3. CHAPTER THREE: METEOROLOGICAL, HYDROLOGICAL AND CLIMATE SERVICES TO SUPPORT DISASTER RISK REDUCTION AND EARLY WARNING SYSTEMS IN BOSNIA AND HERZEGOVINA

Floods are the most frequent major natural hazards in Bosnia and Herzegovina causing disasters by affecting large amounts of the population and causing significant economic losses. Other major natural hazards with significant impacts are drought, landslides, extreme temperatures, storm and wildfires. All these are caused directly or partially by extreme weather, water or climate conditions. In addition, a number of hazards pose risks across the borders in the SEE 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 Bosnia and Herzegovina to support DRR. It highlights that:

- As there are no national level hydrometeorological services in Bosnia and Herzegovina, it is necessary to promote the cooperation between the hydrometeorological services of the two entities (FHMI, RHMS RS) and with the aviation weather services as well;
- There are needs to promote the DRR management and clarify the roles and mandates of different sectors and technical organizations, especially the hydrometeorological services.
- The technical, human and financial capacities of the NHMSs are not adequate to produce sufficient services and support to the DRM;
- There are urgent needs to establish a hydrometeorological database at the national level.
- It is necessary to enhance investments in climate modeling 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.

3.1. Bosnia and Herzegovina vulnerability to hydrometeorological hazards

3.1.1. General overview of country's economic sectors

The economy of Bosnia and Herzegovina has been completely shocked by the collapse of Yugoslavia and the consequent war. Under former Yugoslavia, military industries were promoted in the republic, resulting in the development of a large share of Yugoslavia's defense plants. Now, Bosnia and Herzegovina faces the dual problem of rebuilding a war-torn country and introducing market reforms to its formerly centrally planned economy. High unemployment rate and declining reconstruction and humanitarian assistance from the international community are actually the two most serious economic problems.

The economy is based mainly on services and on the primary sector. Agriculture and forestry till 2004 contributed for 24% of the GDP. Services are the main contributor of GDP, for about 46% in 2004. The industry sector (10% of GDP) is characterized by a strong component coming from electricity production (5.7% of GDP in 2004).

Table 8: List of the economic sectors ranked by their contribution to GDP in BiH

Economic sectors	Contribution to GDP (%)		
	2002	2003	2004
Agriculture & forestry	25,5	24,7	24
Transport	9,6	10	9,9
Industry	10,5	10,2	10,4
- electricity production	4,1	4,8	5,7
Services	45,9	46,1	46,3
Construction	8,6	9,1	9,5

3.1.2. Hydrometeorological hazards in Bosnia-Herzegovina

Floods are the most frequent major natural hazards related to weather and climate in Bosnia and Herzegovina, causing disasters by affecting large amount of the population and causing significant economic losses. Approximately 75% of the territory of Bosnia and Herzego9vina is located in the transboundary Sava River Basin area and 25% of the country drain into the Adriatic Sea. In 1976, three floods affected 43 of 109 municipalities in the country. In April 2004, flooding affected over 300,000 people in 48 municipalities, destroyed 20,000ha of farmland, washed away several bridges, and contaminated drinking water. In December 2010, Bosnia and Herzegovina experienced the largest amount of precipitation recorded in the last 100 years, which resulted in massive floods on the entire territory. According to national authorities, the hardest hit areas were on Drina River, in Central and Eastern Herzegovina. In these areas alone, more than 4,000 people were evacuated.

Although fire is listed as one of the top hazards in Bosnia and Herzegovina the collection of data has been minimal and as a result the risk is hard to quantify. Forest land covers approximately 50% of the territory of Bosnia and Herzegovina and is equally divided among the entities. In the Federation of Bosnia and Herzegovina and Republic Sprska, forest fires present a problem, burning anywhere from 1,000 to 3,000 hectares annually.

Other major natural hazards causing significant consequences since 1992 have been drought, landslides, extreme temperature, storm and wildfires. All these are caused directly or partially by extreme weather conditions. The occurrence of landslides in the mountainous areas of Bosnia and Herzegovina is very common due to the presence of underground water flows. After a large landslide that occurred in 2000 in the area of Zenica seven people lost their lives and many families remained homeless. The number of landslides has increased considerably over the last 15 years due to the uncontrolled exploitation of forests and minerals and because of an increase in illegal and or unplanned construction. Bosnia and Herzegovina have also a number of environmental issues. These include air pollution from the country's metallurgical plants and other sources. There also many other hazards related to weather, like harsh winter conditions. They may

cause accidents which are in some countries on annual level even more costly than the traditional natural hazards. From Bosnia and Herzegovina no data of this type of weather related hazards was available.

The severity of extreme events like drought, heat waves, forest fires and flooding has intensified over the last few decades and as revealed in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, this trend is expected to accelerate in the future as a result of climate change, leading, together with changes in land-use patterns and increased human settlements in areas that are prone to disasters, to increased hydrometeorological and climate-related risks in the coming years.

3.1.3. Sectoral analysis of the vulnerability to hydrometeorological hazards

Agriculture is still one of the most important sectors of the economy (10.4% of the GDP in 2006) providing food security for large part of the population. Out of total area of 5,113 millions hectares of the country, 47% represents agriculture land. Bosnia and Herzegovina is relatively poor in agriculture resources with 66% of its territory considered mountainous or hilly and, only 20% of the country is suitable for intensive farming (around 1 million ha). The structural of agriculture is sector is characterized by small sized family farms which to large extent produce for home consumption – ; the state firms, generally much larger, are mostly not operating or in difficulties often due to not finalized state of privatization. Agriculture production in Bosnia and Herzegovina is dominated by crop production, with livestock production representing less than one third of the total output. The economically most important sub-sector of BiH agriculture is vegetables. Of considerable importance are also fresh cow milk, maize and potatoes. On the Entity level, the agriculture sector is more important for the economy of Republika Srpska (RS), when it is estimated to be around 13% of the GDP (2005), than for the Federation of Bosnia & Herzegovina where it stands stable at 6%. Agro-food processing industry is recovering after a long period of under-investment over the last decade and its share in the GDP is increasing (8% in 2005).

Agricultural sector in BiH is highly vulnerable to drought, because of lack of modern technologies, policies or strategies aiming to strengthen agriculture resilience to drought. The risk of drought is high in the north eastern and southwestern parts of BIH in relation to the central mountains. Main drought and floods affecting the country have been:

- in August 2002, BiH suffered the worst drought in 120 years, with an estimated decrease of agricultural production of 60% leading to a serious food crisis;
- a 4-month drought and a series of storms hit several communities in BiH in summer 2003. This caused an estimated EUR 200 million damage to agriculture and affected up to 200,000 people;
- in summer 2007, extreme heat and drought destroyed more than 40% of the country's crop production resulting in extremely high food prices.

Projected climate changes in the SEE region will probably worsen the frequency and intensity of droughts and reduce the growing season for many crops.

Bosnia and Herzegovina possesses considerable water resources, and in the future water may become one of the foundations of the general economic development in many areas. However, the damages of the war, insufficient maintenance and inadequate regulatory framework, have brought water management, just like other sectors of the economy, into a difficult situation. The quality of potable water from the water supply system has been deteriorating steadily, the existing infrastructure is in poor condition, and water resources are increasingly polluted. Sustainable development in the field of water management is possible only with the implementation of the principles of integrated water resources management, by joint problem-solving in the main segments of water management, specifically in exploitation, protection of waters and protection from damaging effects of waters.

The condition of flood control facilities is very poor as a result of war damage, many years without maintenance, and minefields laid around some facilities. This is particularly true for towns along the Sava River. The consequences of floods resulting from exceptionally high waters in this area, if they were to occur, would be immeasurable. The situation is not much better in other parts of the country, as is evident from the floods in the Tuzla Canton in June 2001. The major damages, estimated at more than KM 60 million, were inflicted on crops, housing and infrastructure, and in the form of the erosion of arable land and the increased incidence of landslides. The problem of flood control in urban areas is also encountered in towns of Banja Luka, Čelinac, Prnjavor, Derventa, Modriča, Janja, Zvornik.

3.2. Institutional Framework of Disaster Risk Reduction in Bosnia and Herzegovina

3.2.1. Legal framework and policy supporting DRR in Bosnia and Herzegovina

The national policy of Bosnia Herzegovina (BiH) towards Disaster Risk Reduction (DRR) does not exist as a formal document but rather within the established system of decentralized responsibilities and capacities at all levels. The Ministry of Security (Sector for Prevention & Rescue) has coordinated the development of the National Platform for DRR.

At the national level, the framework is set by the Law on the Protection and Rescue of People and Material Assets from Natural and Other Disasters (hereinafter referred to as the Law on Protection and Rescue of Bosnia and Herzegovina) (Official Gazette BiH no.50/08) in Bosnia and Herzegovina, which was passed in 2008 and calls for the creation of a development programme that includes the development of mechanisms for Disaster Risk Reduction (DRR). Laws on the protection and rescue of people and property from natural and other disasters at lower levels of organization (i.e., the two entities, the Brcko District and the cantons) provide for the development of certain strategic documents which will, inter alia, include the issue of DRR. Entity level protection and rescue laws are:

- The Law on the protection and The Law on the protection and rescue (Official Gazette FBIH 39/03);
- The Law on the protection and rescue in RS (Official Gazette 01-346/02).

The national Law as well as legislation on protection and rescue in the entities prescribes the development of risk assessment. The basis for the national risk assessment is the Methodology for the Assessment of Risk from Natural and Other Hazards ("BiH Official Gazette" No. 86/09), which has been developed by the Sector for Protection & Rescue in cooperation with the UNDP. It includes a risk assessment whose goals are articulated as (i) identification of all hazards for the territory of BiH, (ii) an assessment of the vulnerability of people, property and critical infrastructure and (iii) the systematic dimensioning of risk, their likelihood, causes and consequences (expressed in human, material and or financial losses) as well as capacities.

Republic of Srpska has developed a Protection and Rescue Plan, which was delivered in 2003, whilst in 2008 the Federation of BIH adopted its Protection and Rescue Plan. Brcko District does not have its own plan.

There is no Ministry of Spatial Planning at state level, however they do exist at entity levels. Under the Law on Spatial Planning and Land Usage in the Federation of BiH spatial plans must contain data on areas prone to flooding. In RS there is the Spatial Plan of Republika Srpska for period 2005-2015.

Currently there is no law, which would clearly define the roles of hydro-meteorological services on the State level. In RS the duties and position of the Republic Hydrometeorological Service concerning floods and drought are regulated principally by the:

- Law of Administration of the Republic, Official Gazette of RS, No. 11/2008;
- Law on the meteorological and hydrological activity in Republika Srpska, Official Gazette of RS, no 20/2000.

In FBiH the duties and position of the Federal HydroMeteorological Institute concerning floods and drought are regulated by the:

- Law on Federal Ministries and other authorities of the Federal Administration (Official Gazette FBiH, 19/03);
- The Law on Hydro-Meteorological affairs of interest to Republic Bosnia and Herzegovina (Official gazette RBiH 10/76). The law is inherited from former Republic of Bosnia and Herzegovina and former Yugoslavia.

Furthermore the Law on Water (completely harmonized between Federation of BiH, Republika Srpska and EU Water Framework Directive), besides stating that preventive measures are to be taken to protect people and material goods from potential damage caused by waters, includes an assessment of the risk posed to areas as well as of the level of their vulnerability. The roles of FHMI and RHMS RS are also defined by the entity laws on water:

- Water Law (Official Gazette of the Federation BiH" 70/06);
- Regulation on the types and contents of the plans for protection from the harmful effects of water ("Official Gazette of the Federation BiH" 26/09);
- The Law on water RS (Official Gazette 01-557/06);
- Flood Risk Directive (Official Gazette of Republika Srpska, No. 50/06).

