7. CHAPTER SEVEN: METEOROLOGICAL, HYDROLOGICAL AND CLIMATE SERVICES TO SUPPORT DISASTER RISK REDUCTION AND EARLY WARNING SYSTEMS IN SERBIA

The major natural hazards to which the Republic of Serbia is exposed are: floods, torrential floods, storms, heavy rain, atmospheric discharge, hail, drought, landslide or landslip, snow deposits and avalanche, extreme air temperatures, ice accumulation on the water flow, earthquakes, epidemic livestock diseases and the emergence of pests and other large-scale natural phenomena that may endanger the health and lives of people or cause extensive damage. A number of hazards pose risks across the borders in the SEE region, especially floods, drought, forest fires and dispersion of airborne pollutants.

This chapter presents all the findings related to the assessment of the Disaster Risk Reduction institutional framework and the technical capacities of the NMHS of Serbia to support DRR. It highlights that:

- The new Law on Meteorological and Hydrological activity ("Official Gazette of the Republic of Serbia, No. 88/10) has identified as a priority the development of hydro-meteorological early warning systems, including hydro-meteorological hazard mapping, development of meteorological and hydrological databases, including the information on meteorological and hydrological disasters, creation of the national infrastructure of spatial meteorological and hydrological data in accordance with the EU INSPIRE directive, and the assessment of climate change impacts, vulnerability and options for adaptation to natural disasters related to climate change;
- The technical and human capacity and scientific skills of RHMSS are at a high level compared to most of the NHMSs in SEE countries. Memberships in European leading meteorological organizations have strengthened RHMSS capacity during the latest years. However, lack of modern weather radar technology, automated hydrological measurements, state-of-the-art communication facilities, experts and insufficient level of governmental appreciation and financing limits the capacity of RHMSS to produce state-of-the-art products and services for disaster risk reduction;
- 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.

7.1. Serbia's vulnerability to hydrometeorological hazards

7.1.1. Hydrometeorological hazards in Serbia

The major natural hazards to which the Republic of Serbia is exposed are: floods, torrential floods, storms, heavy rain, atmospheric discharge, hail, drought, landslide or landslip, snow deposits and avalanche, extreme air temperatures, ice accumulation on the water flow, earthquakes, epidemic livestock diseases and the emergence of pests and other large-scale natural phenomena that may endanger the health and lives of people or cause extensive damage.

Table 38: Potential impacts of hydro-meteorological hazards on economic sectors - RHMSS

Hydro-meteorological hazards	Impacts
Hail	Damage of all field crops, damage of properties, injuries of people and animals, problems in transportation.
Strong wind and gust	Damage of properties, problems in transportation, damage of agricultural cultures, forest damage, damage of trees in parks and individual trees, problems in civil engineering construction works - especially works with cranes, indirect impact on the safety of people and animals, makes already existing dangerous security situations more complicated (forest and other fires, environmental disasters, disturbance of rescue actions).
Droughts	Enormous losses in agricultural production, problems in water supply, river transportation, hydro-electric power plants operation…
Spring and autumn frost	Damage to agriculture – vegetable, vineyards and fruit are especially vulnerable.
Flash flooding and flooding	Endangered lives of people and animals, damage in all weather dependent economy sectors, damage or major losses of properties.
Fires	Forestry damage, endangered lives of people and animals, a great danger for environment, industrial and other plants.
Extremely low air temperature	Endangered lives of people and animals, problems in thermal and electric power supply, road and river traffic problems, forestry damages, agriculture damages and damages of other weather dependent sectors of economy.
Extremely high air temperatures	Endangered lives of people and animals, problems in electric power supply, traffic problems, favourable conditions for forest and other fire occurrences.
Heavy and intensive precipitation	Causing of flooding and flash flooding, risk of mudslides and landslides, disabling the planned agricultural works. Endangered lives of people and animals, damage of properties.
Long-term precipitation	Causing of flooding, problems in all agricultural production activities, traffic problems, risk of landslides and mudslides.
Freezing rain and ice (glaze)	Traffic problems (to possible traffic blockade), problems in electric power supply - possible great damages in electric transmission systems, pedestrian injuries.
Snow	Problems in traffic and other forms of communication, problems in electric power supply.
Wet snow	Problems in traffic, problems in electric power supply - possible great damages in electric transmission systems.
Blizzard and snowstorm	Traffic problems (to possible traffic blockade), makes already existing dangerous security situations more complicated (partial or total blocking of rescue actions).
Thunderstorms (thundering and lightning)	The risk of thunder stroke, operation problems for all electrical devices, the risk of fire initiation, telecommunication problems, together with the risk of strong wind, gust wind and flash flooding.
Fog and low cloud	Traffic problems (to possible traffic blockade), makes already existing dangerous security situations more complicated (partial or total blocking of rescue actions).
Deviation from the usual climatological and weather cycle	Disruption of usual activities in water and food supply, supply of thermal and electric energy, possible negative impact to tourism and trade.

Floods are by far the most prevalent and constitute 34% of all occurring hazards in the 1989-2006 period, affecting 125,412 people. The valleys of larger water courses, in which the largest settlements and the best farmland, infrastructure, and industry are located, are highly prone to floods, that are occurring most frequently in the Vojvodina region and along the river courses of the Sava, Drina, Velika Morava, Juzna Morava and Zapadna Morava. For example in 2005, the Tamiš River breached a dam in Romania, causing major flooding in the Vojvodina province with economic damages reaching 12, 6 million €. In 2006, the flooding of the Drina river over three countries inundated 5% of total Serbian arable land, with damages of around 35, 7 million €, including in the city of Belgrade.

Droughts are most prevalent in the eastern portion of the country and the Pannonian Basin in the north; catastrophic droughts struck Serbia three times in the last 20 years. Mean damages, mainly to agricultural production, are estimated to reach 500 million € per year. A severe drought, coupled with the longest registered wave of extremely high air temperatures (10-17 days with temperatures from 35 to 45 degrees centigrade) occurred in July and August 2007.

Mainly triggered by droughts, wildfires are equally frequent and widespread during the dry summer season, threatening the 28% of Serbian territory covered by forests. Between 1998 and 2008, 853 forest fires burned an area of 16,357 ha. 258 forest fires were counted in 2007 alone, causing damages of approximately 40 million € burning more than 5200 ha.

7.1.2. Sectoral analysis of the vulnerability to hydrometeorologival hazards

Weather-dependent sectors are those sectors that are most dependent of the weather conditions and, at the same time, are critical to the national economy (high GDP share). GDP structure by sector in 2009 was: services 63.8%, industry 23.5%, agriculture 12.7%. Serbia's primary industries include processing of base metals, furniture, food processing, machinery, chemicals, sugar, tires, clothes and pharmaceuticals. The main Serbian agriculture products are wheat, maize, sugar beets, sunflower, raspberries, beef, pork and milk.

Table 39: Sectors exposed to hydrometeorological hazards in Serbia

Sectors	Hazards affecting these sectors	Sensitivity
Agriculture	Hail, Strong wind, Flood, Late/Early frost, Drought	High
Production transmission & distribution of electricity and heating energy	Extreme low & high air temperature, Heavy precipitation especially wet snow, Thundering and lighting struck, Drought	Relatively high
Transport (road, rail, river and air)	Fog, Heavy rain, Snow, Slippery conditions (glaze, freezing, ice), River froze	Medium, But air High
Civil engineering (road construction and bridges, water engineering, building construction…)	Strong wind and gust of wind, Heavy precipitation, Frost, Thundering and lighting struck	Relatively low
Water resources	Drought and Flood	Relatively high
Tourism and trade	Every deviation of normal climatologically and weather seasons	Medium

The agriculture sector is one of the most important sectors in the Serbian economy. Primary production from agriculture accounted for approx. 12.7% of GDP in 2009. Over two thirds of the total land area of Serbia is agricultural land and two thirds of the population in rural areas are involved in agriculture. Characterized by rich land resources and favorable climate, agriculture represents a vital sector of the Serbian economy.

A variety of different favorable natural conditions result in a high diversity of agricultural production. There are three broad agricultural regions that can be distinguished in Serbia on the basis of geography and climate, land quality, farm production systems, and socio-economic development, namely: Vojvodina, Central Serbia and Southern Serbia. Serbian terrain ranges from the flat and

rich lowlands of Vojvodina in the north for crop farming and vegetable production, to hilly terrain in central Serbia and high mountains on the eastern, western and southern borders of the country, suitable for sheep and cattle breeding, and fruit and wine production.

Drought is a real threat for Serbian agriculture. For example, according to the evaluation of drought impacts on the crop yield in east Serbia in the period 1989–2000, the average drop in yield was 40.9% in comparison to the average annual yield in the years without drought. Bearing in mind the projected increase in air temperature and decrease in precipitation, it was concluded that agricultural production will be very vulnerable to climate change in the future. The assessment of potential climate change impacts on agriculture in Vojvodina generally indicate a high level of vulnerability of agricultural production to extreme weather conditions and systemically modified weather conditions, as well as of the damage that could cost millions. Also, the results of the crop production model SIRIUS showed that, in case of the climate change scenario A2, the yield of winter wheat in Vojvodina in 2040 and in 2080 will have dropped by 5–8% and 4–10%, respectively, relative to the average yield in the period 1981–2005.

