to increase capacity to run higher resolution (1-3 km) mesoscale model for Montenegrin territory.

The ETA model includes a dust transport module, which is used to forecast dispersion and deposition of dust from Sahara. WAM –Wave Atmospheric Model- is used to predict sea waves and it is run at 12.5 km horizontal resolution.

As HMI does not have adequate capacity to operate the models they are automatically run by a private Serbian meteorological consulting SEWA. It is envisaged that HMI would have at least two persons to work with NWP models. However, currently there is only one person at HMI that meets current needs and who is available for operational services for analysing and weather forecasting, and is available also after working hours.

Currently HMI has limited computing resources, and actually there is no backup system available to ensure sound computing in case of emergency. This makes the national DRR system at all levels quite vulnerable.

HMI does not operate any modern automatic processing and visualization software of Weather Prediction Products.

6.3.5. Warning products and services

6.3.5.1. Warnings and mandates

Currently there is no law which would define the responsibilities and mandates concerning production and dissemination of warnings and alarms for natural hazards. However, only HMI has the established mandate to issue general science based warnings of hydrometeological hazards (strong winds, hail storm, thunderstorm, heavy snow, freezing rain, dense fog, storm surge, icing of roads, heat & cold waves, drought, river flooding and marine hazards) through media, its internet pages and directly to authorities.

Table 34: Warnings for natural and technical hazards in Montenegro, based on Annex 2

Hazard	Exists in the country	Warning by	Type	Warnings / year
Heavy precipitation	Yes	HMI	I	10-20
Flash floods	Yes			
River flooding	Yes			
Coastal Flooding	Yes			
Hailstorm	Yes	HMI	I	5-10
Thunderstorm or lightning	Yes	HMI		60-70
Heavy snow	Yes			
Freezing rain	Yes			
Dense fog	Yes			
Tornado or cyclone	No			
Strong wind	Yes	HMI	I	
Storm surge	Yes	HMI	I	60-70
Heatwave	Yes			
Cold wave	Yes			
Drought	Yes			
Marine hazard	Yes	HMI	I	
Sandstorm	No			
Landslide or mudslide	Yes			
Avalanche				
Airborne hazardous substance	Yes			
Waterborne hazards	Yes			
Hydrometeorological hazards for aviation	Yes	SMATSA	III	
Icing of roads				
Forest or wildland fire	Yes			
Smoke, dust or haze	Yes			
Earthquakes	Yes			
Tsunamis	No			
Volcanic events	No			
Dispersion of insect pests	Yes			
Desert locust storm	No			
Hazard for allergic reactions	Yes			

HMI does not analyse potential impacts of the hazards. However, concerning flash floods HMI measures and forecasts precipitation, and gives an estimate whether this could cause flood or not. The warnings are based on 1-10 day weather forecasts, and on the data from the observation networks. Warnings on flooding are given in close communication and cooperation of Sector of Meteorology and Sector of Hydrology (precipitation + temperature + water level). HMI does not warn for floods or flash floods, but it warns for heavy precipitation and high water levels and indicates whether it might lead to flooding.

6.3.5.2. Warning dissemination mechanism

HMI provides information and warnings via bulletins to authorities, the 112 system and some industrial sectors with contract. In some cases, the produced information is tailored to specific users e.g.:

- Information to public disseminated via mass media;
- Information about weather condition to SEM via bulletins (also available on the web);
- Warning dissemination and alerting via Centre 112, and via Fax to SEM in case of expecting emergency situation;
- Bulletins, reports, studies for Ministry of agriculture, forestry and water management;
- Information about floods provided by official reports and direct communications to Ministry of water management.

In November 2010, HMI became the member of the EUMETNET METEOALARM system and HMI has received proper software and training. Some of hazard mapping analyses are available at the HMI official web page www.meteo.co.me.

Currently there are only few TV stations (e.g. RTCG 1 and VIJESTI), which prepare weather forecasts based on HMI data and information, or have specific contract with HMI, which engages meteorologists to make weather forecast and present it on the TV. Moreover, HMI forecast is used by two newspapers: Pobjeda and Vijesti.

Current dissemination mechanism of warnings and advisories is not very effective thinking about getting the information to the authorities and the public and especially to those who are at the dangerous areas with as long lead time as possible.

6.3.6. Climate change analysis

Information of impact of climate change at local level is essential for governmental and industrial strategy planning and for adaptation to climate change. Currently HMI does not have a specified or active role in climate change studies.