The Water Law of FBiH states that “Operational Plan for Flood contains planning of maintenance and updating of communications system for all levels of management the measures of flood control, and connects its system links with the Federal Hydrometeorological Institute”. Article 29 of the Regulation on the types and contents of the plans for protection from the harmful effects of water states that Federal Hydrometeorological Institute, in case of active flood:

- performs regular monitoring of hydrological and meteorological data;
- prepares reports on the quantity, type and intensity of precipitation in areas affected by rainfall;
- makes predictions on the intensity and rainfall, time, etc;
- regularly submits information system of water agencies in the data on water levels in rivers with hydrological stations under its jurisdiction and the state of snow cover;
- at the time of the active flood data from the fourth indent this paragraph, the competent Agency delivered every four hours, and if necessary more frequently.

According to the Water Law of RS (Section 90), flood protection includes the implementation of activities and measures aimed at reducing or preventing vulnerability of people and property from flooding, and removing the consequences of their actions. For protection from water, Republic of Srpska and local governments must provide planning of protection measures, construction and management of protection facilities, especially dams, dikes, facilities to stabilize the bottom and the banks and facilities for the drainage of internal water in accordance by this law. On the basis of Article 230 of Water Law (Official Gazette of the Republic of Srpska", No. 50/06) and Articles 82 and 69 of the Republic Administration Law ("Official Gazette of the Republic of Srpska", No. 118/08), Minister of Agriculture, Forestry and Water management shall issue an Order on Main Operating flood protection plan which define the flood protection in the area along the Sava river for each year.

The Sava River Commission prepared in 2009 the Sava River Action Plan, designed in full coherence with the European Flood Directive flood action plans for sub-basins. Thus the Action Plan requires Member States to first carry out a preliminary flood risk assessment to identify areas at risk of flooding. For such areas they would then need to draw up flood risk maps and establish flood risk management plans focused on prevention, protection and preparedness. According to the Action plan for sustainable flood risks management in the Danube Basin with applications on sub-basin of river Sava, the Republic of Srpska prepared the Action Plan for the period 2010-2021. Action plan should serve as an essential mean of support and harmonization between the given sub-basins in the area of flood risk, by:

- Preparation and maintenance of strategies and methodologies for flood protection;
- Improving the flood protection, focusing on the protection of human life and safety and providing the value of goods and property;
- Introduction of flood mapping;
- Increasing the willingness and responsibility in case of flooding;
- Improvement of bilateral and multilateral cooperation on the strengthening of planning, especially in planning.

Moreover, the Integrated Republic of Srpska Water Management Strategy and the Republic of Srpska Flood Risk Management Plan are in preparation.

3.2.2. Institutional framework

3.2.2.1. List of agencies involved in Disaster Risk Reduction for hydrometeorological hazards

At National level:

- Sector for Protection and Rescue (PRS) - Ministry of Security of BiH.

The country is governed at several levels: state level (Bosnia and Herzegovina), entity level (Federal of Bosnia and Herzegovina, Republic of Srpska, and District Brcko), canton level (only in FED BH) and on municipality level. The relations to international organizations (UN, WMO, etc.) are organized at state level, while e.g. hydro-meteorological and environmental monitoring and weather forecasts are organized at entity level.

In the Federation of Bosnia and Herzegovina:

- Civil Protection Administration (CPA);
- Federal Hydro Meteorological Institute (FHMI);
- Agency for Watershed of Adriatic Sea (AWAS);
- Agency for Watershed of Sava River (AWSR).

In the Republika Srpska:

- Civil Protection Administration (CPA);
- Republic Hydro-meteorological Institute of Republic of Srpska (RHMS RS);
- Water Agency for Sava river district (WASR);
- Water Agency for Trebisnjica river district (WATR).

On country level there are no national organizations responsible for hydrological or meteorological observations and services. The hydro-meteorological sector in BiH is divided into two entities the Federal Hydro Meteorological Institute (FHMI) in Sarajevo and the Republic Hydro-meteorological Service of Republic of Srpska (RHMS RS) in Banja Luka. District Brcko has no own hydro-meteorological institutions. The Ministry of Civil Affairs of BiH is an umbrella institution at the level of BiH, which coordinates the work of two institutes in the entities.

3.2.2.2. Sector for Protection and Rescue

The Ministry of Security of Bosnia and Herzegovina, in accordance with its statutory powers, has a leading role in DRR at the national level and most of the structures related to DRR activities are embedded in the system of emergency response. The Ministry of Security realizes its role in DRR through its organizational unit: the Sector for Protection and Rescue. In the event of a large-scale accident with trans-boundary effects or which cannot be resolved at the local (i.e., entity level leadership), the Ministry of Security of Bosnia and Herzegovina and the Coordinating Body of Bosnia and Herzegovina take the leading role. The Coordinating Body of Bosnia and Herzegovina is composed of the Council of Ministers (heads of relevant Ministries), five representatives from the Federation of Bosnia and Herzegovina, and five from RS and two from Brcko District with the Chairman of the Coordinating Body being the Deputy Minister of Security of Bosnia and Herzegovina.

At State level, the Sector for Civil Protection of the Ministry of Security is the central body with competences in, and responsibility for, international cooperation, internal coordination, strategic planning of protection and rescue measures and training programmes. The Sector for Protection and Rescue objectives in 2009 were the establishment of an effective disaster management and coordination body and an operational 112 Centre, the development of strategic documents specified in the State law (Methodology of Risk Assessment, Risk Assessment, and Emergency Response Plan), the protection and rescue coordination, including better networking with Ministry of Defense and other authorities, enhanced international cooperation, and the harmonization of protection and rescue law with by-laws in Bosnia and Herzegovina. The Ministry of Security coordinates and manages planning and exchange of data and information, and reports on the risk reduction activities of entities and Brčko District.

The Ministry of Security of Bosnia and Herzegovina - Protection and Rescue Sector was founded in 2004. Protection and Rescue Sector is managed by Assistant Minister, Head of Protection and Rescue Sector. Ministry of Security is authorized for:

- Execution of international obligations and cooperation in civil protection execution;
- Coordination of activities of Civil Protection Administrations of Entities in Bosnia and Herzegovina and adjusting their needs in case of natural or other disaster that affect Bosnia and Herzegovina;
- Passing programs and plans of protection and rescue.

The Protection and Rescue Sector is organized according to the constitution of BiH, the Framework Law on Protection and Rescue, and Entity Laws on Protection and Rescue/Civil Protection: At state level it is composed by 3 departments:

- Department for International Cooperation and Coordination;
- Department for Strategic Planning and Protection and Rescue Measures;
- Department for Structure and Training.

The Operational-Communication Centre of BiH -112 is also a part of Protection and Rescue Sector, and operational centres of other institutions and bodies of BiH, as well as the centres of Brcko District, will be connected to the Operational-Communication Centre. The Operational Center “OC 112” is authorized to collect and distribute data and warnings on the occurrence of natural hazards and other disasters and to make timely alerts to the population. The OC 112 should also create a central storage system that would allow for the establishment of easy mechanisms for collection, storage and dissemination of disasters data.

The Coordination Body of Bosnia and Herzegovina for Protection and Rescue is the Body of the Council of Ministers BiH.

At lower level, there are the Entity Civil Protection Administrations (Civil Protection Administration of Federation BH and Civil Protection Administration of Republic of Srpska) and Department for Public Security of Brcko District BH (Civil Protection Service). In the case of large-scale accident with trans-boundary effects or which cannot be resolved at the local entity level, the Ministry of Security and the Coordinating Body of BiH take the leading role. The Law on Protection and Rescue in BiH prescribes obligation of forming the Coordination Body BiH for protection and rescue as a professional and operational body of the Council of Ministers BiH. The Coordination Body would, in case of natural or other disaster, manage and coordinate protection and rescue actions.

At the request of the entities or BD the Coordinating Body proposes the declaration of a state of natural or other disaster within the territory of BiH to the Council of Ministries of BiH as well as the termination of the aforesaid state; it also coordinates the activities of protection and rescue with institutions, the entities and BD as well as the institutions and bodies at the level of BiH. It also coordinates the activities of protection and rescue of institutions and bodies at the level of BiH

during the implementation of measures of prevention and preparedness for natural and other disasters and coordinates them with the entities and BD.

Department for Strategic Planning and Protection and Rescue Measures is involved in drought/flood risk assessment. They are members of the Interdepartmental Working Group for the Development of Risk Assessment regarding Natural and Other Disasters in Bosnia and Herzegovina.

3.2.2.3. Federal HydroMeteorological Institute of Federation of Bosnia and Herzegovina

FHMI is an independent institution overseen by the BiH Ministry of Civil Affairs for meteorology, BiH Ministry of Foreign Trade and Economic Relations for hydrology and BiH Ministry of Security for seismology. FHMI, according to the applicable laws, performs professional and other activities relating to permanent monitoring in the field of meteorology, hydrology, environment quality, seismology and astronomy; conducts researches of atmosphere, water resources, environment (water, soil, air), seismologic processes and astronomic events; collects, processes, analyses and publishes data from its scope for the Federation BiH; issues on daily basis weather bulletins and forecasts, and actively cooperates with the World Meteorological Organization applying its standards in data exchange and improvement of this service.

FHMI is responsible for measuring, observation, collecting, publishing, and providing information, products and services related to the weather, climate and water, as well as their application in the human activities that are under the influence of atmospheric and related phenomena. FHMI produces hazard information by request, gives expert advice to different sectors, and provides historical hydrometeorological data for risk assessment projects, etc.

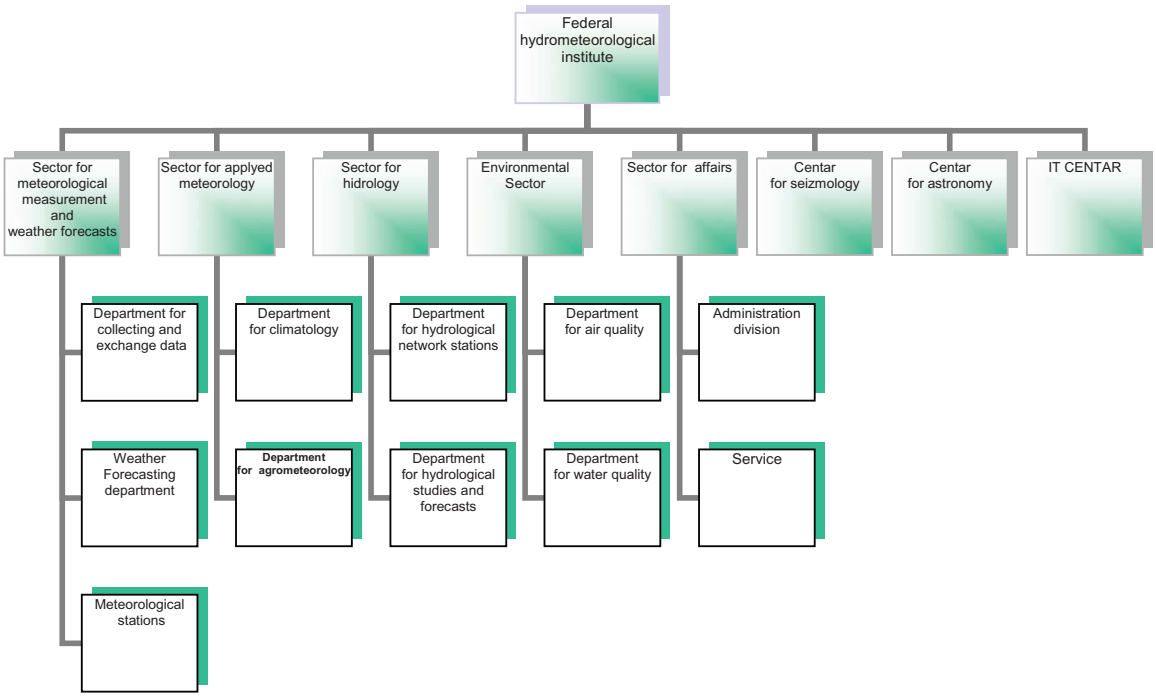

Figure 4. Organization chart of FHMI

3.2.2.4. Republic HydroMeteorological Service of the Srpska Republic

The Republic HydroMeteorological Service of the Srpska Republic is under the Ministry of Agriculture, Forestry and Water Management. According to the applicable laws, the obligations of RHMS RS under the law are:

- monitoring parameters: seismological, hydrological, meteorological, and air quality;

- creation and management of databases from the scope of activities;
- study of climate trends of climate, hydrology studies;
- weather forecasting;
- applied meteorology and hydrology;
- public information, media services;
- research activities;
- publishing and protection of data.