Table 40: Estimated losses in Serbia caused by unfavourable hydrometeorological events

Sectors and Hazards	Evaluated losses	
	Mean annul economic losses (million €)	Human losses
Agriculture - Flood	From 38.75 to 106.25	Few, up to 10
Water Resource Management - Flood	About 24.5	---
Agriculture – Hail, Heavy rain and strong winds	About 91.45	Few, up to 10, thunderstruck
Agriculture – Drought	About 500	No losses
Energy Production (heating plants) – Extreme low air temperatures	About 8.95	Few, up to 10
Road maintenance – Snow, slippery conditions (glaze, freezing, ice)	About 43.75	-------
Human losses on highway, regional roads and local roads due to bad weather: from 105 to 131		
Commercial air transport	From 0.675 to 0.9	----
TOTAL	From 208.1 to 607.15	From few to 160

Regarding the water sector, the territory of Serbia covers two main river basins: From the territory of Serbia, the waters gravitate towards the Black Sea (the rivers of the Danube basin), the Adriatic Sea (the Drim and the Plavska Rivers) and towards the Aegean Sea (the Pcinja, the Dragovistica and the Lepenac Rivers). Southern, south–western and western parts of the country are richer in water than the northern, central and eastern regions. Flood protection is the most important aspect of defense against the harmful effects of water, due to the fact that in the flood–prone areas, about 1.6 million hectares, are situated over 500 larger settlements, more than 500 large commercial building, around the 1,200 km of railway and more than 4,000 km of roads. In order to protect from flooding, over 3,400 km of dams were built and river regulation of about 420 km was realised. However, long–term/multiannual investment reduction in the maintenance of facilities and of riverbeds has led to a reduction in the security and level of protection from the destructive effects of water. Due to lack of maintenance of riverbeds, embankments of waterways under a torrential hydrological regime are threatened. Climate change is expected to affect water resources in many different ways. A preliminary assessment of climate change effects on the water resources indicate that a decrease of water flow on the national level is to be expected in the forthcoming period caused by decrease in annual precipitation. It should also be taken into consideration that the above projections show that climate change might cause more intense flood and drought episodes, greater both in scope and duration.

7.2. Institutional Framework of Disaster Risk Reduction in Serbia

7.2.1. Legal framework and policy supporting DRR in Serbia

The Law on Emergency ("Official Gazette of the Republic of Serbia", No. 111/09) created a unified legal framework for the effective protection of citizens and property in emergency situations when the risks and threats or the consequences of disasters, emergencies and other threats to the population, environment and property are of such magnitude and intensity, that special measures must be used in their mitigation and elimination. The new Law on Emergency Situations has shifted the focus from preparedness and response to disaster prevention and risk reduction. The Law encompasses the guidelines and proposals of the United Nations International Strategy for Disaster Risk Reduction (UN / ISDR), as well as basic principles of Hyogo Framework for Action.

In accordance with the new Law on Emergency Situations, which entered into force in July 2010, preparations for drafting the National Strategy for Protection and Rescue started. Developing the Strategy involves participation of appointed representatives of all competent authorities, scientific and educational institutions, non-governmental associations (The Serbian Red Cross, humanitarian organizations and other relevant associations). The appointed representatives of the Republic Hydrometeorological Service as a National Hydrometeorological Service of the Republic of Serbia (RHMSS) also participate in the Strategy development. It has been planned that the Strategy and the Action plan include all disaster risk reduction components (prevention, risk reduction, emergency response and preparedness). The aspects of the organizational structure of DRR shall also be covered at all administrative levels (national level, autonomous level and local self-government level).

Other laws defining the legal framework are:

- Law on Ministries ("Official Gazette of RS", No. 65/08, 36/09 and 73/10);
- Law on Meteorological and Hydrological Activities ("Official Gazette of RS", No. 88/2010), regulates the authority of the Republic Hydro Meteorological Service of Serbia (RHMSS), as a National Hydro Meteorological Service in the establishment and functioning of the National Hydro-Meteorological system of early warning, the authority of RHMSS to issue warnings on the occurrence of disasters of meteorological and hydrological origin, as well as development of risk maps and vulnerability to weather hazards. The section of the Law on Meteorological and Hydrological activity related to the authority of RHMSS in DRR activities is in full compliance with the Law on Emergency Situations, and the Hydro Meteorological system of early warning is designed to represent an integral part of the national protection and rescue system;
- Law on Waters ("Official Gazette of RS", No. 30/2010), harmonized with the EU Water Framework Directive, identifies priorities in terms of protection against flooding and shipwreck water pollution;
- Framework Directive of the European Union on Water;
- EU Directive on Floods Protection.

The Sava River Commission prepared in 2009 the Sava River Action Plan, designed in full coherence with EFD (Directive of the European parliament and of the Council on the assessment and management of flood risks) 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.

7.2.2. Institutional framework

7.2.2.1. List of agencies involved in hydrometeorological risks reduction

- Sector for Emergency Management (SEM) - Ministry of Interior;
- Republic Hydrometeorological Services of Serbia;

- Water Directorate (WD) – Ministry of Agriculture, Forestry and Water Management (MAFWM);
- Indemnity Fund – Ministry of Agriculture, Forestry and Water Management.

7.2.2.2. Sector for Emergency Management

In June 2009, Protection and Rescue Sector of the Ministry of Interior (MoI) was reorganized into the Sector for Emergency Management, which is directly under the Minister of Interior. The Sector integrated the Protection and Rescue Sector of MoI and the Department for Emergency Situations of MoD. The structure of SEM is described in Figure 24. The most important step of the Sector toward the establishment of an integrated emergency management system was the setting up of a legal framework in this area. On 29 December 2009, the Serbian National Assembly adopted the new Law on Emergency Situations and the new Law on Fire Protection. In accordance with the Law on Emergency Situations, the Sector coordinates the activities of all state institutions involved in emergency and disaster management.

This Law defines activities, declaring and management in emergency situations; system of protection and rescue of citizens, material and cultural goods from natural and man-made disasters; rights and obligations of citizens, state agencies, autonomous provinces, local self-governments, companies and other legal persons and entrepreneurs; inspection and supervision, international cooperation and other issues relevant to organization and functioning of the protection and rescue system.

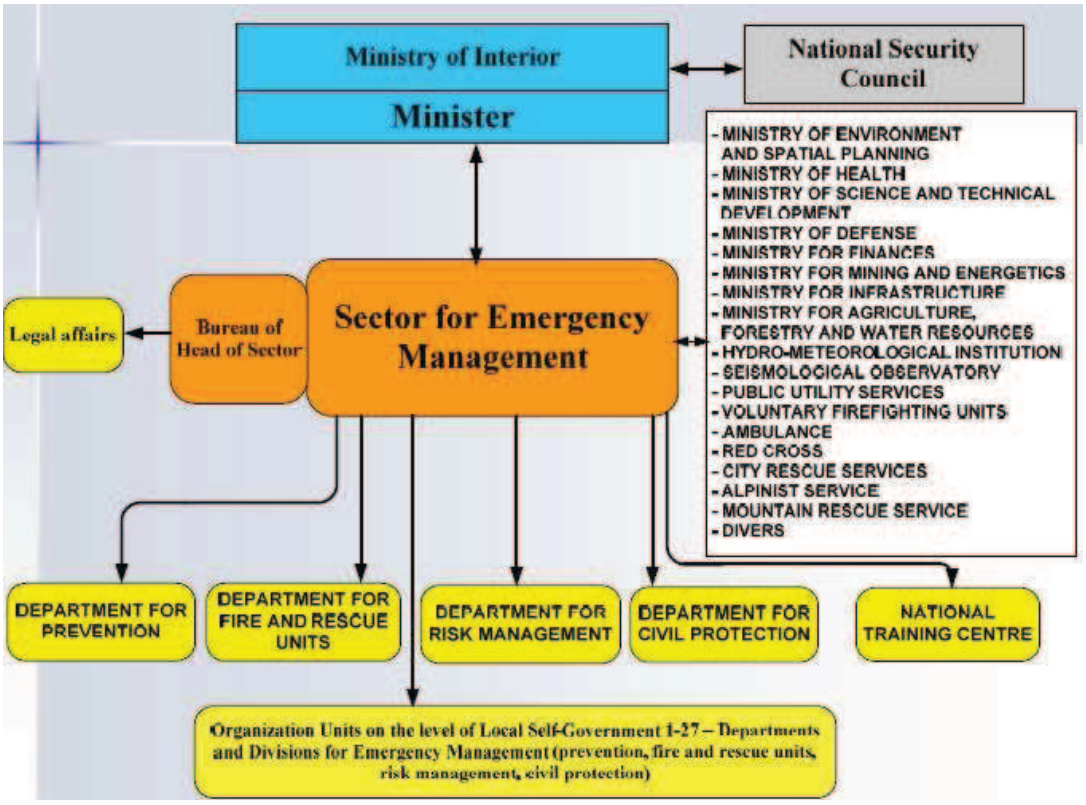

Figure 34. Structure of Sector for Emergency Management

The strategic axes of activity of the SEM are:

- Development of Emergency Plans;
- Adoption of National Strategy for Disaster Risk Reduction;
- Implementation of a single European emergency call number 112;
- Enhancement of international cooperation.