It can be expected that also Montenegro could significantly benefit from the new South East European Virtual Climate Change Center (SEEVCCC), which was established in 2008 within the Serbian National Hydrometeorological Service.

6.3.7. Information Technology and Telecommunication capacities

Quick reliable communication system is critical for collection of data, data sharing and dissemination of products and warnings. Internet has become a very important tool among advanced NMHS to disseminate information and warnings. Currently HMI does not have capacity for on-line data collection and tools for automated production and dissemination of products and warnings.

At present the data from the manual national network is collected via telephone lines and from AWSs by mobile phones. Climatic and some other data are delivered from the stations to headquarters by post. Data, information and products are distributed to media, other information channels and end-user by telephone, mobile phone, internet, email and post. Warnings are sent by phone and mobile phone only, which also guarantees some response from the receiver (Table 35).

HMI is linked to WMO GTS through connection to Sofia RTH.

Table 35: Equipment in use for data communication and warnings and other products dissemination

Telecommunication Equipment	To receive data	To send data	To send warnings	To send products
Telephone	X		X	X
Mobile Phone	X		X	
Telefax				
Dedicated Leased Lines				
UHF radio transceiver				
High frequency/Single side band radio				
HF Radio Email				
Aeronautical Fixed Telecommunication Network				
Very Small Aperture Terminal				
Data Collection Platforms used to transmit data from AWSs				
Global Telecommunication system (WMO-GTS)				
Meteosat Second Generation Satellite system				
Other satellite systems				
Internet				X
Email				X
Post/mail	X			X
Print media				
TV –national				
TV-commercial				
Radio				
Bulletins			X	
Printed text			X	X

6.3.8. Human resources

The HMI has scientific background and knowledge, but insufficient number of employees, to participate in DRR, and to produce critical data for analyses of hydrometeorological extremes and to operate an adequate early warning system.

The total number of HMI staff is 125, and the number of permanent employees is 113. Close to half of staff are women. The educational level of the staff is quite low; with only 7 persons with MSc degree.

In comparison to EUMETNET NHMSs the amount of human resources look quite adequate. However, more than half (65%) of the HMI staff are technicians/observers at manned weather and hydrological stations, while the number of observers at european NHMSs is very low due to high degree of automation of the observation network, but also of data management, analysis, production and information delivery systems. Actually the number of scientifically adequate staff of HMI in hydrological and meteorological sectors is alarming low, with respect to ordinary operational work and especially to DRR related duties: only 5 forecasters (while SMATSA has 7 forecasters). There is also significant lack of professional IT or ICT staff. Only one person is capable to run the numerical weather prediction models, and during the weekend, holidays/vacations, the model is running by itself using special script which initiates the model automatically.

Unlike the hydrometeorological services in EU the HMI has insufficient number of employees to operate a 24/7 monitoring, analysis and forecasting system. HMI suffers severely from lack of computing and IT systems , with proper back-up system, and human resources (which are critical for running of data collection, data management, data sharing and numerical weather models) makes the national DRR system at all levels quite vulnerable. The office hours for the weather forecasting department are from 04 to 18, daily.

Table 36: Number of HMI staff by branch and level of education

Branch	Field and education														TOTAL
	Techn-icians	Meteorologist			Hydrologist			Engineer			Physicist, Chemist, Economist			Other	
		BSc	MSc	PhD	BSc	MSc	PhD	BSc	MSc	PhD	BSc	MSc	PhD		
Observation network	56								2		7			2	67
Telecommunication															
Data management	13					3					7			1	24
Weather forecasting		1	1								2			1	5
Hydrological forecasting															
Climatology			2								1				
Agrometeorology											3				3
NWP			1												
R & D															
Weather modification															
IT personnel											2				2
Commercial services															
Accounting											3				3
General administration	8													3	11
Other															
TOTAL	**77**	**1**	**4**			**3**			**2**		**25**			**7**	**119**
Female in % of total	40	0	50			30			50		60			50	40
Men in % of total	60	100	50			70			50		40			50	60

HMI has lost qualified staff during the latest years to other sectors and providers of weather services. Currently it is difficult to get new people into the hydrometeorological sector. Low visibility, low salary level and less interesting brand of HMI does make it interesting for young people. However, these problems have been recognized by the decision makers, so it can be expected that the situation will be improved in near future. Currently there is either any university level education in meteorology available in Montenegro, which will be an obstacle for finding new academic staff.