RHMS RS conducts the monitoring of hydrological and meteorological parameters, carries out an elementary statistical analysis of data and the analysis and forecast of meteorological parameters. The forecasts are issued as warnings in case of arrival of extreme weather (meteorological) and hydrological phenomena. RHMS RS has developed internal plans for strengthening the role of the institute relating to:

- Monitoring: the revitalization of the monitoring system, establishing new measurement stations, station automation and transmission of data, collecting center and database management; software for DB management, increasing the number of major meteorological stations with measurements of 24 x 7 days a week;
- Hydrology: establishing a system for hydrological forecasting, hydrological and hydrostatic model forecasts; integration with meteorological data and models, verification of the models output quality, a number of flow measuring stations in water streams;
- Meteorology: improving weather forecasting systems: working on the numerical prediction models for the development of new forecasting products; verification of model quality, analysis of specific synoptic situation through hind-cast runs of the model, now casting, using of forecasts in the weather alarm system;
- Climatology: creating climatological database; buying the software CLIDATA; climatological analysis and trends, participating in development programs, projects and cross-border cooperation.

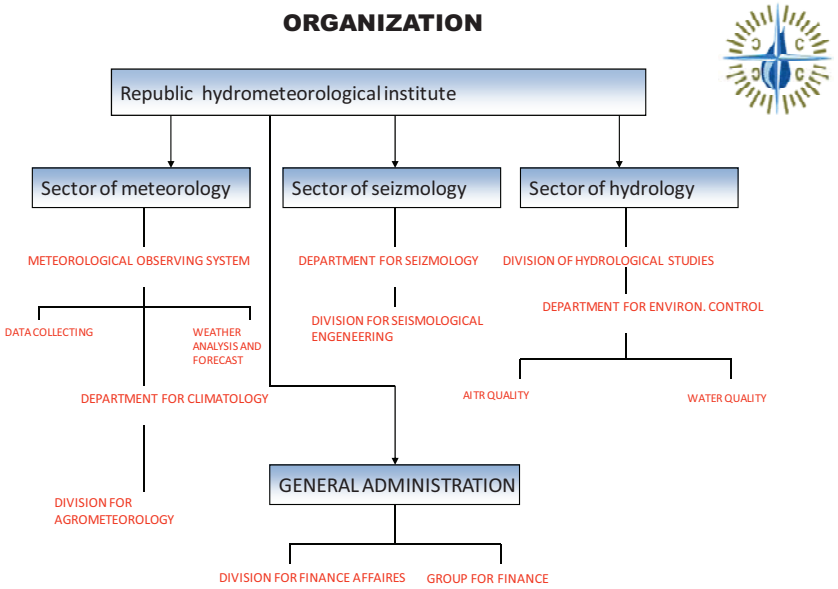

Figure 5. Organization chart of RHMS RS

RHMS RS has been involved in the working group of experts from different fields and sectors for the risk assessments of BiH threat from natural and other disasters. Government of Republic of Srpska at its session held on 4 and 5 March 2010 adopted a Decision appointing the members of Inter-working groups to work on risk assessments of BiH threat of natural or other disasters ("Official Gazette of the Republic of Srpska" No. 22/10).

3.2.2.5. Water Agencies

Currently there are 4 Water Agencies in Bosnia and Herzegovina, 2 in the Federation and 2 in the Republic:

- Agency for Water Catchment Area of the Adriatic sea Mostar, FBiH;
- Agency for Water Catchment Area of the Sava River, FBiH;
- Agency for Water catchment Areas of the Sava River Basin Bijeljina, RS;
- Agency for River Basin Water District of Trebišnice River from Trebinje, RS.

Water Agencies, established by Ministry of Agriculture, forestry, and water management, are responsible for implementation of long-term, middle term and annual water sector development plans:

- Flood protection;
- Maintenance, construction and operation of water sector facilities of general interest;
- Operation and Maintenance specially important independent regional water supply systems to the place of connection on municipal network;
- Preparation of drafts and technical studies for routine maintenance and rehabilitation;
- Participation in organization and implementation of studies and investigation tasks in water sector;
- Monitoring and control of water use, control of gravel exploitation;
- Exploitation of material from river course.

They are charged to implement the different steps foreseen by the European Flood Directive. The first step is planned to prepare a preliminary assessment of flood risk to be done by the end of 2011 and to be actualized in 2018, and thereafter in cycles of six years. The second step is the mapping of flood risk, to be done by the end of 2013. The third step is the preparation of flood risk management plans, to be completed and plans published by the end of 2015 and put into practice since the beginning of the 2016 and revised by the 2021 year and then actualized every six years.

The Agency for Water Catchment Area of the Adriatic Sea in Federation of Bosnia and Herzegovina (AWAS) is based in Mostar. AWAS is charged of watershed management, water use, water protection, protection from water, Hydrometeorological stations monitoring network, hydrologic and hydraulic modelling, flood mapping. AWAS has very closely collaboration with FHMI. The data collected by its own observation network are regularly transmitted to FHMI.

The Water Agency for Sava River District in Republika Srpska (AWSR RS) performs tasks related to:

- organizing the work and functioning of water management at the regional and river basin, as well as working offices of the water basin management;
- proposing long-term and medium term plans and programs for water resources development;
- taking care of providing the necessary funds and the manner of their use;
- monitoring the implementation of plans and programs for development of water management;
- controlling the dedicated use of funds;
- suggesting the rate of compensation;
- proposing the annual program and financial plan;
- proposing criteria and standards for routing and resource allocation;
- performing other duties in accordance with the law and other regulations of the Republic of Srpska and Bosnia and Herzegovina.

In the Agency, Water Management Sector and Department for Protection from Water are involved in floods risk assessment.

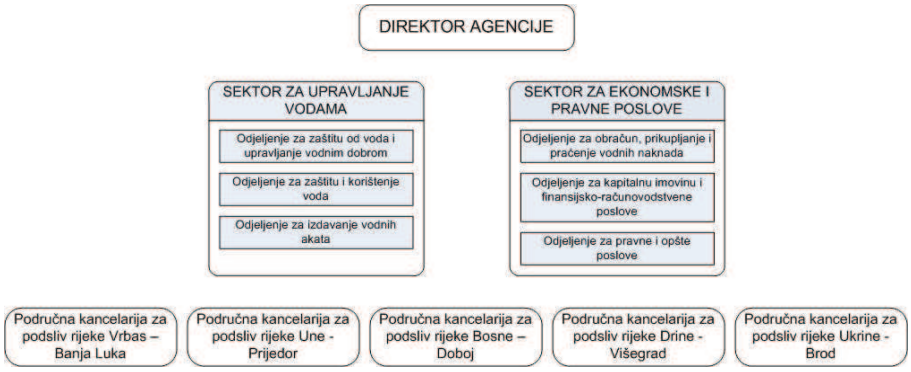

Figure 6. Organization chart of AWSR RS

AWSRRS is developing a real time flood prediction model for the Bosna river basin (Spanish financed flood risk mapping project-EPTISA). The objective is to implement a flood prediction and early warning system for the four remaining river basins (Sava, Una, Vrbas and Drina). An integrated flood forecasting and warning system is under the development.

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

The national policy of BiH towards DRR does not exist as a formal document but rather within the established system of decentralised responsibilities and capacities at all levels. To date there is no national strategy aimed at DRR and nor is one mandated by law. The Ministry of Security, through the Sector for Protection and Rescue, has realised the importance of mainstreaming DRR into its national policy.

The Ministry of Security of BiH, in accordance with its statutory powers, has a leading role in DRR at the national level and most of the structures related to DRR activities are embedded in the system of emergency response. A National Platform for DRR, as a functional body, does not exist, but the Sector for Prevention & Rescue has prepared activities such as seminars and workshops for the development of a National Platform. Implementation of these activities is planned for 2011 and the Ministry of Security has established cooperation with the relevant UN institutions as well as with EU countries and other South Eastern European countries that have National Platforms, so that this important segment of DRR can be established. In particular, BiH has established cooperation with representatives of the former Yugoslav Republic of Macedonia, which currently Chairs the European National Platform, in order to gain expertise for the purpose of developing the BiH National Development Plan as well as a National Platform for DRR.

Currently the cooperation between FHMI, RHMS RS and the aviation weather services, as well with the agencies collecting hydrological data, is quite low. Standard Operating procedures (SOP) and Quality Management Systems (QMS) between the hydrometeorological services and the DRM sector have not been developed. Currently data exchange and cooperation with the Water Agencies also is not at optimum level.

3.2.4. Roles and responsibilities in flood and drought risk assessment

According to the Law on protection and rescue, risk assessment in BiH is performed at three different levels:

- National level, coordinated by the Ministry of Security BiH, Sector for Protection and Rescue;
- Entity level, coordinated by the Civil Protection Administrations;
- Local level, coordinated by the local Authorities.

The National Risk Assessment is under finalization, applying the Methodology for Risk Assessment regarding natural and other disasters in BiH adopted on September 30th 2009. This is coordinated

by the Protection and Rescue Sector. Interdepartmental Working Groups composed by representatives of state and entity ministries, Public Safety Department of Brčko District BH, experts from various fields of governmental and non-governmental sector and civil society are established. Each working group developed the Risk Assessment concerning its thematic. Floods and drought are included among the 4 types of climatic hazards.

By the end of 2011 BiH will have a Disaster Risk Assessment that will consist of risk and vulnerability analysis. It is the first assessment for the whole territory and will be available for all institutions and public.

The two HMS participated in the working group, provided analyses of these main hazards, mainly statistical on frequency, number of events, affected areas. Water Agencies participated as well providing maps of areas affected by floods.

Concerning floods at entity level (Figure 7), Ministry of Agriculture, Forestry and Water Management is the main body authorized for both administrative and technical obligations, adopting general annual flood protection plans, organizing the preparation of water balances at entity level and for basic river basins. The Water Agencies, established by Ministry of Agriculture, Forestry, and Water Management, are responsible for implementation of long-term, middle term and annual water sector development plans. WAs collect floods information, make floods hazard maps and flood risk assessments. They are also charged to perform the preliminary floods risk assessment as per the EC Directive on floods. WAs provide information for physical planning to local and entity authorities, for environmental planning, hydroelectric companies, water user, etc.

Concerning impact data, Protection and Rescue Sector and OC 112 consolidate the drought/floods impact data delivered by lower levels, and utilize these data in specific reports regarding disasters impact in BiH. The reports with consolidated drought/flood impact data produced by the Sector are used by other state institutions, international and humanitarian organizations. WAs collect floods impact data as well as local authorities.