The first axe concerns the Development and Adoption of Emergency Plans, where SEM acts as coordinator of other actors setting up the mechanisms for emergency management. Within axe two, SEM is fostering the adoption of a National Strategy for DRR, aiming to risks and vulnerability reduction within the context of sustainable development to create the conditions for prompt first response and rescuing people and property. The implementation of 112 as a single European emergency call number includes also the establishment of an operational information center, which besides normal 112 activities should be able to store, manage and analyze data concerning hazards and risks. For the operational implementation of 112 center an ad-hoc working group defined the work plan and a draft of project proposal has been prepared for the IPA programme. The 112 information center will be also responsible for the floods risk assessment, while the sector doesn't have mandate for the drought risk assessment. The sector is still in the re-organization phase and also the legislative framework is not complete, thus it is not fully operational, particularly concerning risk assessment.

7.2.2.3. Republic Hydrometeorological Services of Serbia

Republic Hydrometeorological Service of Serbia (RHMSS), as a special organization within the state administration of the Republic of Serbia, performs the tasks of monitoring, research, analyzing and forecasting of weather, climate and water, air and water pollution, air and precipitation radioactivity including monitoring of transboundary air and water pollution, the activities of meteorological and hydrological support of air, land and river traffic, tasks of early warning and alarms against the occurrence of atmospheric and hydrological disasters and catastrophes, monitoring and action on hail-bearing clouds as well as other activities of National Hydrometeorological Service as public service important for preventive protection of human lives and mitigation of material damage. RHMSS also performs international obligations in the field of meteorology and hydrology as well as other activities defined by the law.

These duties of RHMSS are regulated by the Law on Ministries ("Official Gazette of RS", No. 65/08, 36/09 and 73/10), the Law on Meteorological and Hydrological Activities ("Official Gazette of RS", No. 88/2010), the Law on Waters ("Official Gazette of RS", No. 30/2010), the Law on emergencies ("Official Gazette of RS", No. 111/2009), the Law on Air Navigation ("Official Gazette of RS", No. 73/2010), the laws on ratification of the international conventions related to meteorology, hydrology, climate change and environment quality monitoring and other bilateral and multilateral regional agreements. In accordance with its jurisdiction stipulated by the laws and relevant international conventions and protocols, Republic Hydrometeorological Service of Serbia carries out the activities of international cooperation in the field of meteorology and hydrology as well as the functions of National meteorological, climate and hydrological center of Serbia in the World Meteorological Organization (WMO), Group on Earth Observations (GEO), European organization for the exploitation of meteorological satellites (EUMETSAT), European center for medium-range weather forecast (ECMWF), European regional telecommunication network of WMO (RMDCN), Danube Commission for the Danube navigation security, Protocol on long-term financing of the Cooperation program for the assessment of transboundary long-range pollutant transport in Europe (EMEP), then the function of National Focal Point in Intergovernmental Panel for Climate Change (IPCC), and participate in the implementation of the UN Framework Convention on Climate Change (UNFCCC), UN Convention on desertification (UNCCD) and other international treaties.

With regard to DRR activities, Republic Hydrometeorological Service of Serbia is responsible for the establishment and functioning of basic components of hydrometeorological early warning system as a part of National Protection and Rescue system coordinated by the Ministry of Interior-Sector for Emergency Management which, in disaster risk or disaster occurrence, activates, through the headquarters for emergencies, the proceeding pursuant to the adoption of the decision to declare emergency situation. The basic duty of RHMSS is to provide timely and reliable information necessary for the life and goods protection. For its operative work there are available products of global numerical models and own operational regional weather and climate models.

RHMSS computer resources make possible the carrying out of various functions and tasks of integrated meteorological and hydrological multi-hazard early warning system.

In accordance with the Law on emergencies and Law on meteorological and hydrological activities, RHMSS, as a competent organization for operative functioning of the hydrometeorological early warning system, is responsible to make the vulnerability assessments within the scope of its work and to make risk maps for particular meteorological hazard and send them to the Ministry of Interior which is coordinator for the preparation of protection and rescue plans.

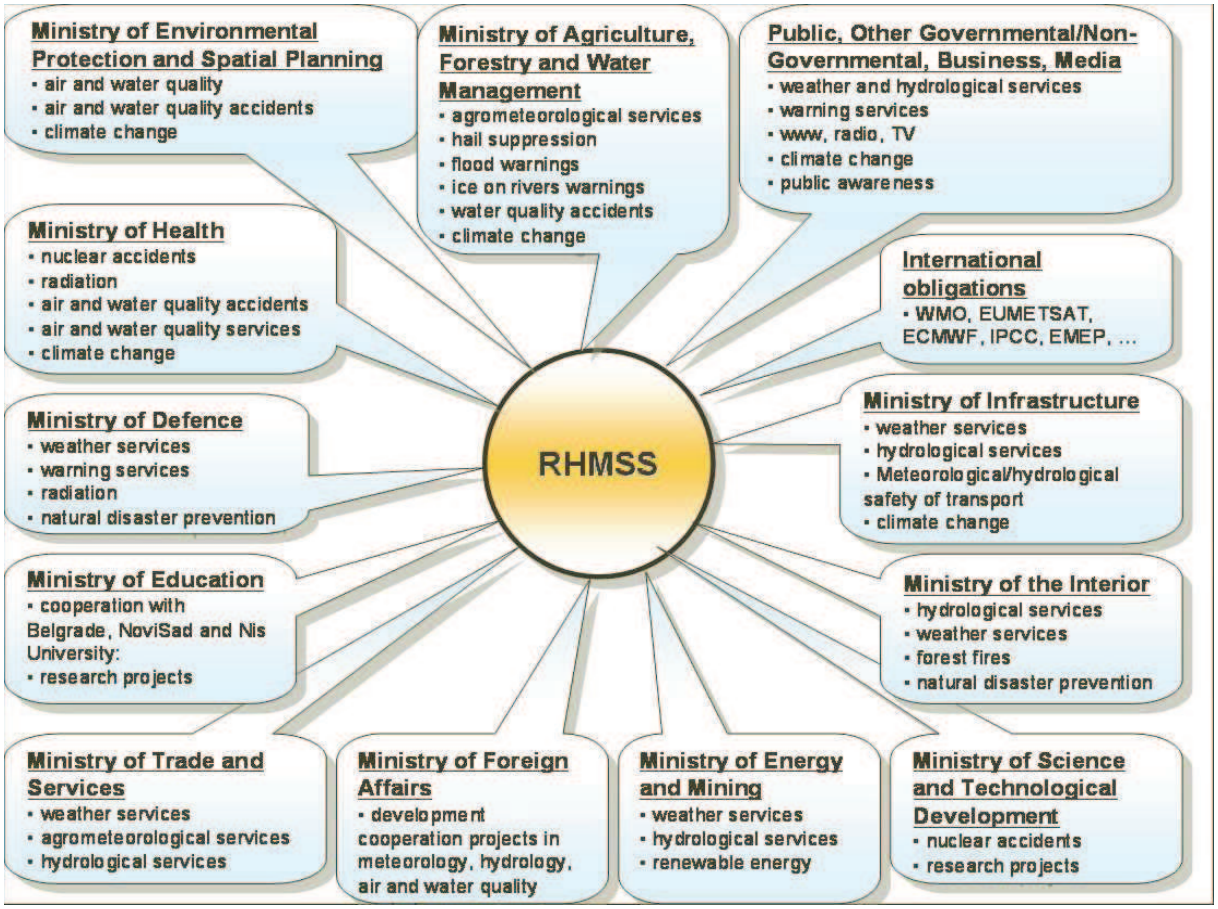

Figure 35. Operational linkages of RHMSS with other institutions in DRR

RHMS of Serbia is responsible for monitoring, detection, forecasting and issuing of warnings for the following hydro-meteorological hazards: Rotational high winds, Flash floods, Strong winds, Hailstorm, Thunderstorm or lightning, Heavy snow, Freezing rain, Dense fog, Heat waves, Cold waves, Drought, River flooding.

In the course of 2008, experimental development and operative implementation have been completed for the installation of early warning and alarm system against atmospheric and hydrological disasters and catastrophes for the territory of the Republic of Serbia, so-called “MeteoAlarm” and “HydroAlarm”. Serbian “MeteoAlarm” system has been included in the European Meteoalarm that represents one especially important EUMETNET program. Also, Serbia became a member of European Flood Alert System (EFAS).