6.3.9. Training related to DRR

Currently HMI has no training programme for experts. Due to low number of experts it is difficult to send staff to be trained by European or other advanced NHMS.

HMI participates in WMO and UNISDR workshops and training as much as possible. However, the low number of forecasters and meteorological and hydrological experts limits the possibilities for them to participate in this type of training, which would be very essential for HMI and the DRR in Montenegro.

6.3.10. Financing

HMI, which should have a critical part of the DRR budget, is severely under-financed for essential parts concerning DRR. HMI does not have resources to operate a 24/7 analysing and forecasting system. HMI is also under-financed with respect to purchase, operate and maintain adequate hydrometeorological observation network (adequate number automatic real-time meteorological and hydrological stations) or modern weather radar and lightning detection networks.

Up to now, the HMI has not received financial resources to implement investments in order to strengthen its capacity to better promote national, regional and european DRR, as proposed by the recent UNISDR-WMO-WB initiatives and project reports. The value of better hydrometeorological observations and services to the national economic development, and especially to DRR, is not yet fully recognized and appreciated at policy level.

6.3.11. International and Regional Cooperation

Successful operation of NMHS is based on international cooperation. Weather forecasts and forecasting of natural hazards are based on products from global and regional scale state-of-the-art numerical weather prediction models, use of satellite data and sharing of data from conventional and modern remote sensing systems. Regional, local and mesoscale numerical weather prediction models are developed by international consortiums. EU based hydrometeorological organizations provide most state-of-the-art models, software and tools to be utilized by the member NHMSs. The integration into the European hydrometeorological infrastructure was given the highest priority in the 2007 project in developing the capacities of the NHMSs to implement best European practices and to produce improved products and services in support of national economic development and DRR.

Table 37: International and regional cooperation partners of HMI

International and regional organisations and cooperation mechanisms	HMI status
WMO	Member
WMO RAVI	Member
RMDCN	No
IOC	No
UNISDR	Yes
UNDP	Yes
Red Cross/Red Crescent	MoU
EUMETSAT	no
ECMWF	Cooperating state
EUMETNET	Member
METEOALARM	Member
ECOMET	No
EUFP7 projects, networks	No
EU JRC	No
EU PHARE	No
EU CARDS	No
EUCLID	No
EUR-OPA	No
DMCSEE	Yes
SEEVCCC	Yes
SAVA Commission	Yes
NWP consortium membership	None
NMHS bilateral	Albania, Serbia, FYR of Macedonia, Croatia, Republic of Sprska
NMHS MoU	RedCross, Emergency situation organizations

Montenegro has become a cooperating state with ECMWF, which provides the HMI possibility to utilize all the ECMWF products. Currently there have not been any actions on governmental level to participate to EUMETSAT. HMI has become a member of EUMETNET METEOALARM in 2010, and a member of EUMETNET in 2011. HMI is partner in the DMCSEE project financed by EU.

HMI has many cooperation agreements with Hydrometeorological services of other countries in the SEE Region: including the Hydrometeorological Institute of FYR of Macedonia, the Republic

Hydrometeorological Service of Serbia, Albanian Institute of Energy, Water and Environment. MoU is under preparation with Slovenia, Turkey and FHMI/BiH.

There are also cooperation agreements with European countries (Norwegian Directorate for Water and Energy) and international organizations. Norwegian Directorate for Water and Energy was financing the automatization of part of the hydrological stations. It has also co-financed the purchase of hydrological database WISKI. HMI is collaborating with the Norwegian company Startcraft in the hydrological modelling of a river using HBV model.

HMI has experiences in research and development projects at the international level, such as:

- AdriCosmStar – integrated river basin and coastal zone management system, sponsored by the Italian Ministry of Environment, Land and Sea; project related to the bathymetric measurements of the Montenegro coastal area, Bojana river catchment and Scadar Lake;
- project SEE-ERA related to the regional transport of desert's sand;
- research project EWCM related to the extreme weather conditions in Montenegro.

Currently the level of international cooperation is at quite low level partially because of lack of experts and academic staff with good skills in European languages, especially English. This aspect is often under considered, but it hampers dramatically the participation of personnel to international workshops or trainings.

6.4. Technical recommendations to strengthen HMI capacities in support of DRR

Based on technical feasibility study of the HMI and assessment in the current DRR system in Montenegro, following recommendations can be made in order to promote the contribution of the hydrometeorological sector to the DRR in Montenegro.