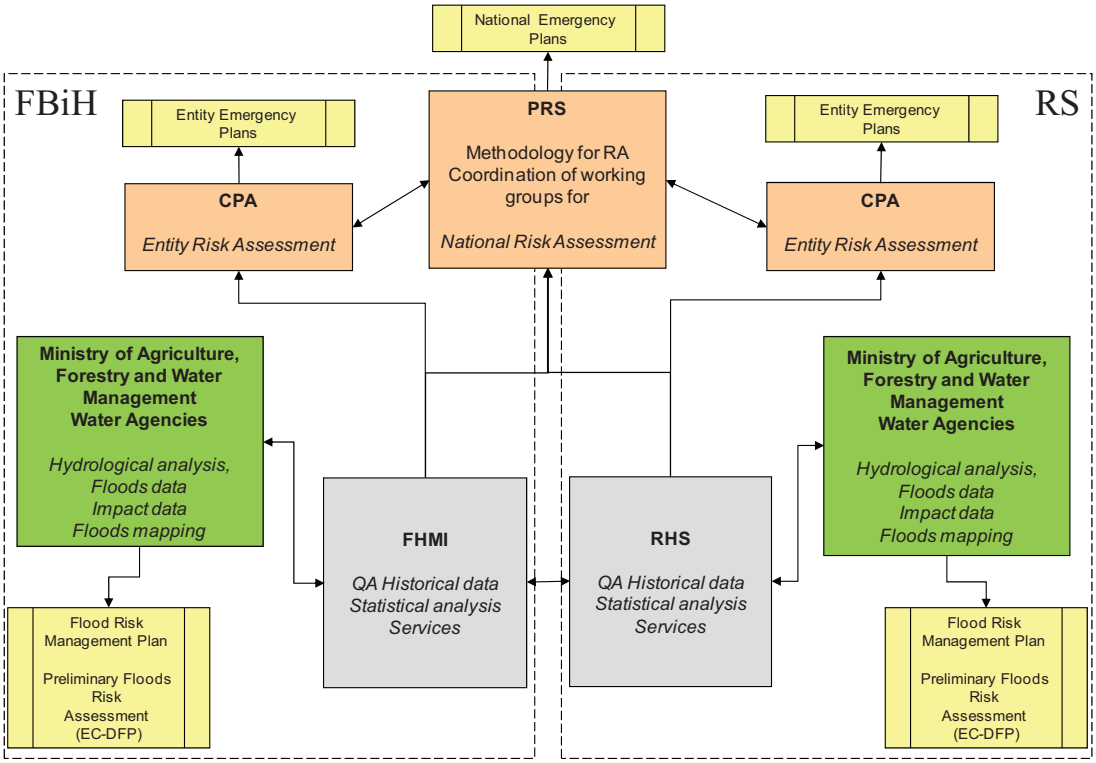

Figure 7. Workflow for Floods Risk Assessment in BiH

All existing planning documents are produced in line with a single methodology. At lower level of organization (entities, cantons and municipalities) there are inter-agency plans. Studies have shown that these plans are not very functional and useful only to a certain extent due to the actual system and structural changes in society, as well as an extremely complex system of bureaucracy. Protection and Rescue Sector is making efforts to consolidate the system conducting activities that should lead to a final goal: a unified methodology for preparation of planning documents at the state level, unified plans at state level and adequate guidance on the content, method of preparation and approval of these documents that would establish a system of mutual coordination plans for preparedness to disasters at the interdisciplinary multi-organizational level. The assumption is that this activity could be completed by the end of the 2012.

3.2.5. Budget and funding for DRR

Basic government funding mechanisms aimed at DRR are channelled through budgeting for projects aimed at the establishment, construction and functional development of a system of disaster management. Financing of these activities is conducted exclusively through planned budgeting for all institutions in the system working in this area. The Council of Ministers of BiH has provided significant financial resources, amounting to 4.2 million BAM (approximately USD 3 million) for the period 2009-2011, for the construction and establishment of a single European number for emergency situations: 112. The latter represents one segments of DRR as it is a contributing factor to preparedness: preparedness being one of the five priorities of the Hyogo Framework for Action. The specific issues of budgeting and funding at the state level are regulated by the Law on Protection and Rescue of BiH, which, among other things, requires the below stated:

- In the budget of the institutions of BiH and in accordance with the international obligations of BiH financial resources are to be ensured for the equipping, training and the setting up of an operational and functioning 112 centre, as well as equipping and training for an operational and functioning Coordinating Body. Professional development and training of civil servants and employees involved in protection and rescue within institutions and bodies at the level of BiH should be provided along with compensation costs for protection and rescue work of an international nature. In the case of natural or other disasters the execution of orders by the competent authority for protection and rescue and the provision of assistance to other states, entities and the Brcko District of BiH additional equipment and training of units may be provided;
- To finance part of the needs and activities referred to above funds can be secured through the financial and material technical benefits of the legal entities of BiH, donations given by other countries and international organisations and other forms of assistance. The lower levels of the organisational system in BiH (entities, cantons/regions) allocate significant budgetary resources for the development of the system of management for emergency situations.

In accordance with the organization of the public administration system in BiH all of the structures of public administration have their own budgetary resources. This fact explains the complicated system of relations in the activities aimed at introducing DRR. The entities have their own independent sources of financing and budgets and consequently the system of budgeting for DRR is not firmly established. So far the most significant assistance provided for the implementation of projects regarding DRR has come from the relevant UN structures: mainly from the UNDP, EU, NATO and through bilateral cooperation with DEMA.

3.3. Institutional and Technical Capacities of Hydrometeorological Services to support Disaster Risk Management

3.3.1. Monitoring and observations networks and data exchange

Hydrometeorological observation networks are established not only for national needs but also to be a part of the WMO Global Observation System (GOS) comprising of standardised measurements taken at constant hours using surface observation and monitoring stations, upper

air observation, hydrological measurements and satellite observations. International exchange of data is the core for monitoring and forecasting the weather globally, regionally and nationally. Long-time historical time series of accurate quality controlled observations are required for hazard analyses, climatological studies and monitoring of climate change. Real-time observations are critical for:

- prompt reaction in meteorological, hydrological and air quality emergency situations;
- reduction of vulnerability to the risks caused by meteorological, hydrological and environmental hazards;
- short term forecasts;
- validation of forecasting models;
- improved data assimilation, which will benefit the global, regional, local and mesoscale4 NWP modelling.

Quality of hazard analyses and global & regional weather forecasting depend strongly on quality and spatial density and representativeness of the observation network. The most important data for numerical models is upper air observations (soundings). In Bosnia and Herzegovina there are no upper air observations or weather radar observations available. The availability of such data would significantly improve quality of aviation weather forecasts and in general for short-term forecasting and now casting.

The observation network in Bosnia and Herzegovina is described in terms of number of different types of station in Tables 9 (FHMI) and 10 (RHMS RS). Before 1992, the hydrometeorological network which was managed by the Republic Hydrometeorological Institute of Bosnia and Herzegovina consisted of about 600 stations, including 19 principle weather stations, 91 climatological and 276 rainfall stations. During the war the observation network was heavily destroyed. At present several regions in FED BiH and also in Republic of Srpska are totally uncovered with synoptic stations (especially eastern Bosnia). Currently FHMI and RHMS RS have their own separate meteorological and hydrological measurements, with the objective to monitor on entity level only.

At the moment no weather radars or remote sensing equipment is available. Satellite data is essential for forecasters. Currently FHMI has a satellite data receiving system. Data is received mainly as basic picture as currently FHMI does not have capacity to use digital data to produce own analyses. RHMS RS does not currently have equipment to receive satellite data except as internet pictures.

The data exchange between FHMI and RHMS RS is very limited. Data from only 13 main meteorological stations is sent internationally through the WMO GTS. In order to send data to the WMO GTS RHMS RS is connected to FHMI and both then to the GTS hub in Sofia, Bulgaria.

The meteorological sensors and equipment at the manned stations are mainly obsolete. Due to lack of calibration facilities, calibrations and maintenance the measurements from these stations do not meet the WMO requirements and standards.

FHMI collects the following data: (i) Climate data (hourly, daily, monthly): precipitation, temperatures (soil and air), pressures, wind speed and direction, relative humidity, cloudiness, snow cover, evaporation etc. and (ii) Hydrological data (hourly, daily, monthly): water level and water temperature. The data collection process for automatic weather stations of FHMI is based on the new IMS software, receiving and sending data through the ADSL connection, which completely abolished the previous method of communicating by phone and radio stations. For the first time, FHMI is sending hourly report from synoptic stations, which greatly improved the quality of work. Regarding hydrology, FHMI has access to 25 automatic hydrological stations with real-

[4] Mesoscale meteorology general definition: Horizontal dimensions generally range from around 5 kilometres to several hundred kilometres. Examples of mesoscale weather systems are sea breezes, squall lines and mesoscale convective complexes. Today horizontal resolution of mesoscale models is typically from 1 to 3 km.

time data transfer by using radio and/or GSM telecommunication systems (FHMI collects data from 10 hydrological stations with real time data transfer). Water Agencies periodically submit to FHMI data on water levels recorded on CD or via e-mail (circa 50 stations). FHMI operates also environmental measurements: air quality is measured in Sarajevo, Tuzla and Ivan Sedlo, nuclear radiation is measured at 6 stations of which one is out of order, ozone near surface is measured at 4 stations (Tuzla, Sarajevo and Ivan Sedlo) and UV radiation at 1 station. FHMI operates one regional GAW station, Ivan Sedlo. Components measured are NO2 (Saltzman method) and SO2 (Absorptio-Photemetry/Colorimetry).

Table 9: Observations stations operated by FHMI

Type of observations stations	2007	2010	GTS	Comments on 2010 network
Atmospheric domain				
Surface synoptic stations (> 8 obs./day)	16	14		
Manned stations	13	13	12	Availability of data 69%
AWS or AWOS	3	1	1	Availability of data 75%
Cloud-height – automatic	0	0		
Climatic stations (3 obs day)				
Agrometeorological stations	NA	17	12	Availability of data 88%
Lake stations – manned	0	0	0	
Lake stations – automatic	0	0		
Rainfall station – manual (2 obs./d)	26	26	0	Target 250
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	0	0		
Weather radars	0	0		
Hale radars	0	0		
Lightning detection stations	3	3	0	Old type
Lightning detection hub station	0	0		
Satellite MSG ground station	1	1	-	
Hydrological domain				
Hydrometric stations	80	80	0	Availability of data 70%
of which autom. water level/discharge	59	59	0	
of which real time data transfer				
Maritime domain				
Maritime weather stations – manned	1	1		
Maritime weather stations - automatic	0	0		
Buoys	0	0		
Buoys with meteorological observations	0	0		
Tidal stations	0	0		
Tidal stations with met. Observations	0	0		
Environmental domain				
Air quality	4	4	0	Sarajevo, Tuzla and Ivan Sedlo
Water quality	0	0		
Nuclear deposition	4	6	0	5 operational
Ozone – near surface	2	2	0	Only 1 operational
Ozone – upper air	0	0		
UV radiation	1	1	0	
GAW station	1	1	0	Availability of data 90%
Seismological domain				
Seismic stations	3	3		Availability 70%

In 2007 the RHMS RS network meteorological stations contained 29 stations (all types) whereof only two were manned Main Meteorological Stations (operational 24h) with 24 hours of work, i.e. Banja Luka and Gacko, and the main climatological station Čemerno was in preparation to become the main meteorological station (0-24 h). Even if the total number of stations has decreased, the number of AWSs increased in the last years (one situated in Banja Luka and 5 in the area of the river basin Trebisnjica). However, the loss of manned synoptic stations been replaced with AWSs further reduces the capacity to provide adequate observations for the DRR system.