RHMS is the host of sub regional South East European Virtual Climate Change Centre (SEEVCCC) which was included in 2009, in accordance with the Resolution of WMO RA VI, in the Pilot program of European network of WMO Regional Climate Centers. One of the key functions of the Center relates to climate monitoring, seasonal forecasting and warnings (Climate Watch) on

the occurrence of climate extremes and disasters as well as development of scenarios of regional climate change and research of climate change effects, vulnerability and adaptation options. The Center and RHMSS have signed agreements on expert-technical cooperation with majority of NMHSs in the region. Strengthening of regional cooperation in the field of climate change will certainly contribute to more efficient functioning of national meteorological, hydrological and climate early warning system.

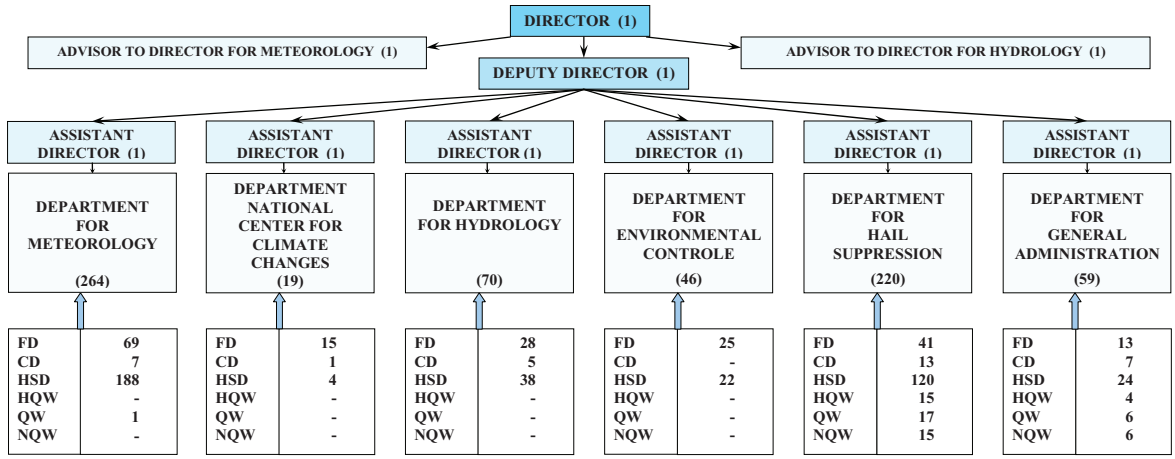

Figure 36. Organizational and Qualification Structure of the RHMSS

7.2.2.4. Water Directorate

Activities related to fresh water management (use, preservation, flood control, pollution control, water regime/quality and quantity, etc.) fall under the jurisdiction of the Ministry of Agriculture, Forestry and Water Management of the Republic of Serbia/Republic Directorate for Water (WD).

WD is responsible for the flood protection infrastructures and for flood protection planning. In this framework WD performs flood risk assessment for the areas with flood defenses, but not for the other areas or those under the responsibility of other Water management institutions (Belgrade Vode, Serbia Vode etc.). WD is updating the Water Master Plan, which was adopted initially in 2002. WD is also involved in drought management, by proposing the appropriate accumulation and flows regimes in case of low water levels for hydrological drought management. WD, in collaboration with the Ministry of Environment and Spatial Planning, has been involved in the preparation of the second communication of Serbia to the UNFCCC, concerning the water resources issues.

In the framework of the International Commission for the Protection of the Danube River (ICPDR), the WD participates in the common assessment of floods and floods report on Drina and other 2 rivers have been prepared in 2010. In support to the framework agreement on the Sava river basin a protocol on flood protection has been signed, but not yet ratified. It should be a strong supplement to the FASRB, aiming to create the conditions for flood risk assessment and sustainable flood protection.

WD benefits of many international programs and projects, such as:

- Design and Implementation of a Water Management Information System in Serbia - European Commission;
- The overall objective of the project is to strengthen the protection of water resources, water quality and public health. More specifically it aims at strengthening the capacity of the Water Directorate of the Ministry of Agriculture, Forestry and Water Management to manage water resources, to provide improved access to information and data on water resources, and to promote the inter-institutional exchange of information and data on water resources;

- Study of flood prone areas in the Republic of Serbia – European Commission;
- The project has been designed to assist Serbia in the harmonization with the European Flood Directive in the fulfillment of its obligations in the integrated management of hydraulic resources field and the global protection against floods. In this project funded by the IPA Program (Instrument for Pre-Accession Assistance) of the European Union, the maps of the floodable zones following the master lines fixed by the European Flood Directive and Water Framework Directive (WFD) are prepared. Maps are based in GIS technologies to be incorporated lately to the National Water Management Information System;
- Regional Flood Risk Project on Danube river- European Commission, IPA programme;
- Flood vulnerability assessment in pilot basins - European Commission, under development;
- Sava hydrological modelling – US corps of engineering.

The WD coordinates all these initiatives and should ensure the methodological coherence in flood risk assessment and mapping, but doesn't take part of technical activities, being principally a managerial institution.

Other institutions are involved in water management. JVP "Srbijavode" (Public Water Management Company "Serbia Waters") was set in 1996 to implement the water management activities. The structure was altered in 2003 with the creation of the Provincial Secretariat of Agriculture, Water Management, and Forestry of Vojvodina Province and the setting up of the new JVP "Vode Vojvodine" (Vojvodina Waters), that covers water management responsibilities on the territory of Vojvodina Province. Field activities are carried out by 55 companies, under contractual arrangements with JVP "Srbijavode" and "Vode Vojvodine". Water supply public companies are guided by the Ministry of Public Administration and Local Self-government. The authority of the Ministry of Agriculture and Water Management in this regard is mainly in the sphere of issuance of water management criteria and permits for the use or release of water, as well as in the encouragement of and provision of subsidies for construction of capital projects.

7.2.2.5. Ministry of Agriculture, Forestry and Water Management - Indemnity Fund

The Indemnity Fund (IF) is an implementing agency of the Ministry of Agriculture. IF deals mainly with insurance and compensation in case of disasters. Drought, hail and strong precipitations are the priority hazard for insurance. The Ministry of Agriculture covers the 40% of insurance costs for the farmer. A pilot insurance project in Serbia is developed with Delta Generali and Swiss Re. RHMSS participate in this project, by providing meteorological data and analysis. Insurance companies collect data on damages in agriculture and as stated by the agreement they should provide them to RHMSS. The IF in collaboration with the Institute for statistics and the Institute for Science in Agriculture are developing the project for the "Establishment of the Serbian Farm Accountancy Data Network (FADN)" in the framework of IPA 2010 programme. The system of agricultural accountancy data to be developed aims to monitor the level of income and expenses of the registered farms and family farms, assess the efficiency of agricultural production and analyze the agricultural policy measures. The interesting aspect, concerning drought risk assessment is the establishment of a general database containing useful information for drought vulnerability assessment. The current phase doesn't foresee the development of a GIS, but only a statistical database organized geographically by Region and thematically per value of output and type of farm.

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

RHMSS participates in the creation of the National Protection and Rescue Strategy, and the Director of the RHMSS holds the function of Member of the National Security Council and the Republic Emergency Headquarters.

RHMSS cooperates with other technical agencies related to hazard mapping, expert advice, provision of historical data for risk assessment, real time monitoring, issuance of

hydrometeorological maps etc. However, the level of cooperation has been very low as the need of cooperation has not been fully acknowledged.

RHMSS has a quality control mechanism based on regular interaction with the stakeholders and by providing training for stakeholders to understand hazards and warnings. Currently there is not similar interaction with the general public, but RHMSS will open next year a possibility for feedback on their web pages.

7.2.4. Roles and responsibilities for flood and drought risk assessment

Flood risk assessment is under the responsibility of the Republic Water Directorate of the Ministry for Agriculture, Forestry and Water Management of the Republic of Serbia for the areas protected against floods and for flood defense planning purposes. The areas non protected are under the responsibility of Municipalities concerning flood risk assessment for spatial planning and of the Sector for Emergency Situations for flood risk assessment for disaster management planning.

For drought risk assessment, there is no specific legal or institutional framework. Drought is considered by SEM only as condition for wild fires. Operationally, drought risk assessment is performed under specific projects or activities by different collaborating institutions, among which RHMSS. RHMSS has clear mandate only for meteorological hazard risk mapping, including meteorological drought.

SEM is responsible for the national risk assessment, based on which, the Government determines the types of natural disasters and technical/technological accidents and hazards requiring preparation of plans, and determines the state authorities to be involved in their preparation. But being a new organization, SEM does not have yet all the capacities for playing operationally this role. The establishment of an operational information center is foreseen by the Project “Implementation of a single European emergency call number 112”, which besides normal 112 activities should be able to store, manage and analyze data concerning hazards and risks. The 112 information center will be also responsible for the management, analysis and mapping of information for the national vulnerability and risk assessments, including floods risk assessment, while the SEM does not have the mandate for drought risk assessment. Actually, hazard mapping is done within the Department for Fire and Rescue Units, which has some mapping capacities and a database of past events. A risk map for 4 types of hazard, including floods, has been prepared using the frequency of past events. Moreover, natural disaster risk maps, relating to forest fires, floods, landslides, earthquakes, droughts, storms and hail, have been made and they represent integral parts of the Spatial Plan of the Republic of Serbia. The National Vulnerability Assessment is in progress and the SEM ensures its coordination, as well as for the National Risk Assessment. Line Ministries and specialized services contribute in the framework of their specific mandate, providing data, elaborated information and analysis. Concerning risk assessment methodology, SEM is defining the methodology for the multihazard national risk assessment, which should be (as bylaw) approved by the government. This comprehensive methodology should take into consideration the existing thematic methodologies, e.g. the flood risk assessment methodology developed by the WD.