Legal framework and institutional arrangements related to the role of NMHS in DRR

1. There are urgent needs to improve the national legislation concerning the DRM and the role of different technical agencies including HMI;
2. There are needs to better integrate HMI into DRR planning;
3. There are needs to promote cooperation with other technical agencies.

Monitoring and observations networks and data exchange

4. There is an urgent need to establish a reliable calibration and maintenance system in order to produce measurements which meet the WMO standards;
5. There are urgent needs to establish automated weather stations at sea and coastal regions, where the tourism is growing rapidly;
6. There are urgent needs to establish a weather radar network;
7. There are needs to establish 1 upper air sounding station;
8. There are needs to establish automatic hydrological stations.

Forecasting

9. There is a need to further develop capacities to support DRR through nowcasting and long-term forecasting;
10. There is a need to improve the technical capacities to develop monthly and seasonal climate outlooks;
11. There is a need to develop and integrate additional modelling for hydrology and air quality and to link these models to NWP;
12. There is a need to improve capacities to use automatic analysing, editing and dissemination tools.

Hydrometeorological data management systems

13. There is an urgent need to initiate a data rescue programme to digitise and quality ensure the historical data;
14. There is a need to develop the technical capacities for data management and to adopt automatic quality control systems of hydrometeorological data.

Hazard analysis and mapping to support risk assessment

15. There is a need to develop hazard analysis and mapping (through GIS tools) based on historical data and climate change projections to support risk assessment;
16. There is the need to develop capacities in the use of GIS, spatial analysis and management of geographic data;
17. There is the need to develop capacities in hydrological analysis;
18. There is the need to develop capacities in agrometeorological and drought analysis, including remote sensing applications;
19. There is the need for better management of hazard impact data.

Information technology and telecommunication issues

20. There are urgent needs to upgrade the communication system to promote on-line and real-time data collection;
21. There are urgent needs to modernize the communication systems to efficiently disseminate warnings and other products.

Warning products and services

22. There are needs to enhance the mandate and capacity of HMI to produce and issue more weather and climate related warnings efficiently and timely;
23. There is an urgent need to establish a 24/7 science based analysing, forecasting and warning system at HMI;
24. There are needs to further promote cooperation between HMI and different socio-economic sectors in order to increase the number of special services and warnings tailored to the needs of customers;
25. There are urgent needs to automate the warning production and dissemination systems.

Climate change analysis

26. There is a need to develop a climate data management system and climate analyses;
27. There is a need to develop the technical capacities for climate change projections downscaling to local scales;
28. There is a need to develop climate change impact studies in cooperation with DRR, industry and other sectors.

Human Resources

29. There are urgent needs to promote the human resources through investment in forecasters, ICT experts, NWP experts and scientists;
30. There are needs to increase the number of staff with academic MSc and PhD degrees;
31. There are urgent needs to promote the skills especially in English in order to increase the capacity to participate in EU activities;
32. There are urgent needs to promote training of the mid-management in leadership, project management, cooperation with industry and participation in EU R&D projects;
33. There are needs to establish a systematic training programme for whole staff by adapting the trainings systems in use in some of the advanced EUMETNET NHMSs;

34. There are needs to increase the salary level of HMI staff to the level of meteorologist in the aviation sector in order to promote the attractiveness of HMI.

Regional cooperation

35. A regional Multi-Hazard Early Warning System composed of inter-operable national Early Warning Systems should be designed through a regional cooperation process. A comprehensive design and planning document should include institutional and technical aspects of MHEWS, as well as a cost-benefit analysis and a fund-raising strategy;
36. Risk assessment at regional, national and local level is the foundation for development of agreements and implementation plans;
37. Modernisation and interoperability of the meteorological and hydrological networks should be implemented at the sub-regional level to benefit from economies of scale and financing opportunities. This plan should include automatic on-line stations, a sub-regional radar network as well as a lightning detection network;
38. To improve their forecasting capacities SEE countries should increase their cooperation with global, regional and specialized Centres producing NWP, by developing their NWP capacities and become members of NWP model consortiums. Linkages between NWP models and hydrological models should also be developed for a better flood forecasting;
39. A regional harmonisation of watch and warning systems should be promoted;
40. Cross-border exchanges of real-time data, forecasts and warnings should be increased;
41. Improve the English knowledge of HMI technical staff.