Table 10: Observation stations operated by RHMS RS

Type of observations stations	2007	2010	GTS	Comments on 2010 network
Atmospheric domain				
Surface synoptic stations	16	3	1	Earlier 5 stations to GTS
Manned stations (8 obs/day)	14	1		
AWS or AWOS	2	6		
Cloud-height – automatic	0	0		
Agrometeorological stations	NA	1		
Lake stations – manned	0	0		
Lake stations – automatic	0	0		
Ordinary climate station (3 obs/day)	9	23		
Rainfall station – manual (2 obs./d)	NA	NA		
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	0	0		
Weather radars	0	0		
Hale radars	0	0		
Lightning detection stations	0	0		
Lightning detection hub station	0	0		
Satellite MSG ground station	0	0		
Hydrological domain				
Hydrometric stations		24		
of which autom. water level/discharge	0	0		
Maritime domain				
Maritime weather stations – manned	0	0		
Maritime weather stations - automatic	0	0		
Buoys	0	0		
Buoys with meteorological observations	0	0		
Tidal stations	0	0		
Tidal stations with met. Observations	0	0		
Environmental domain				
Air quality	0	1		
Water quality	0	0		
Nuclear deposition	0	0		
Ozone – near surface	0	1		At Banja Luka
Ozone – upper air	0	0		
UV radiation	0	0		
GAW station	0	0		
Seismological domain				
Seismic stations	5	5		3 operational , 1 partially

At manned stations RHMS RS takes measurements every hour during the working time of the station. According to standards of WMO, the data are registered in the weather diaries and are observations forwarded to a collection center. Data collection is automated to a lesser extent, the

data is delivered to a greater extent in the form of synoptic reports for meteorology and txt. form for hydrological measurements. RHMS RS receives data from:

- Water agencies, this data are managed as the RHMS RS own data;
- FHMI, there is an agreement for data exchange, but is on demand and there are not automatic procedures for data exchange;
- Hydropower plants, but this data often are collected not applying WMO standards and only in some cases are used;
- Hydrometeorological services in the region, on project basis;
- the WMO GTS network.

RHMS RS operates an automatic air quality station in Banja Luka, 2 automatic monitoring stations in Bijeljina, manual stations for air quality (2 parameters) and temporal stations in Stanari, Ugljevik and Gacko. Additionally 4 automatic monitoring stations are operated in Banja Luka by Integral Engeenering. All measured data are sent to RHMS RS and forwarded to Sarajevo in FHMI and EIONET.

Currently there are 3 meteorological observatories in Bosnia and Herzegovina: Observatori Bjelasnica, Observatory Sarajevo –Bjelave (FHMI) and Observatory Banja Luka (RHMS RS). Radioactivity of air is measured (filter system) in following cities: Banja Luka, Novi Grad, Prijedor, Bijeljina, Gacko i Višegrad. Additionally radioactivity is measured from precipitation in Banja Luka at present. Near surface ozone is measured in Banja Luka.

Also other governmental entities, such as the different Water Agencies are also collecting, storing and analyzing relevant data from their respective area of responsibility. The Water Agency for the Adriatic Sea basin collects data on Water levels, Discharge, Rainfall, Air temperature, wind, solar radiation, evaporation, air pressure and Water quality. All data are received in real time from automatic hydrometeorological stations. The hydrometeorological network is under the ownership of three companies: (AVP Jadransko, Hydroelectric company EP HZH-B, and Hydroelectric company EP BiH), with 72 automatic hydrometeorological stations. Data for the last 10 years are stored in ASCII format (WordPad, excel). Older data are stored at FHMI. The Agency is receiving meteorological data from the FHMI, Hydroelectric companies and Croatia Waters. Data are shared with Federal Hydrometeorological Institute under a signed agreement, with Croatia Waters in case of floods events and with Faculties. The Water Agency for Sava River District in Republika Srpska (AWSR) collects data on temperature, water level, discharge, and water quality parameters. Data are collected automatically by the automatic measuring stations, and then transmitted to a central server. The server is configured in such manner, that in defined time periods it connects with each station and downloads the measured values, which are stored in the database in the form of time series data. One part of data has been collected manually or imported from the old database or taken from other institutions. Basic controls of data accuracy are done by the automatic measuring stations, and calibration and verification are made during the station maintenance 4 - 6 times a year. All data bases are implemented in Microsoft SQL Server, the server has a SAS hard disks in RAID1 configuration. Database backup are stored automatically. Access to the database or server is controlled by assigning permissions to individual users or groups. Data is exchanged with the Republic Hydro-Meteorological Institute, which is in charge of public dissemination of information. In accordance with the law, data is shared at entity level and at international level (ICPDR, ISRBC). Data are available on request to other institutions, and some of the information is available through the website: www.voders.org. AWSR-RS receives free data from other services: Republic Hydro-Meteorological Institute, Hydropower Trebisnjica, Visegrad, Zvornik and Bocac.

3.3.2. Hydrometeorological data management systems

Operational adequate data management system is part of the core capacities of modern hydrometeorological services. This includes data collection, quality control, data base, availability of data, and real time use of data. Historical hydrometeorological data is critical for hazard analyses and planning and design within various economic sectors. In this regard,

hydrometeorological data must be properly quality-ensured and stored in historical user-friendly digital databases.

Currently in Bosnia and Herzegovina there is no common general hydrological or meteorological database at country level. FHMI and RHMS RS collect separately meteorological data and operate the databases which in both institutes include data collected by the state hydrological agencies. Additionally, the Water Agencies collect hydrological data. Up to now no actions are taken to merge these databases to form one national hydrometeorological database (with direct access from both hydrometeorological services) which would significantly improve production of state level and entity level analyses of different hydrometeorological parameters. The possibility of producing a joint state level hydro-meteorological database, which could be available at both services, was discussed in the WMO-UNDP mission meeting. The benefits from such a database would be significant.

The FHMI digital hydrometeorological database includes data since 1968. 65% of the pre-war historical data before are in digitised and archived in a database and the rest remains on paper format. 30 years of data are also compiled on Excel as result of different projects. These data are for the whole Bosnia and Herzegovina and are available at FHMI but not at RHMS RS. FHMI operates the digital database CLIDATA/Oracle, which was donated and installed by Czech Hydro-meteorological Institute through the WMO-VCP in 2005. Licence for Oracle was part of the donation. Typically data from synoptic stations are stored for each third hour, while data from climatological stations consist only of three observations per day, and from precipitation stations twice a day (12 h cumulative precipitation). Quality control and validation are provided by CLIDATA on 3 levels: (i) when data are entered or imported, using defined elements limits; (ii) through logic control, using formulas, which are created by administrator; and (iii) through spatial control, using GIS technology. Data security is ensured by backup copies, made regularly once per month. Control and validation of hydrological data are performed according to the guidelines to the hydrological service. There are needs to improve the software, and create the capability to include all data collected into the database. PENTIUM III and PENTIUM IV with Windows XP are in use.

RHMS RS hydrological and meteorological databases are in an Excel format, because RHMS RS still does not have CLIDATA. The meteorological database includes monthly data from 10 stations since 1960. Daily observations are available partially since 1980, but mainly from 1996. Latest database consists of data from 25 stations. An old DOS version of CLICOM is still used for storing some historical data. Many daily meteorological data are on paper. Historical hydrological data before the war are mainly on paper and in a little part in an Access database. Hydrological data after the war are in digital format (excel) but there are some missing periods. In order to backup the data they are copied on different media. There is a systematic review of data when digitized, on a daily and monthly basis in terms of climatological data.

It is necessary to urgently come up with a digital data base, including real time quality control. For both state and entity level planning and hazard mapping it would be vital to have one national level data base, or at least two synchronized databases operated by both services.

Concerning data dissemination and exchange, FHMI has signed Memorandum of understanding and cooperation with RHMS RS in Banja Luka. Data are exchanged through the internet, free of charge. Restrictions in data exist only for commercial purpose. FHMI receives also the data of water monitoring from the station under the jurisdiction of Water Agencies, regularly and without charge and restrictions.

Hydrological department of the Institute processes the data and prepare hydrologic reports, including Yearbooks. Yearbooks are printed in cooperation with Water Agencies. As a result of the restoration of hydrological stations and hydrological observation and measurements, after a break of ten years, hydrological yearbooks are printed again since 2001, initially only for the Sava River catchment area in the Federation of Bosnia and Herzegovina. Since 2005 yearbooks include collected and processed data from the surface hydrological stations for both Sava River and the

Adriatic Sea from the area of Federation of Bosnia and Herzegovina. As an example, Yearbook 2005 contains daily data on water levels for 50 stations, flows for 39 stations, water temperature – 23 stations, precipitation – 22 stations, and air temperature –23 stations.

Exchange and distribution of RHMS RS data is done according to the law of hydro-meteorological services and the Rules of Procedure of the hydrometeorological service, and according to the agreements of cooperation in the region, with other hydrometeorological services. RHMS RS shares data under the WMO information exchange obligations. Concerning hydrological data, daily information from 6 stations is exchanged through the WMO GTS system.

3.3.3. Hazard analysis and mapping to support risk assessment

Hazard analyses and risk assessment need to be based on long-time accurate and geographically representative measurements or observations. However, lack of state level hydrometeorological database and coordination of hazard mapping hampers production of hazard maps for Bosnia and Herzegovina.

FHMI Does not collect specific data on hazard but has historical data archives including the data registered in cases of floods and droughts. Concerning floods, its Hydrological Sector collects the hydrological data during the year, including periods of extreme phenomena, water levels and water discharges. Concerning drought, FHMI before the war, collected data on soil moisture and water stresses on agricultural crops (maize and wheat). But after the war these measurement have been abandoned. Actually, FHMI collects phenological data for 5 stations, which are stored on paper. Actually, FHMI produces drought indices.

RHMS RS also has historical data archives and monitors changes in water level, flow to a certain level of water, depending on whether the flow curve is defined in the zone of high water. RHMS RS collects some phenological data but not systematically.

Water Agencies collect information in case of floods about the flooded area, the water levels, the river discharge, etc. The AWAS FBiH has a database for water levels and flow discharge of past flood events. AWSR RS has some historical data, but not systematically organized in a flood database.

The Protection and Rescue Sector and its 112 Operationnal Center collect hazard data from entity civil protection administrations, water agencies and hydro-meteorological services. PRS does not have a database of past events, but with the establishment of the OC 112, there is an opening to create a central storage system, which would allow the establishment of easy mechanisms of data collection, storage and dissemination since the OC 112 is a unified system of communication throughout the whole territory of BiH. PRS does not perform analysis on such data, but hazard mapping has been performed by the Working group on Risk Assessment. PRS does not have yet GIS capacities and nor manage analysis and mapping tools, but it has planned to develop a Risk Observatory Project so that these analysis and mapping would be available in the future.

FHMI produces analyses on averages, trends, variability and extremes and makes studies of potential flood impacts. Studies of 100 year return periods have been done for some meteorological and hydrological extremes, for stations with long time measurements. Observed annual peak of discharge data are used to calculate statistical information such as mean values, standard deviations, skewness and recurrence intervals. This statistical data is then used to build frequency distributions, graphs and tables showing the likelihood of various discharges as a function of recurrence interval or surplus probability. Flood hazard maps have been produced for the Sava river as a part of an international project, and the hazard mapping for Una river is under preparation. Concerning drought mapping, only drought indices are available from FHMI, while RHMS RS has not been involved in the DMC-SEE programme and is not producing any drought index. FHMI operatively uses the following agroclimatic drought indices: Standardized precipitation index (SPI), De-Martonne aridity index, Seljaninov index; Precipitation quantity expressed in the

percentage of long-term average for month, season and vegetation period. These indices are calculated on station data.

RHMS RS doesn't produce any systematic analysis on drought and floods. Only particular situations are analyzed, often at the request of specific ministries and scientific institutions.

Both HMSs have suffered lack of proper software for climatological and other analyses.

Due to the lack of GIS tools FHMI and RHMS RS currently are not able to produce hazard mapping. Currently the hydrological and meteorological maps produced by FHMI or RHMS RS are not in GIS format, which makes it difficult to use hydrological and meteorological climatological and hazard maps together with land use and other maps.