According to the Law on meteorological and hydrological activities and Law on emergencies, the RHMSS produces and periodically updates vulnerability maps and assessment of the Republic of Serbia for drought, floods and other meteorological natural hazards, applying a set of operational methodologies. RHMSS produces also risk maps, delivered to the ministry in charge for protection and emergencies activities. Moreover, drought and flood information are disseminated on regular basis. Additionally, some drought and flood information (relevant data sets, studies etc.) are delivered upon the request of various users. Concerning hazards, RHMSS produces analyses on averages, trends, variability and extremes and makes studies of potential impacts.

WD has mainly a coordination role, it is a managerial structure with few technical capacities. For technical issues WD relies on the Institute for Water Management Jaroslav Cerni (IWMJC) and in a

lower measure on the RHMSS. WD, according to the new law on water, which adopts the EU Framework Directive on Water and the EU Flood Directive, is responsible for the three steps of flood analysis:

- Preliminary flood risk assessment for each river basin, to be completed by the end of 2011 using available data;
- Flood mapping including flood hazard maps and flood risk maps, to be complited by 2013;
- Floods risk management plans, to be completed by 2015.

Currently, WD is developing the first step and operationally this task is performed by the IWMJC. The Institute has been also involved since the beginning (2 years ago), and in partnership with the Ministry of Science to developed the methodology for flood risk assessment. This methodology should be applied by any flood risk assessment initiative in Serbia. Other countries in the ICPDR have adopted or are adopting their own methodologies and finally all methodologies will be tested as well as the comparability of their results. WD is also responsible for the flood risk assessment and the preparation of the national plan for floods protection (each 5 years) and also the annual plans, done in collaboration also with other concerned actors. These assessments and plans cover the area protected against floods, but the non protected areas are under the responsibility of SEM and Local Authorities. The Belgrade area is under the responsibility of Belgrade Vode, which is independent. The plans identify the roles and responsibility of different actors in floods protection and management. WD is developing the Water Management Information System, which in perspective should be interoperable with SEM Information system and RHMSS system. With RHMSS an agreement defining data exchange is already in development. WD has good operational relations with RHMSS, which provide to WD data, analysis and services. Relations with SEM are as well good, even if at the beginning the mutual roles and responsibilities were not clear.

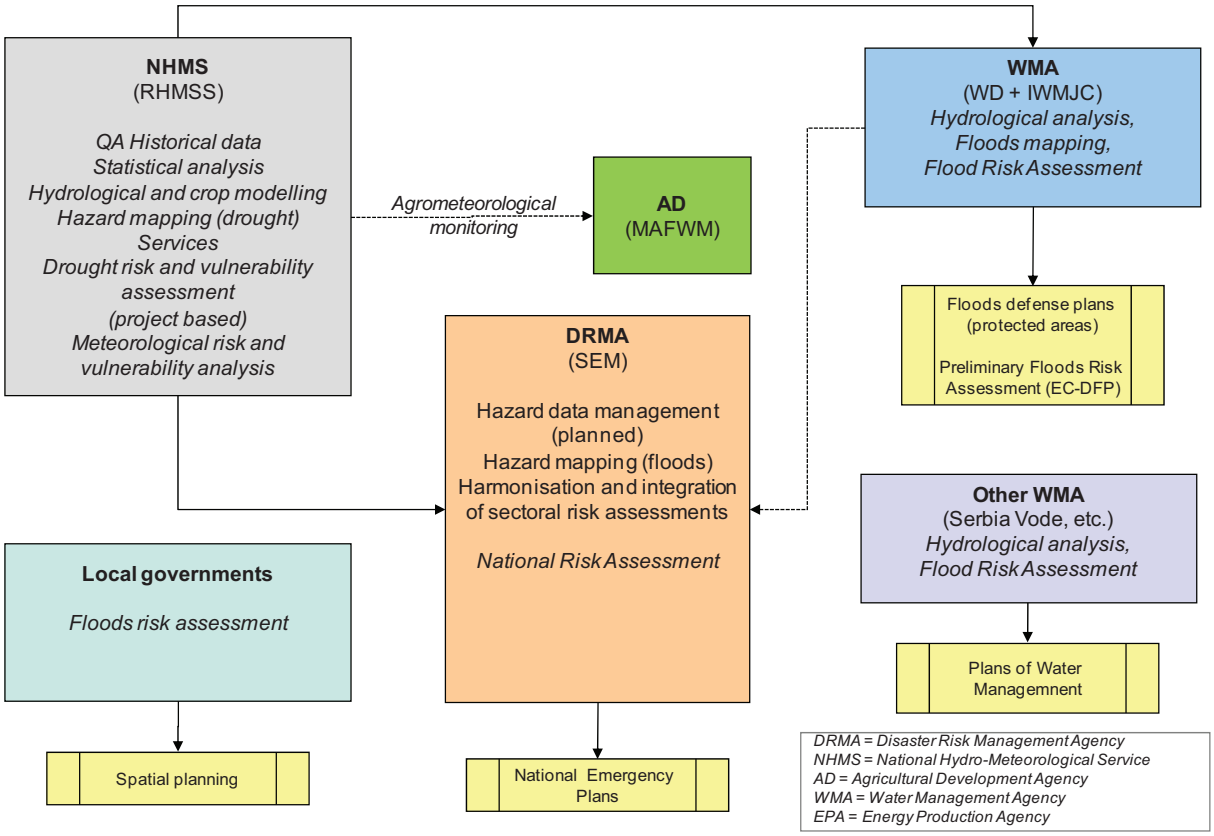

Figure 37. Floods risk assessment workflow in Serbia

Statistical data about agriculture production, surfaces and yields are stored and managed by the Institute for Statistics, while the Ministry of Agriculture stores only specific data for its own interest.

The methodology of data collection and also the processing are different so MAFWM and Statistical Institute data are not always comparable.

Concerning the impact of disasters, the data are collected at local level by the local commissions or the municipal headquarters for emergency situations, applying specific protocols for damage assessment. The data concern fires, floods, landslides and avalanches and are available generally on paper at the municipalities. Then they are transmitted to the special governmental commissions and finally stored at the Statistical Institute. WD collects data only for the damages of the hydraulic and flood protection infrastructures. Data about drought consequences in agriculture are not collected by the MAFWM, but they are however available at Municipality level in the various regions of the country. The RHMSS uses this data as feedback for validation/calibration of the drought monitoring system. Concerning floods, the data also exist, including damages to property and persons. But all the data are dispersed and available with different levels of precision from different actors: Municipalities, Ministry of Agriculture, Institute of Statistics, Ministry of Finance, etc. Damages to agriculture in case of floods are collected by the local commissions and are available generally on paper at municipality level. The data are quite precise but not digital.

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

7.3.1. Monitoring and observations networks and data exchange

Observations, and especially the upper air observations are essential for global, regional and local weather forecasting and numerical modelling of the atmosphere. 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 of meteorological, hydrological and environmental hazards;
- short term forecasts;
- validation of forecasting models;
- improved data assimilation, which will benefit the global, regional, local and mesoscale NWP modelling.

Table 41: Meteorological data collected by RHMSS

Term measurements	Periodical Daily measurements	Chronology of events	Agrometeorological data
- Air pressure at the station - Air pressure on the station - Dry thermometer temperature - Wet thermometer temperature - Relative humidity as per hygrometer - Wind direction - Wind speed - Sunshine duration - Precipitation quantity - Precipitation duration - Soil condition - Horizontal visibility - Quantity, description and amount of clouds - Phenomena in observation term	- Maximum air temperature - Minimum air temperature - Minimum air temperature at 5 cm - Precipitation quantity - Precipitation type - Snow soil cover degree - Characteristics of snow cover surface - Total snow height - New snow height - Evaporation as per Piche	- Identity, - intensity, - intermissions - duration of phenomena	- Soil temperature (three terms) - Evaporation from water surfaces (two terms) - Evapotranspiration at the lysimetric station - Belgrade (automatic hourly observations) - Soil moisture at 6 depth levels up to 1 meter - Phenological observations

Regular meteorological measuring of temperature, humidity, precipitation, wind and air pressure started on 1 January 1848 in Belgrade. In 1856 well-organized network of meteorological stations became operative in 20 towns of Serbia, and in 1857 there were 27 of them and that was the densest network in Europe at that time. Belgrade Observatory was founded on 26 March 1887, and became central institution for data collection from the whole Serbia. During the wars in late 1990s much of hydrometeorological instruments and facilities were damaged or destroyed. Renovation and upgrading of the observation network has been quite slow. However, since 2007 the number of automatic weather stations has significantly increased and RHMSS has been able to install one new technology weather radar. Actually, meteorological data collected by RHMSS are presented in Table 41. The current RHMSS observation network is described in terms of number of different types of station in table 42.