6.5. Recommendations from the Montenegro National Policy Dialogue

Based on the detailed assessments of the DRR policies and practices as well as the NMHS capacities, gaps and needs in the beneficiaries to support DRR, policy recommendations were developed. Initial results were presented to national stakeholders for review and discussions during National Policy Dialogues organised by WMO together with the UNDP in Kolasin, on 24-25 November 2010. During this meeting, high-level participants endorsed the assessment, as well as the set of recommendations emanating from it and presented hereunder.

HFA priority 1: Ensure that disaster risk reduction (DRR) is a national and a local priority with a strong institutional basis for implementation

Recommendation 1: To establish and adopt byelaws that support legislation pertaining to DRR in order to give greater legal authority to the process of building effective DRR systems and structures in Montenegro.

Recommendation 2: To promote and support dialogue and exchange of information and cooperation among all relevant agencies and institutions at all levels aiming at fostering a unified approach to DRR.

Recommendation 3: Creation of the National Platform for Disaster Risk Reduction which should establish responsibilities at the national through to the local levels, to facilitate coordination across sectors, relevant to DRR.

Recommendation 4: Clarification of roles and responsibilities by positioning the Sector for Emergency Management in accordance with best international practices, in such a manner that it will have direct responsibility to the Government.

Recommendation 5: Create a DRR action plan to enhance National Strategy for Emergencies with enumerated responsibilities and financial plan.

Recommendation 6: Ensure financing mechanisms for Disaster Risk Reduction are in place, utilizing both regular budget resources and financial resources from donor community.

HFA priority 2: Identify, assess and monitor disaster risks and enhance early warning

Recommendation 7: To establish a national system for collection, analysis and dissemination of all relevant disaster data (to inform Early Warning System, but also related to post-disasters data collection).

Recommendation 8: To enhance institutional capacity by further developing capacity for Risk Assessment in the Sector for Emergency Management, Hydro-meteorology Institute and Seismology Institute.

Recommendation 9: To enhance technical and human resources of the technical agencies, such as hydro-meteorological institute to support the early warning system.

Recommendation 10: Increase capacity for Risk Assessments at Municipal Level (Sectors for Spatial Planning, local communities) with emphasis on Vulnerability Assessments.

Recommendation 11: Establish mechanisms to preserve existing and future capacity for Disaster Risk Reduction within relevant institutions.

Recommendation 12: Work on regional harmonization of Risk Assessment related methodologies.

Recommendation 13: Mainstream adaptation to climate change into all DRR strategic elements at all levels.

Recommendation 14: To develop national capacities for climate services to support medium and long-term sectoral planning in the context of reducing overall risks, and with consideration for increasing climate associated risks.¨

HFA priority 3: Use knowledge, innovation and education to build a culture of safety and resilience at all levels

Recommendation 15: To integrate DRR into curriculum at all levels of education.

Recommendation 16: Develop capacity for DRR in media in order to raise level of public awareness on DRR.

Recommendation 17: Create and implement a DRR Strategy for awareness raising, in order to raise level of overall understanding of the importance of Disaster Risk Reduction among population at large.

Recommendation 18: Create national translation of UNISDR Terminology for Disaster Risk Reduction.

HFA priority 4: Reduce the underlying risk factors

Recommendation 19: Promote reduction of disaster risks by systematically integrating DRR outcomes and activities into policies, plans and programmes for sustainable development and poverty reduction as well as the National Development Plan.

Recommendation 20: In the context of reducing vulnerability, integrate DRR in implementation and ongoing development of Government Plans for Informal Settlements.

Recommendation 21: Develop national capacities for climate services to support medium and long-term sectoral planning in the context of reducing overall risks, and with consideration for increasing climate associated risks.

HFA priority 5: Strengthen disaster preparedness for effective response at all levels

Recommendation 22: Strengthen the sustainability of disaster preparedness systems and structures through:

- Developing capacities for the implementation of policies, strategies and mechanisms for disaster preparedness and response to ensure sound linkages between international, national and local levels;
- Ensuring protocols and mechanisms of information management for effective response are permanently in place and regularly updated to anticipate future disasters.

Recommendation 23: Ensure standard operating procedures in response and response preparedness are well defined, regularly tested and continuously improved.

Recommendation 24: Define and improve role of media during disasters.

Recommendation 25: Introduce post-disaster recovery into disaster preparedness planning.