AWAS analyses past floods and make hydraulic simulations of past flood events. Flood mapping is performed for streams and rivers of I. category. AWAS produces flood mapping, thanks to its GIS expertise (Arc GIS). AWSRRS produces potential flood mapping using basic level of GIS expertise. At the moment, flood mapping is available only for river Bosna. AWSR uses basic geo-data (as digital model of terrain) and other geo-layers too (aerial photos, etc.).

Currently there is no designed body with responsibility to collect hazards statistics and impacts. Many institutions collect data in case of disaster, Municipalities, NGO, etc. but the data is not centralized nor harmonized, different figures emerge from different surveys and there is not a real assessment of damages. There are different standard protocols for collecting the drought/floods impact data at local level and the data analysis and information mapping is not standardized nor in line with EU directives.

PRS does not collect drought/flood impact data on the field. The Sector receives these data from Entity Civil Protection Administrations, consolidates them and utilizes this data in specific reports regarding disasters impact in BiH. The reports with consolidated drought/flood impact data produced by the Sector are used by other state institutions, international and humanitarian organizations.

AWAS collects damages data on buildings and damaged riverbanks and flood protection constructions. This information is collected mostly directly, but some information is received also from Municipalities and residents. AWSRRS started collecting data at the beginning of this year, but standard protocols don't exist yet.

3.3.4. Forecasting

Public weather forecasts are produced only at the entity level. There are no hydrological, flood forecasts or any environmental forecasts produced in Bosnia and Herzegovina. Currently 24/7 weather services are not available in Bosnia and Herzegovina.

Table 11: FHMI forecasting products

Forecast type	weather			Hydrological			environmental		
	provide	n/d	on web	provide	n/d	on web	provide	n/d	web
nowcasting	no			no			no		
12 hours	no			no			no		
24 hours	yes	3/d	yes	no			no		
48 hours	yes		yes	no			no		
3-,4-, 5-days	yes	1/d	yes	no			no		
one week	no			no			no		
10 days	no			no			no		
monthly outlooks	no			no			no		
seasonal outlooks	no			no			no		

n/d: number of observations per day

Table 12: RHMS RS forecasting products

Forecast type	weather			Hydrological			environmental		
	provide	n/d	on web	provide	n/d	on web	provide	n/d	web
nowcasting	yes	2/d	yes	no			no		
12 hours	yes	2/d	yes	no			no		
24 hours	yes	2/d	yes	no			no		
48 hours	yes	2/d	yes	no			no		
3-,4-, 5-days	yes	1/d	yes	no			no		
one week	no			no			no		
10 days	no			no			no		
monthly outlooks	no			no			no		
seasonal outlooks	no			no			no		

n/d: number of observations per day

The weather forecasting is based on observations, information received from international numerical weather prediction models run by international centers (1-10 day forecasts), or by FHMI or RHMS RS (1-2-3 day forecasts), and on use of international satellite image data. Satellite data is not used for e.g. drought and snow cover analyses and forecasts. The kind of forecasts produced by FHMI and RHMS RS are described in Tables 11 and 12. In addition, FHMI provides specialised agrometeorological forecasts to the agriculture sector on 7 day periods and RHMS RS produces 3-5 days specialized weather forecasts occasionally to agriculture, transport, water transport, construction, air transport, tourism and energy production sectors.

Both FHMI and RHMS RS use ECMWF forecasts for long term general forecasting. As Bosnia and Herzegovina is not a member of ECMWF, they do not have access to same state-of-the-art digital products. Both FHMI and RHMS RS operate numerical weather prediction models, as described in Tables 13 and 14. FHMI operates currently local scale models: the NMM (from Deutsche Wetter Dienst) at 14 km horizontal grid, and two local scale open source models, WRF-ARW and WRF-NMM from USA, which are run at 4 km and 5 km horizontal grid resolution. The boundaries are taken from global NWP model AFS operated by NCEP. FHMI does not have capacity to run coupled wave models, or any dispersion models. RHMS RS operates the ETA model at 32 km horizontal grid, and at local level the WRF-NMM model at 12 km and 5 km horizontal resolution. The models are run twice a day. RHMS RS also operates with the WRF ARW model. FHMI or RHMS RS have no data assimilation system in use in the NWP modelling. There are no flood forecasting models available. The outputs from numerical weather prediction models can be used for dispersion models of air borne pollutants. However, currently air quality models and NWP models are not coupled.

FHMI produces statistical monthly forecasts and uses seasonal forecasts produced by SEE VCCC Belgrade and ECMWF. Advanced NMHSs produce and disseminate forecasts for any requested place/location, and usually the dissemination is automatic and the products are produced individually for each customer. However, modern analysing, editing, visualisation and dissemination tools are not available in Bosnia and Herzegovina. In order to at least partially solve this problem, both HMS are going to have the METVIEW-4 system from ECMWF. METVIEW is an interactive meteorological application, which enables operational and research meteorologists to access, manipulate and visualise meteorological data. The system is based on the ECMWF standards for graphics (Magics) and data access (MARS) but can also access locally stored data. The HMS have participated the METVIEW training in March 2010 and the hardware and software will be installed in early 2011.

In hydrology, FHMI calculates discharge for gauged rivers using river cross section at main hydrological stations and discharge profiles. FHMI and RHMS RS do not use any hydrological model. AWAS uses 3 or 6 days weather prediction from “Aladin” of Croatian National Hydrometeorological Institute. Concerning hydrological models, AWAS uses HEC-HMS, HEC-RAS, MIKE 11. Models use hourly data from automatic hydrometeorological stations. AWSR uses HEC RAS hydraulic model for river Bosna (test phase), and in preparation for river Sana. At AWSR, the flood wave analysis for the river Sava is in preparation. Potential floods mapping is also done.

Table 13: Operational numerical models used by FHMI

Type of forecast	Name of the model	Δz km	Levels	boundaries from	Data assimilation	Times/day
Weather	HRM (DWD)	14	40	DWD (Germany)	No	2/d
Weather	WRF-NMM	4	30	AFS (USA)	No	2/d
Weather	WRF-ARW	5	30	AFS (USA)	No	2/d
Discharge	none					
Flood	none					
Flash flood	none					
See wave	none					
Air pollution	none					

Δz is the horizontal resolution

Table 14: Operational numerical models used by RHMS RS

Type of forecast	Name of the model	Δz km	Levels	boundaries from	Data assimilation	Times/day
Weather	ETA	32		AFS (USA)	No	2/d
Weather	WRF-ARW	12		AFS (USA)	No	2/d
Weather	WRF-ARW	5		AFS (USA)	No	2/d
Discharge	none					
Flood	none					
Flash flood	none					
See wave	none					
Air pollution	none					

3.3.5. Warning products and services

3.3.5.1. Warnings and mandates

In Bosnia and Herzegovina warnings of hydrometeorology-related hazards are produced by FHMI, RHMS RS and the new state level 112 system (Table 15). FHMI has the mandate to produce and present weather forecasts to the public and several economic sectors for the area of Federation of Bosnia and Herzegovina. The forecasts may include general information of extreme weather phenomena. RHMS RS issues warnings for the area of the Republika Srpska. The Aviation Weather Services in the both entities have the mandate to produce warnings to the civil aviation sector in respective entities. The night time services from Croatian Aviation Service for Sarajevo and from Serbian Aviation Service to Banja Luka are given to the pilots only.

The warnings produced by FHMI and RHMS RS are based on hydrological and meteorological observations and use of numerical weather prediction models. Currently the 112 center has on-line access to some of the hydrological and meteorological data, but the center does not have meteorological or hydrological experts in the team, so their capacity to produce warnings relies totally on services available from FHMI and RHMS RS. For instance flood, air quality or water quality warnings are not produced. Warnings for aviation sector are produced by state enterprises but not by FHMI or RHMS RS, which differs significantly from the system in use in most of the EU countries.

3.3.5.2. Warning dissemination mechanism

The warnings produced by FHMI or RHMS RS are available to the public through internet pages. Currently also SMS, phone, email, paper copy, fax are all available for dissemination of warnings.

FHMI disseminates warnings to public media and State Information Organizations by SMSs and Internet. RHMS RS produces regular bulletins 3 times a day and warnings up to 5 days in advance. In case of flood, bulletins are produced every 3 hours. The contents of the reports refer to the trend of water levels, length of dry period, the duration of rainfall and its amount. RHMS RS produces also special reports during extreme meteorological condition, such as floods, cold and

warm wave, fires, thunderstorms and strong wind situations, sent to Civil protection Administration and on the OC 112.

Table 15: Warnings issued in BiH for natural and technical hazards, based on Annex 2

Hazard	Exists in the country	Warning issued at entity level			
		Given by	Type	Given by	Type
Heavy precipitation	Yes	FHMI	I	RHMI	I
Flash floods	Yes				
River flooding	Yes				
Hailstorm	Yes	FHMI	I	RHMI	I
Thunderstorm or lightning	Yes				
Heavy snow	Yes	FHMI	*		
Freezing rain	Yes				
Dense fog	Yes				
Tornado or cyclone	No				
Hard wind	Yes	FHMI	I	RHMI	I
Storm surge	Yes				
Coastal flooding	Yes				
Heatwave	Yes				
Cold wave	Yes				
Drought	Yes				
Marine hazard	Yes				
Sandstorm	No				
Landslide or mudslide	Yes				
Avalanche	Yes				
Airborne hazardous substance	Yes				
Waterborne hazards	Yes				
Hydrometeorological hazards for aviation	Yes	DAC	III	IABL	III
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				

* according to agreements with customers

Media produces their own warnings, and they may also use other information than that produced by FHMI or RHMS RS. FHMI has no direct visibility on TV or radio (no TV presenters or logo). RHMS RS has direct access to a TV station with its logo and presenters, as well as on the Radio of Republika Srpska. Currently they do not have the right to cut TV or radio programmes with urgent warnings. Alarm stripes during any programs are not used by the TV.

The European METEOALARM system is under preliminary preparation. The NHMSs have participated the training in Austria in June. However, internet must be considered as a passive warning dissemination system.

FHMI prepares analysis and calculates drought agroclimatic indices and provides weekly agrometeorological forecasts and warnings for the needs of farmers. This information is issued regularly and diffused through agrometeorological bulletins via Internet and radio stations to farmers, manufacturing companies and Ministries for Agriculture, Water Management, Forestry, scientific institutions and other users free of charge. Nevertheless, FHMI doesn't receive any feedback from the users. FHMI provides other information through bulletins, web pages, E-MAIL. Concerning drought indices, the users are generally satisfied with time of delivery, format and comprehensibility, but drought is a slow-onset process and it is very difficult to predict the onset, duration frequencies and the end of drought periods. Drought indices are sometimes inadequate

for detecting the early onset and end of drought. FHMI often receives specific requirements, for example, determination of return periods or excedence probability of an extreme phenomenon.

RHMS RS analysis and warnings are available outside through internet and bulletins on media. The information is provided to some end users for free, but also at cost depending on the kind of institution. Universities, scientific institutions and individuals in the post graduated studies and PhD programs, government agencies and institutions, public services, get information and analysis for free. RHMS RS has some specific users for tailored information and products. Concerning feedback information, RHMS RS has cooperation agreements with some users ensuring a feedback concerning the quality of services and the verification of data and forecasts.

3.3.6. Climate change analysis

As climate change is expected to increase hydrometeorological extremes and hazards frequency and severity, it is critical to take into account the impacts of climate change also in hazards studies. It is necessary to produce representative projections of climate change for Bosnia and Herzegovina and downscale global model products to local scale and to study the potential impacts of climate change. Currently FHMI and RHMS RS do not have adequate capacity to produce these studies.