Table 42: Observation stations operated by RHMSS

Type of observation stations	Number		Connected to WMO GTS	Comments of 2010 network
	2007	2010		
Atmospheric domain				
Surface synoptic stations (> 8 obs./day)	31	60		
Manned stations	28	28	28	
AWS or AWOS	3	32	0	On-line stations
Cloud-height – automatic	0	0		
Agrometeorological stations	28	30		
Ordinary climate station (3 obs./d)	70	70		
Rainfall station (2 obs./d)	400	400		
Rainfall station – automatic	0	-		
Meteorological towers	0	0		
Upper air radio sond stations	1	1	1	LAN
Pilot balloon stations	1	0		
SODAR/RASS	0	0		
Wind profiler stations	0	0		
Lidar	0	0		
Access to AMDAR data	-	-		
Weather radars	3	3		
Hale radars	10	10		Occasionally available
Lightning detection stations	0	0		
Lightning detection hub station	0	0		
Satellite MSG ground station	1	1		
Hydrological domain				
Hydrometric station	185	200	21	60 sends data on-line
Stream gauge station – manual				
Stream gauge station – automatic				
Water level post – manual				
Water level station – automatic				
Environmental domain				
Air quality	24	24		
Water quality – surface water	149	149		12 real-time stations
Water quality likes and accumulation	33	33		
Ground water quality	68	68		
Nuclear radiation/deposition	NA	9		RHMSS only collects data
Ozone – near surface	1	1		In experimental phase
Ozone – upper air	0	0		
UV radiation	0	0		
GAW station	1	1		

Currently RHMSS has one about 20 years old AWS, one 5 years old and two 10 years old while all the others are MicroStep-MIS stations purchased in 2008-2009. The upper air sounding station is Vaisala DIGICORAIII with GPS system and soundings are done twice a day at 00 and 12 UTC.

RHMSS has 14 radars; the 10 Mitsubishi RC34A radars were installed 26-32 years ago and are mainly used for hail monitoring, 3 Gematronik weather radars were installed in 2000/2002 and the LCWR located in Beograd in 2007. The weather radar network in general is out-dated and does not meet the range and current technical capacity of modern radars. The old system requires big investments in maintenance. During the mission e.g. the Belgrade weather radar was not operational. In principle some of the radars could be upgraded, but not to the level of modern weather radars, which have e.g. possibility to detect different forms of rain, which is very essential in the climatic conditions in Serbia and SEE countries. Currently RHMS presents some of the radar images as single pictures showing the measured dBZ distribution from observed obstacles. However, the images do not represent very valuable information for other end-users than meteorologists without training. RHMSS does not have capacity to produce near-real-time composite pictures and animations of precipitation areas with intensity of rain, which are produced by EU NHMSs, and which are among the most popular and utilized products by companies and the public.

RHMSS uses the Meteosat Second Generation with multispectral imagery of the Earth's surface and cloud systems every 15 minutes from twelve spectral channels. The resolution is 1 km for the visible channel and 3 km for the others. For other information such as permanent data about the temperatures of clouds, land and sea surface data, the channels in the thermal infrared are used. Also, the Meteosat Second Generation (MSG) satellite has channels that absorb ozone, water vapour and carbon dioxide, which are used to analyze the characteristics of atmospheric air masses. The available data are used in the process of detection and monitoring of hydrometeorological hazards. Also, these data in combination with radar data are used in order to alert the warning.

The hydrological network consists of 5 regional station centers, which operate 119 surface water stations of the first order, 191 stations of the second order and 438 ground water stations. New technology is adopted during the latest years for discharge and water level measurements. In the network 66 stations located in main rivers monitor and send data in real-time and data from 41 of these are collected by automatic GSM system. Hydrological data observed by RHMSS are water level, water temperature, ice phenomena for surface water, and water level and water temperature for underground water: Hydrological data calculated by RHMSS are water discharge using rating curves.

RHMSS receives data also by other entities. The Law on meteorological and hydrological activity ("Official Gazette of RS", No. 88/10) defines the National station network and Additional network of meteorological and hydrological stations. Additional networks of meteorological and hydrological stations can be established if the requirements are met regarding station location, program of meteorological and hydrological measuring and observing as well as the station reporting mode. RHMSS keeps the Register of national and additional networks of meteorological and hydrological stations. The owners of additional network are obliged to send to RHMSS available data and information obtained in the period before, during and immediately after the occurrence of meteorological and hydrological natural disasters, catastrophes and nuclear accidents. Hydrological data are provided by the Water management organizations and the power plants for national data, and by Data exchange as a part of Danube commission at the international level:.

The mechanism of acquisition is GTS, the data are free and are stored in the RHMSS database.

Air quality monitoring is based on collection of 24-hourly sample collection (1.6 – 2.5 m3/dan):

- 24 stations for measuring of SO2 smoke immission (soot);
- 18 stations for measuring NO2;
- 7 stations for precipitation sampling.

Water quality observations are strongly included into international data exchange: data from 18 surface water quality stations are sent to ICPDR and from 77 to EEA once a year, from 14 water

quality accumulation measurements stations and from 16 ground water quality stations are sent to EEA once a year.

Nuclear radiation is monitored at 9 stations, but RHMSS only collects data from this network.

RHMSS is connected to WMO-GTS via RMDCN network has been established with ECMWF, DWD Germany, Austrocontrol Wienna and Hungarian Met Service. RHMSS sends bulletins and messages of different types according to the WMO and ICAO manuals. The data-sharing protocols meet WMO, EU, EUMETSAT and EUMETNET protocols.

Significant gaps in observing network of RHMS of Serbia are as follows:

- The density of main meteorological stations (synoptic stations) is about 2500 sq. km. This is the lowest level according to WMO recommendations and DRR requirements;
- Approximately 80% of meteorological and hydrological instruments and equipments are at the end of their life cycle including weather radars stations and computers;
- Insufficient number of Automatic Meteorological Stations, Automatic Rain gauge stations, Lighting location system, Radio sounds and other vertical profiling equipment, Automatic Hydrological Stations, Acoustic Doppler Current Profiler, Weather radars, adequate monitoring network for micro and mezzo atmospheric process and adequate telecommunication system for collecting such data;
- The existing Weather Radar Network is not fully automated.

RHMSS in cooperation with the government has developed the plan for modernization of Observing, Telecommunications and Forecasting. Modernization program is based on “Study on Economic Benefits of RHMS of Serbia”, The World Bank study group, 2005, Belgrade, Serbia and “Strengthening the Hydrometeorological Services in South Eastern Europe”, 2008., The World Bank, ISDR, WMO, Finnish Meteorological Institute.

7.3.2. Hydro-meteorological data management systems

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.

RHMSS has quite advanced data management system and facilities. There are several databases in use based on Oracle, OTHER, dBase IV and CLIDATA. However, the time series in digital format from climatological and synoptic stations cover only 45 years. Quality control is done in real-time and in non real-time. Data stored (with formats) into other storages currently are (average number):

- hourly data (paper sheets): 40 years series;
- hourly climatological data (dBase IV format): 39 years series for 5 stations;
- climatological data (paper sheets): 57 years series;
- rainfall data (paper sheets): 42 years series;
- rainfall data (dBase IV format): 15 years series;
- radar data (Convective clouds): 30 years series;

RHMSS collects data from the original paper reports, which are being digitized by manual typing. The digital data is stored in the CLIDATA database on Oracle. Part of data is also available in Access database. Older data (more than 45 years old) is still only on paper or in book, and needs to be digitalized. Non real-time data pass three levels of data quality control:

- Technical control consists of checking temporal consistency of the data files. Omitted data are either found and filled in, or left blank, depending on the paper from which the data have been digitized;
- Logical control is being performed using a developed logical test. The test has two levels. Level one, alarms for obvious erroneous data, exceeding physical limits of the measured

value. It also alarms on non-logical data combination (i.e. precipitation from a clear sky). Alarmed data must be corrected. Level two, alarms on critical values that most probably contain errors. These data are corrected only if they are proved to be an error; otherwise it is left for further data analysis;

- Comparison of data from two or more logically (climatologically) related stations is being performed using ad-hoc graphs for temperature time course and 'snapshot' graphs of station level pressure data, ordered by altitude. Data are corrected only if the outliers on the graphs are proved to be errors.

Real-time data are checked in 5 steps:

- The formats of all coded reports are checked;
- Surface and upper air reports are checked for internal consistency before storing and exchange;
- Checks on temporal consistency;
- Checks against the model background values;
- Surface and upper reports are included in QC.

Data stored currently into RHMSS database are (average number):

- climatological data (7, 14 and 21 h) - 45 years series;
- hourly data (SYNOP code).

Data stored (with formats) into other storages currently are (average number):

- climatological hourly data (paper sheets): 40 years series;
- climatological hourly data (MS Access format): 39 years series for 5 stations;
- climatological three terms data (paper sheets): 57 years series;
- rainfall data (paper sheets): 42 years series;
- rainfall data (MS Excel format): 15 years series;
- Data (without regard to formats) are stored permanently.