Bosnia and Herzegovina has joined the United Nations Framework on Climate Change in May 2010. It can be expected that also Bosnia and Herzegovina can significantly benefit from the new South East European Virtual Climate Change Center (SEEVCCC), which was established in 2008 within the Serbian National Hydrometeorological Service.

Table 16: 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	
	FHMI	RHMS	FHMI	RHMS	FHMI	RHMS	FHMI	RHMS
Telephone	X	X	X	X				
Mobile Phone	X	X	X					
Telefax						X	X	X
Dedicated Leased Lines								
UHF radio transceiver		X		X				
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)	X	X						
Meteosat Second Generation Satellite system	X							
Other satellite systems	X							
Internet	X	X	X					
Email					X		X	
Post/mail	X	X						
Print media								
TV –national						X		X
TV-commercial						X		X
Radio						X		X
Bulletins					X	X	X	X
Printed text								

3.3.7. Information Technology and Telecommunication capacities

Quick reliable communication system is critical for collection of data, data sharing and dissemination of products and warnings. WMO GTS is the common tool to send and receive data, information and warnings. Internet has become a very important tool among advanced NMHS to disseminate information and warnings. Collection of data may be highly costly depending on the observation network. Use of the General packet radio service (GPRS) system has made data collection significantly cheaper. Both FHMI and RHMS RS use less modern communication systems as described in Table 16.

3.3.8. Customer relations and visibility

In order to promote development and sustainability of the NHMSs it is critical to have capacity to produce end-user oriented tailored products and have a good visibility among the public, industry and government. Currently the relations and cooperation between the both hydrometeorological services of Bosnia Herzegovina and industrial sectors are at very low level compared to advanced EUMETNET NHMS which also collect significant annual revenue from cooperation with industry. The visibility of both FHMI and RHMS RS is quite low at entity and state level.

The Services produce weather forecasts, but they have not regularly direct access to the public and industry through TV, Radio or newspapers, except RHMS RS, which has at one regular TV Station its regular prognosis and presenter and this prognosis is protected by their logo as well on the radio of Republic of Srpska. Media edits and produces their own forecasts, but the quality of their products is not verified scientifically. FHMI ends its forecasts to the Federal News Agency (FNA) which forwards the forecasts to the media while the RHMS RS gives its forecasts to the Serbian News Agency (SRNA) which then forwards the information to other media.

TV weather forecasts, which are very important for dissemination of information and warnings, are produced by the TV editors based on forecasts received through FNA, SRNA, and use of FHMI and RHMS RS and other internet pages. Currently the Services do not have technical capacity to produce e.g. SMS products which could be utilized (and paid) by public or different potential customer sectors.

FHMI main customers are the key economic sectors, including (i) the FBiH Ministry for Agriculture, Water management and Forestry for agriculture and forestry, (ii) the BiH Ministry of Security , FBiH Directorate for civil protection, FBiH Operations center 112, Cantonal Operations centers for Civil Protection, (iii) Transportation (iv) Energy (v) Recreation and tourism (vi) Environment /ecosystems and (vii) Health.

RHMS RS has some specific users of information and products:

- Republic of Srpska electric power industry: a project of delivery predicted values of temperature, precipitation and wind for 5 towns in the Republic of Srpska, which are used as inputs in the software that controls the use of capacity planning for production of electricity, depending on weather conditions and the assumed consumption;
- hydro power Trebišnjica: precipitation forecasts are issued to 144 hours in advance, which are used as inputs for planning the capacity at which power plants will operate, the discharge of the accumulations, and how it will manage the system in case of heavy rainfall and flood hazard;
- the Republic directorate for road maintenance for information about the prognosis of snowfall, ice, and snow cover height;
- Special bulletins to the Ministry of Internal Affairs, government and civil protection in the case that significant and extreme weather may cause disasters and adverse weather conditions which may endanger the normal functioning of the social community;
- information for many other users such as municipal service, plants that warm the urban environment, the organizers of various events when they need a good forecast of meteorological conditions during the course of events, or temperature, and whether there will be frost.

Concerning feedback information, RHMS RS has cooperation agreements with some users ensuring a feedback concerning the quality of services and the verification of data and forecasts. In relation to delivery of information, weather forecasts and the value of meteorological parameters, RHMS RS thinks to know exactly what the customer expects. The number of requests for information, warnings, forecasts of various types, RHMS RS receives now compared to few years ago, shows it has increased to dozens of times from the previous period and indicates the effectiveness and quality of work. This confirms that end-users use and are satisfied with the produced information. Nevertheless, it is important to note that there is a need of improved cooperation with decision makers, particularly in the case of extreme weather events. In this case, a better coordination of the preparatory phase of response is needed.

Currently the only possibility/method to get visibility is to produce the forecasts and other product on their own internet pages. However, at the moment the number of visitors of the internet pages is very low, especially when compared to countries where the visibility and appreciation of NHMSs is much higher.

3.3.9. Human resources

Currently the joint staffs of FHMI and RHMS RS is about 130, which is close to standard for a country of this size and population. However, most of the staff consists of observers at observation stations, while the number of experts with academic degrees (MSc) and qualified ICT experts is very low. This is just opposite to the situation in more developed hydro-meteorological services.

It must be noted that FHMI has currently no staff with academic training in meteorology or hydrology. The number of forecasters is extremely low (3) and only 2 of the weather forecasters have a BSc degree in physics and geography but, all of them are trained in forecasting on various international workshops and all of them are now studying for MSc in meteorology at Belgrade or Zagreb Universities.

Table 17: Distribution of the FHMI 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	45							1			1				47
Telecommunication								1			1				2
Data management								1			1				2
Weather forecasting											2			1	3
Hydrological forecasting															
NWP															
R & D															
Weather modification															
IT personnel	1								1						2
Commercial services															
Accounting	2														2
General administration															
Applied meteorology	2	3													5
Other															
TOTAL	**50**	**3**						**3**	**1**		**5**			**1**	**63**

RHMS RS currently has staff members with academic qualifications in the field of meteorology or hydrology. The number of forecasters is extremely low (4). However, 3 of the forecasters have MSc in meteorology and one is completing his doctorate studies. RHMS RS has three employees who have completed their degree at the Physics University of Belgrade, Department of Meteorology and one in Zagreb. In addition, there are only two communication experts at FHMI

and one at RHMS RS. Furthermore, none of the forecasters or communication experts are working on a 24/7 basis.

The number of academic hydrometeorological and ICT/IT staff is both in FHMI and RHMS RS absolutely too low to have the capacity to work, and to produce services and products at same level than e.g. the Croatian and Serbian Hydrometeorological Services.

Table 18: Distribution of the RHMS RS 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	32							1			1			4	38
Telecommunication															
Data management	3					1					3				7
Weather forecasting	1					3									4
Hydrological forecasting															
NWP															
R & D															
Weather modification															
Seismology								2			2				4
IT personnel									1						1
Commercial services															
Accounting	1											1			2
General administration	1							1							2
Applied meteorology															
Other	3							6							9
TOTAL	**41**					**4**		**10**	**1**		**6**	**1**		**4**	**67**
Female in % of total															31
Men in % of total															69

Table 19: Share of FHMI and RHMS RS staff by sector and gender

FHMI	Number of staff	% Women	% Men
Meteorological	57	19.29%	80.71%
Hydrological	11	27.2%	72.7%
Environmental	6	83.3%	16.7%
Seismological			
Total	74	30%	70%
RHMS RS	**Number of staff**	**% Women**	**% Men**
Meteorological	41	24	76
Hydrological	3	0	100
Environmental	5	80	20
Seismological	5	60	40
Total	54		

3.3.10. Financial resources

In the Federation of Bosnia and Herzegovina entity the value of hydrological and meteorological services is not really recognised by the Federal Government, and there is very little political or ministerial support for the strengthening of the FHMI. RHMS RS, under the Repuiblika Sprska entity level Ministry of Agriculture, have better governmental understanding, and the staff is currently involved in many entity level projects. Still the financing is too low to implement any significant investments.

3.3.11. 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, to which membership provides better and more services than to non-members.

Table 20: International and regional cooperation activities of FHMI and RHMS RS

International and regional organization and cooperation mechanisms	FHMI status	RHMS RS status
WMO	member, PR	through FHMI
WMO RAVI	Member	Member
RMDCN	No	
IOC	No	
UNDP	cooperation	cooperation
UN_ISDR	cooperation	No
EUMETSAT	Access to data	Not yet
ECMWF	In process	In process
EUMETNET	In process	In process
METEOALARM	No	No
ECOMET	No	No
EUFP7 projects, networks	Use of a cluster data	No
EU JRC	No	No
EU PHARE	Not currently	No
EU CARDS	No	No
EUCLID	No	No
EUR-OPA	no	no
DMCSEE	Member	no
SEEVCCC	No	Some cooperation
SAVA Commission	Member	Member
SEE-GRID-SCI	Yes	yes
NWP consortium	No	No
NMHS bilateral	SEE NHMSs, Slovenia, Turkey, FYR Macedonia	Montenegro, Serbia FYR Macedonia
NHMS MoU	Turkey, Iran, Slovenia,	

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 adopt best European practices and to improve quality of products and services in support of national economic development and DRR. European Union research and networking programs create consortiums of excellence, and provides good opportunities to NMHS to network with NMHSs and commercial R&D companies and strengthen their capacities.

Currently the participation of Bosnia and Herzegovina in EU level cooperation has been very low. However regional and has improved during the latest years. The cooperation with EUMETSAT is improving and obviously in 2011 both institutes will have proper access to satellite data. Both NHMSs are negotiating with ECMWF and EUMETNET for closer cooperation and finally of memberships.

In BiH, most of water flows are transboundary. Given the international character of many rivers, it is well recognized that the water and risk management in these basins can take place only through international cooperation, with clearly defined objectives, criteria and restrictions. Bosnia and Herzegovina has ratified the Framework Agreement on the Sava River Basin, in 2002, with Croatia,

Serbia and Montenegro and Slovenia. In 2004 Bosnia and Herzegovina signed the Danube Convention on the sustainable use of Danube River.

RHMS RS together with FHMI are the National Reference Centre for Water in the European Network Activities in EIONET structure, in the air quality sector and in the Danube Commission. Reports for European Environmental Agency (EEA) are prepared through cooperation with different institutions: Public Enterprises for ”Vodna područja slivova Jadranskog mora”, and «Vodno područje slivova rijeke Save», Directorate for Water RS, Institute for Water Bijeljina, UIBG Ltd. Bihac, etc.

FHMI has cooperation agreements or collaborations with national meteorological services of Slovenia, Croatia, Serbia, Montenegro, Macedonia and Turkey. FHMI is partner of the DMC-SEE project. FHMI has cooperation with the following international organizations: WMO, UNDP, GCOS, International Sava Commission, UNHCR, SEE GRID SCI consortium. It is also included in the DMCSEE programme and delegates member in DMCSEE steering committee, although it is not partner in the DMCSEE project in the frame of EU’s transnational cooperation programme.

RHMS RS has agreements on cooperation with the NHMSs of Macedonia, Montenegro and Serbia. RHMS RS has regional cooperation with the International Sava Commission, SEE-GRID-SCI consortium, DMC-SEE, SEE VCCC Belgrade. It has also cooperation with UNFCCC, UNDP and REC.

Up to now, the HMSs of Bosnia and Herzegovina have not fully utilized the regional opportunities of cooperation and the services produced by regional centers of excellence.

BiH participates in ”The Project for Support of Establishing the Joint Emergency Response Units in case of floods in region of SEE”, that has been launched through DPPI SEE. The aim of this project is to institute a disaster preparedness and prevention regional mechanism for regular information exchange with regards of water and floods situation. Participating countries, with support from the Donors and RCC, will establish and train Emergency Response Units in case of floods in the region of SEE. The Joint Emergency Response Units should be able to cross state borders quickly in order to help the efforts in the flood-affected areas in the neighboring countries.