Metadata are not completely available. RHMSS is currently in the process of planning a strategy of running data rescue activities; reports on paper form are kept in the archive, but capacities of existing archive are insufficient to host the entire archived material.

Hydrological data Quality Control concerns logical and visual analysis of observed / measured data and data observed by regional offices staff during inspection; graphical control of data collected from all sources, comparing data from the same river – upstream and downstream stations. Hydrological data management is ensured by the Wiski database on Oracle with metadata, tools for data restore and recovery and authorized users access.

Table 43: Computer capacity in use for RHMSS data management

Server/Workstation/PC	Characteristics	Disk space	Security
HP ProLiant ML 110 Server	XEON Processor	2×160Gb	Symantec AntiVirus
PC (1)	Pentium 4	180 Gb	Symantec AntiVirus
PC (5)	Pentium 4	80 Gb	Symantec AntiVirus
PC (1)	Pentium 4	40 Gb	Symantec AntiVirus
PC (1)	Pentium 3	60 + 8 Gb	Symantec AntiVirus
PC (1)	Pentium 2	6 Gb	Symantec AntiVirus
PC (3)	Pentium 2	4 Gb	Symantec AntiVirus
PC (1)	Pentium 1	1,6 Gb	Symantec AntiVirus
PC (1)	Pentium 1	1 Gb	Symantec AntiVirus

The data management computing capacity is actually the same as it was already in 2007 consisting of server and several Pentium PCs (Table 43). The security system includes the Symantec AntiVirus software. Safety of database system consists of having two hard disk drives in

mirroring mode (one disk is exact copy of another) and soon is planned to make one integral backup. In the near future it is planned to do regular backups (partially - every month and integrally - every six months).

Concerning the policies for data dissemination and exchange, RHMSS attitude is that the reliable weather and hydrological forecasts and warnings, also climatological data that are used for protection of life and property, are a public good. They have to be available to any person or group at essentially free of charge. Only analyses and special data processing are charged. Hydrological data are charged for non-governmental institutions and price list is adopted by Government.

7.3.3. Hazard analysis and mapping to support risk assessment

In accordance with the applicable regulations, natural disasters threat maps have been produced and they are related to forest fires, floods, landslides, earthquakes, droughts, storms and hail and they represent an integral part of the Spatial Plan of the Republic of Serbia. The most detailed are the information about the risk of flooding due to a long tradition in the development of flood protection system, including the preparation and update of the protection plans at the national, regional and local levels. With the aim of implementing the Law on Emergency Situations in part related to adopting the risk assessment and protection and rescue plans of Serbia, autonomous provinces and local governments from natural and other disasters, there is a need for further capacity building of competent authorities in order to apply the methodology of vulnerability assessment of the population and certain economy sectors to some natural disasters and multi hazard risk assessment, including the risk of climate change.

The Law on Emergency Situations and special laws regulating some sectoral aspects of DRR establish the obligation of all authorities to exchange relevant data and information. For example, the Republic Hydro-Meteorological Service of Serbia provides historical and operational meteorological and hydrological data, including the data on natural disasters of meteorological and hydrological origin, short-term, mid-term and seasonal weather forecasts, early warning and alarm on the occurrence of meteorological and hydrological disasters, hazard maps, vulnerability and risk of meteorological disasters, climate atlas, data of radar and satellite observations and climate and hydrological analysis and studies for the development of protection plans.

RHMSS operative drought monitoring procedures include the regular calculation of a number of well known moisture indices and other relevant parameters, as well as usage of some crop models. Within Meteorological sector of RHMSS, agrometeorological data are collected on soil moisture on 6 different levels up to 1m depth from 4 automated stations (Delta-T); phenological data are also collected from 52 phenological stations. Agrometeorological data for about 50 years are managed in an agrometeorological database. Moreover, data on heat waves are collected in critical phases of the development of dominant crops (winter wheat, corn) for 10 meteorological stations for the period 1949-2008. Moisture/drought conditions are monitored operationally by applying Standardized precipitation index (SPI) on the basis of collected daily precipitation data (P) from the network of main meteorological stations of RHMSS. SPI and several other drought indexes (PDSI, Z, Aridity Index (AI), Water Balance (WB)) for the period of 1949-2010 are stored and managed in the database. An assessment of drought consequences (foremost in agriculture) in the various regions of country is incorporated within the agrometeorological system. RHMSS drought analysis include the preparation of drought/moisture index on daily level. The indices are: Standardized precipitation index (SPI) for 1,2,3,6,9,12 and 24 months, Palmer`s indices (Z and PDSI), percents of normal and productive soil moisture storage. Used tools are Microsoft Office, MySQL, R.

Hydrological sector of RHMSS collects data on water level, discharge and temperature on the rivers, groundwater level and temperature. Yearbooks are prepared for each year. RHMSS doesn't collect data on the flood extent, impacts or damages, which are collected by local commissions at Municipality level. Flooded areas are estimated and only in some cases measured with geographical coordinates.

So far RHMSS doesn't use standard protocols for hazard data collection/management. Multiannual data series on different drought indices make possible the preparation of analyses on drought frequency, intensity and return periods. The preparation of drought hazard maps is in progress for various time periods (seasonal, critical periods in crop development). The same is being done with heavy precipitation conditions. RHMSS is also preparing an agro-climatic classification of the regions of Serbia on the basis of average annual precipitation and deficit/surplus in soil water balance. Concerning floods, RHMSS doesn't produces floods hazard maps.

RHMSS is partially using GIS technology, but it doesn't have a common geodatabase at service level, including all basic information. Based on those methodologies and tools, RHMSS produces bulletins and information (maps and graphs of draught/moisture indices, as deviations from normal, SPI and Palmer`s index, maps of agricultural draught probability, risk vulnerability). RHMSS doesn't have capacities in remote sensing applications in agrometeorology.

Currently, there are few other organizations archiving drought or flood related information: Republic Committee for Disasters; Ministry of Interior, Sector for Emergency Management; "Srbija Šume", Republic Directorate for Forestry; Ministry for Agriculture, Forestry and Water Resources, Directorate for Water, Flood Protection Sector.

SEM actually has few capacities for hazard mapping, nevertheless a map for 4 different types of hazard has been prepared, using past events, including floods and fires. SEM has also geographic data on vegetation and land use which are used for fire risk assessment, integrating the fire risk maps produced by RHMSS using the Canadian model.

WD and operationally the IWMJC are performing the preliminary flood risk assessment, according to the EU Directive on Floods. The IWMJC has built a geodatabase containing all the available information about floods, collected by local authorities and the Ministry of Interior, Civil Protection Department. Some impact data are available, e.g. the number of flooded houses and infrastructures) but not for all floods and only aggregated at Municipality level. Moreover the database contains some other basic geographic information such as the population density, land use, morphology, etc.

In general, disasters impact data are officially collected at local level by the local commissions, applying specific protocols for damage assessment, then they are transmitted to the special governmental commissions and finally stored at the Statistical Institute. Civil protection, insurance companies, Red Cross are also collecting impact data. Some data about drought consequences (foremost in agriculture) in the various regions of country are also available at the Statistical Institute aggregated at municipality level. Other data about drought impacts on agriculture are collected by Delta Generali insurance company. Concerning floods, the data also exists, including damages to property and persons. But all this data are dispersed and available with different levels of precision from different actors: Municipalities, Ministry of Agriculture, Institute of Statistics, Ministry of Finance, etc.

Floods impact data on agriculture are collected by the MAFWM, when the Municipalities ask for compensation in case that at least 30% of the cropping area is flooded.

WD collects data only for the damages on the hydraulic and flood protection infrastructures. A central database for hazard impact data and damages doesn't exist. Many institutions manage their own impact data, e.g. Municipalities, Ministry of Finance, Ministry of Agriculture, Statistic Institute, etc.

RHMSS used drought impact data on agriculture as feedback for validation/calibration of the drought monitoring system. RHMSS has analyzed drought/flood impact data also within the Program of adaptation measures of the First national report for UN Framework Convention on Climate Change and the spatial plan of the Republic of Serbia.

In the framework of the Delta Generali insurance project, the data on damages collected by the insurance company will be shared with RHMSS.

RHMSS provides and disseminates drought and flood information on regular basis. After all, some drought and flood information (relevant data sets, studies etc.) are delivered upon the request of various users. Most of drought and flood information, which are prepared on regular basis, are free. Users cover expenses of arrangement of the response to special requirements.

Outputs of RHMSS drought monitoring and analyses (indices and other relevant parameters, assessment of drought consequences, studies, etc.) are utilized by various users. There is a whole spectrum of usages for this information: from planning of field operations and plant protection activities to medium-term and long-term planning of agricultural production and economic ambient and policy. Almost there is no formalized feedback mechanism. Nevertheless, RHMSS takes into account feedbacks received on occasion of contacts with users any time when content of information is discussed. Demands received by feedback are incorporated into the further hydrological information and forecasts (specific forecasting locations, extended forecasting period, etc…). Increased demand for more specific and challenging products is noticeable, e.g. detailed spatial analyses, high resolution maps, outputs from crop yield and plant disease/pest models, long-range drought forecasts, as well as assessment of the effects of expected climate changes on the various aspects of agricultural production. In case of flood information, estimation is that information fully meets the users' expectation in almost any case.