Protection and Rescue Department initiated the partnership of Bosnia and Herzegovina and its Hydrometeorological Services with the Joint Research Centre of the EC through the Early Flood Alert System.

3.4. Technical recommendations to strengthen NMHSs capacities in support of DRR

The technical, human and financial capacities of the NHMSs are not adequate to produce sufficient services and support DRR and could be improved per the following recommendations:

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

1. There are needs by international organizations to accept and recognize that currently there are two NHMSs with equal status in Bosnia and Herzegovina;
2. There is urgent need to prescribe a new law for hydro-meteorological services in Bosnia and Herzegovina, taking into account international commitments, national and entity level needs from public and different economic sectors, regional cooperation and the role of hydrometeorological services in national and regional DRR;
3. There is an urgent need to clarify the mandates and communication routes for alerts, advisories, warnings and alarms from state level to different levels all the way down to the grass root level (individual people) using state-of-the-art communication systems;

Operational relationships with other agencies

4. It is critical to establish better cooperation between the entity Institutes, FHMI and RHMS RS, so that entity prognostic services within the methodology of their work incorporate making joint analysis, forecasts and warnings for the level of Bosnia and Herzegovina, and if possible to establish one 24/7 state level hydro-meteorological and seismological science based multi-hazard analysing and warning centre;
5. There are urgent needs to improve cooperation and data exchange;
6. There are needs to establish Standard Operating procedures (SOP) and Quality Management Systems (QMS) between the hydrometeorological services and the DRM sector.

Monitoring and observations networks and data exchange

7. There is an urgent need to upgrade and further modernize the meteorological and hydrological networks in Bosnia and Herzegovina and to gradually develop the network of automatic observations stations;
8. There is an urgent need to upgrade the calibration and maintenance system of the meteorological and hydrological equipment and to achieve the WMO standards for measurements;
9. There is a need to further strengthen the observation network by developing remote sensing systems, including one upper-station, one or two weather radars and a lightning detection system;
10. There are needs to improve the data transfer systems;
11. There is an urgent need to develop real-time communication system for observations and data.

Forecasting

12. There is a need to Improve the capacities to produce and use Numerical Weather Prediction (NWP) products;
13. There is a need to promote memberships in ECMWF and EUMETSAT;
14. There are needs to join some of the European NWP consortium would benefit the NWP modelling;
15. There is a need to develop and integrate additional modelling for hydrology, air quality, and sea-wave and to link these models to NWP;
16. There is a need to improve capacities to use automatic analysing, editing and dissemination tools;
17. There is a need to improve the technical capacities to develop monthly and seasonal climate outlooks.

Hydrometeorological data management systems

18. There is an urgent need to initiate a data rescue programme to digitise and quality ensure the historical data;
19. There is a need to develop the technical capacities for data management and to adopt automatic quality control systems of hydrometeorological data;
20. There is an urgent need to establish a national database system;
21. There is an urgent need to establish a combined state level hydrometeorological database including the data collected by the Water Agencies.

Hazard analysis and mapping to support risk assessment

22. There is an urgent need to implement modern user friendly software for climatological and hazard analyses;
23. 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;

24. There is a need for GIS training, software and layers for hazard mapping. GIS compatible with the system that water agencies already have is needed (GIS components including layers, GIS software and hardware);
25. There is the need of developing numerical hydrological modelling and training;
26. There is the need to develop hazard databases including impacts and hazard extent.

Information technology and telecommunication issues

27. There is urgent need to promote the capacity of FHMI and RHMS RS to build their information and communication systems to an international level;
28. There are needs to take in use modern tools to automate production of services;
29. There are needs to improve the web pages.

Warning products and services

30. There are urgent needs to establish threshold values and criterion for different types of alerts and warnings;
31. There is an urgent need to establish a 24/7 science based analysing, forecasting and warning system;
32. There in urgent need to strengthen the capacity of the hydrometeorological services to produce flood warnings, to operate hydrological models and to connect hydrological models to numerical weather models;
33. There is an urgent need to engage meteorological and hydrological as well as seismological experts within the 112 center;
34. It is necessary to clarify the mandates and communication routes for alerts, advisories, warnings and alarms from state level to different levels all the way down to the grass root level (individual people) using state-of-the-art communication systems;
35. There are needs to promote provision of direct active warning mechanism from Hydrometeorological Services to the TV and radio, in order to promote dissemination of warnings to the public, and to establish state-of-the-art dissemination mechanisms for real-time hydrological and meteorological observations and warnings to the authorities and the 112 center;
36. There are needs to improve the exchange with end users in terms of information and support fostering the appropriate use of information, receiving feedbacks and suggestions for improving the delivered services;
37. There are needs to have international certification for operation of the institutes and production of services.

Climate change analysis

38. There is a need to develop a climate data management system;
39. There is a need to develop the technical capacities for climate change projections downscaling to local scales;
40. There is a need to develop climate change impact studies in cooperation with DRR, industry and other sectors;
41. There is a need to strengthen the national capacity to produce local-scale projections of climate change in order to promote mainstreaming of adequate analysed impacts of climate change into DRR policy and strategy.

Human Resources

42. There is an urgent need to enhance technical and human resources and capacity of the hydrometeorological and seismological sector to real-time operational monitoring, warning and forecasting and mapping of meteorological, hydrological and seismological hazards;

43. There is an urgent need to increase the number of data management, computing and IT experts in both hydrometeorological institutes;
44. There are needs to increase the number of staff with academic MSc and PhD degrees;
45. 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;
46. 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.

Regional cooperation

47. 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;
48. Modernization 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;
49. To improve their forecasting capacities SEE countries should increase their cooperation with global, regional and specialized Centres (e.g. ECMWF) 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;
50. A regional harmonization of watch and warning systems should be promoted;
51. Cross-border exchanges of real-time data, forecasts and warnings should be increased.

3.5. Recommendations from the Bosnia and Herzegovina 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 Sarajevo, on 21-22 June 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 bylaws that support legislature pertaining to DRR. The mainstreaming of DRR into legislature, such as laws pertaining to spatial planning and forestry, in order to give greater legal authority to the process of building an effective DRR system and structure in Bosnia and Herzegovina, and ensure that the roles and responsibilities and mandates of the various technical agencies, such as the Hydro-met and seismological services, are properly reflected in the legal framework.

Recommendation 2: To formulate the National Platform for Disaster Risk Reduction. A goal for the Government is the establishment of a National Platform which should design responsibilities at the national through to the local level and facilitate and coordination across sectors by maintaining a broad based dialogue at the national and regional level aimed at promoting awareness among the relevant sectors, and ultimately linking such coordination to national planning, budgeting and implementation of DRR activities.

Recommendation 3: To clarify the roles and responsibilities increased cooperation and improved communication between all relevant segments. Promote and support dialogue, the exchange of information and coordination among relevant agencies and institutions at all levels with the aim of fostering a unified approach towards disaster risk reduction. Also promote community participation in disaster risk reduction through the adoption of specific policies, the promotion of networking, the strategic management of volunteer resources, the attribution of roles and responsibilities and the delegation and provision of the necessary authority and resources.

Recommendation 4: Efficient financial planning to ensure that DRR has its own budget allocation. Allocate resources for the development and implementation of disaster risk management policies, programmes, laws and regulations on Disaster Risk Reduction in all relevant sectors and authorities and at all administrative levels with budgets based on clearly prioritised actions.

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

Recommendation 5: To enhance the technical and human resources of the hydrometeorological sector to support risk assessment and early warning systems by promote operational monitoring, warning, forecasting and mapping of meteorological and hydrological hazards. It is critical to urgently renew the legislation for Meteorological and Hydrological Services, upgrade and modernise the national hydro-meteorological observation network, data management and forecasting system and to provide sustainable organisational, human and technical resources to maintain and operate it. It is also necessary to strengthen the early warning capacity with a multi-hazard approach and cooperation with civil protection authorities and other stakeholders in line ministries.

Recommendation 6: To enhance institutional capacity through multi-agency and multi-stakeholders (including both technical agencies such as Hydrometeorological services and civil protections and line Ministries) approach to carry out risk assessment too support policy and planning decision-making.

Recommendation 7: To mainstream adaptation to climate change into DRR strategy. The frequency and magnitude of hydrological and meteorological extremes and hazards are predicted due to climate change. It is critical to invest in local scale climate studies in order to promote adaptation to climate change.

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

Recommendation 8: To improve education of DRR. Promote engagement of the National Platform members, local communities and authorities such as police and fire brigade within the education programs in coordination with the Ministry of Education and local parent-teacher associations to develop sustainable public education programs at primary, secondary and tertiary levels so as to raise awareness and educate children about hazards.

HFA priority 4: Reduce the underlying risk factors

Recommendation 9: Reducing disaster risks by systematically integrating them into policies, plans and programmes for sustainable development and poverty reduction. Supported through bilateral, regional and international cooperation, including partnerships, sustainable development, poverty reduction, good governance and disaster risk reduction as mutually supportive objectives, and in order to meet the challenges ahead, accelerated efforts must be made to mainstream and integrate disaster risk reduction into development and governmental and sectoral strategies. Furthermore, efforts must be made to build the necessary capacities at all levels of institutional organization in Bosnia and Herzegovina to manage and reduce risk. In the context of the

increasing risks associated with climate change, there needs to be enhanced investments in climate modelling and forecasting and analysis to support sectoral planning in at-risk sectors.

Recommendation 10: In the context of reducing overall risks, and with consideration for increasing climate associated risks, development of national capacities for climate services to support medium and long-term sectoral planing, is a critical aspect of risk reduction. Development of these capacities would require a strong collaboration and coordination across many ministeries and with the Meteorological and Hydrological Service, as well as enhanced regional cooperation in this area with other South Eastern European and EU countries.

Recommendation 11: Networking with international organisations/institutions present in the region. There is a need to enhance regional and international cooperation for the purpose of transferring observation data, knowledge, technology and expertise regarding DRR, to share research findings, lessons learnt and best practice, participation in joint trainings and workshops all of which would contribute to enhancing the ability of governments to strengthen DRR mechanisms, raise overall awareness and improve capacity development measures.

Recommendation 12: Examine the ways for establishment of regional funds for support to ongoing projects

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

Recommendation 13: Strengthen disaster preparedness for effective emergency response at all levels. First, ensure that emergency response plans are targeted to the individual needs of the vulnerable communities, authorities and emergency responders. Second, establish guidelines for systematic development of contingency plans at all levels that are backed by the requisite human, material and funding resources. Lastly, harmonise standard operating procedures governing response to emergencies and standardize terminology and capacity development taking into account roles and responsibilities in emergency response.

Recommendation 14: To strengthen awareness about the importance of DRR. Promote the engagement of the media in order to stimulate a culture of preparedness and strong community involvement through sustained public education campaigns and public consultations at all levels of society.

Recommendation 15: Increase the involvement of the private sector in activities aimed at capacity development with special emphasis placed on insurance companies for the purpose of developing sectoral involvement in DRR. There is a need to promote the establishment of public private partnerships to better engage the private sector in Disaster Risk Reduction activities. This can be done by encouraging the private sector to place greater emphasis on and allocate more resources to pre-disaster activities, such as risk assessments and early warning systems and through the promotion of the development of financial risk-sharing mechanisms, particularly insurance and reinsurance against disasters.

Recommendation 16: Increase the involvement of the NGO sector in activities related to DRR. Promote programmes for technical cooperation, capacity development, the development of methodologies and standards for hazard and vulnerability monitoring and assessment, the sharing of information and effective mobilisation of resources with a view to supporting national and regional efforts aimed at developing and strengthening DRR.