7.3.4. Forecasting

RHMSS has operational weather forecasting service available 24/7 producing nowcasting products several times a day, 12 hour forecasts 1-3 times per day, 24 hour and 2-5 day forecasts once or twice per day, 10 days outlooks once a day, 30 days outlooks twice a month and seasonal forecasts (probability of air temperature and precipitation) once a month. Weather forecast for ten major towns in Serbia, for current day and tomorrow, is updated twice a day. The forecast products are available for public on the RHMSS webpages. In addition, specialized forecasts are produced several sectors:

- Air transport - two days ahead – twice a day;
- Electricity production – two days ahead – twice a day;
- Water management – differ types of forecasts with different delivery frequency;
- Agriculture: (i) one to three days ahead - once or twice a week (ii) seven to ten days ahead – once a week (iii) thirty days ahead – twice a month;
- Heating energy production and transmission: (i) one to three days ahead – once or twice a week, (ii) seven to ten days ahead – once a week, (iii) thirty days ahead – twice a month, (iv) seasonal forecasts 6 months ahead – once a month;
- Fire brigades – Forest fire index and weather forecasts depending on the forecast type;
- Road maintaining companies -as for heating energy sector;
- Governmental organizations – as for agriculture sector;
- Transport, Water transportation, Construction, Tourism, Utilities, Health sector - on demand.

7.3.4.1. Weather forecasting

Weather forecasting is based on NWP models. ECMWF and DWD model products are used for 7 days forecasts, the Serbian ETA model for 120 hours and the WRF-NMM (USA) for 72 hours forecasts. The verification of NWP products are done according of "Recommendations on the verification of local weather forecast", ECMWF, TECHNICAL MEMORANDUM, No, 430, December 2003.

For medium term weather forecast RHMS of Serbia uses ECMWF global model products for 10 and 15 days at 16 km horizontal resolution.

Table 44: NWP models used operationally by RHMSS

Model	Type	Data assim.	Horizontal grid size	Vertical levels	Time step	Daily runs UTC	Boundaries from
ETA	hydrostatic	no	18 km	32	45s	00 and 12	DWD
WRF NMM	non-hydrostatic	no	10 km	38	24 s	00 and 12	ECMWF
WRF NMM	non-hydrostatic	no	4 km	45	10 s	00 and 12	ECMWF

Since June 2009 RHMSS is using ENSEMBLE (Article 41) of ECMWF seasonal forecasts and seasonal forecasts produced by own regional climate model-RCM-SEEVCCC in the 30 km resolution and the length of 7 months.

The computing capacity available for running the NWP models consists of two Linux based systems:

- A newer HP CX3000bl Cluster consisting of 16 nodes (8 BL2x220c servers) with 3.0 GHz and 6 GB of DD2 memory;
- An older stand-alone HP rx3600 with two Intel dual-core Itanium2 processors. The system should be replaced with a state-of-the art computing system.

As there is need to go to higher resolution (horizontal scale, vertical levels, time steps) in NMP modelling there will be needs to enhance the computer capacity.

For visualization of Numerical Weather Prediction Products RHMSS uses its own graphical package named MICA (Meteorological Information, Charts and Animations), MetView and MAGICS, graphical system from ECMWF and Grads from NCAR (USA National Center for Atmospheric Research) and also Messir Vision. Editing tools allow the forecaster to work on observations, change soundings and forecasts. Visualization actually covers a vide range of products from analyse and forecasting maps, and charts, to digital analysing and editing of NWP products and observations. E.g. tailored ready-to-print products can be produced and sent automatically to each newspaper, or disseminated on the NHMS web pages. Typically the modern NHMSs, and especially the private commercial forecasting offices, have a fully end-to-end automated production system. These NHMSs have also invested significantly in proper number of experts working with software development.

RHMS of Serbia prepares also forecasts of clear air turbulence and icing for the area of Serbia, Montenegro, part of Bosnia and Herzegovina, Bulgaria, Romania and Macedonia.

7.3.4.2. Hydrological forecasting

RHMSS uses several forecasting methods for hydrological forecasting. For large rivers, forecasts are made for few days ahead applying models for water waves propagation (flood routing). For the Danube river correspondent discharge, for the Sava river multiple linear correlation and for the Morava river MANS modelling are used. Non-linear conceptual TANK / SSAR models, based on modelling of water balance component of the hydrological cycle, have been applied for Kolubara river basin. Input data are daily values of water levels, discharge, rainfall, and air temperatures from the reporting hydrological and meteorological stations in the Kolubara river basin as well as forecasted rainfall values obtained from numerical meteorological forecasting models. According to operational experience, the TANK model did not give satisfactory results because after a prolonged dry period empties deep tanks give, as a final result, total lack of flow in the river. For small rivers the graphical coaxial correlation method is used. Method takes into account precipitation index, number of week in the year, time of rainfall duration and total rainfall.
Ice events forecast for Danube, Tisa, Sava and Great Morava rivers are issued in winter by applying a method of physical - statistical dependence of total heat loss indispensable for ice occurrence and hydrological elements.

The products of NWP models (ETA model, NMM model with 4km resolution) and ECMWF model are used as input for hydrological/hydraulic models. The South East European Virtual Climate

Change Centre (SEEVCCC) runs also HYPROM (an hydrological model based on Mike11) coupled with the regional Climate Model WRF-NMM.

Table 45: Available hydrological models for flood analysis

Methods	Basins	Lead time
Method of corresponding discharge/water level	Danube and Tisa	4 days
Models based on multi-linear correlation	Sava, Danube, Tisa	4 days
Adaptive model MANS	Velika Morava	
HBV model	Jadar, Kolubara, Jasenica, Kubrsnica and Mlava,	3 days

RHMSS also receives the flood warnings from the European Flood Alert System (EFAS), as RHMSS has been the member of EFAS since 2007. EFAS products are regularly reviewed by the EFAS partner network which currently consists of 24 National flood forecasting centres across Europe. EFAS is currently under development at the European Commission Joint Research Centre. Serbia became member of the EFAS in 2007. The European Terrestrial Network for River Discharge (ETN-R) is an information infrastructure for the automated collection, quality control and redistribution of near real-time river discharge and water level data from 30 European national and trans-boundary river basins, involving in total 35 countries. The ETN-R project will promote the EFAS system.

Table 46: Characteristics of the meteorological forecasts used for EFAS flood warnings

Forecast name	Forecast range	Number of ensembles
Deterministic DWD	7 days	1
Deterministic ECMWF	10 days	1
Ensemble ECMWF	10 days	51
COSMO-LEPS	5 days	16

7.3.4.3. Air quality

RHMSS has several models for dispersion of airborne pollutants:

- AIRMOD - Gaussian plume dispersion, uses stability classes;
- ISC3 MODEL – Gaussian plume dispersion, can be used for point, area, line and volume sources;
- AFTOX - (Air Force Toxics Model) is a Gaussian dispersion model that will handle continuous or instantaneous liquid or gas elevated or surface releases from point or area sources. Output consists of concentration contour plots, concentration at a specified location, and maximum concentration at a given elevation and time;
- DREAM8 – a modified DREAM is used to model dispersion of dust particles which is run operatively once per day.

Dispersion models are linked to the ETA NWP model.

7.3.5. Warning products and services

7.3.5.1. Warnings and mandates

According to the laws RHMSS is responsible for monitoring, detection of hazards, forecasting and warning formulation and information dissemination for the following hydro-meteorological hazards: rotational high winds, flash floods, strong winds, hailstorm, thunderstorm or lightning, heavy snow, freezing rain, dense fog, heat waves: period of abnormally high temperatures, cold waves: period of abnormally low temperatures, drought, river flooding. Since the legal regulations concerning EWS are new, sets of bylaws and relevant technical regulations need to be reached for the purpose of governing all the technical issues in the process of making, issuing and dissemination of warnings.

The RHMSS Early Warning System is divided into two parts consisting of Meteorological Early Warning System and the Hydrological Early Warning System. The law, bylaws and technical regulations define different warning levels and their relation to emergency preparedness and response decisions, as well as actions at national to local levels. The meteorological early warning is based on use of up to 10 days weather forecasts produced by ECMWF and other international centers, RHMSS NWP modelling, observations and satellite data.

Table 47: Warnings for natural and technical hazards in Serbia, based on Annex 2

Hazard	Exists in the country	Warning by	Type	Warnings / year
Heavy precipitation	Yes	RHMSS	I	
Flash floods	Yes	RHMSS	I	
River flooding	Yes	RHMSS	I	15
Coastal Flooding	No			
Hailstorm	Yes	RHMSS	I	
Thunderstorm or lightning	Yes	RHMSS	I	
Heavy snow	Yes			
Freezing rain	Yes			
Dense fog	Yes	RHMSS	I	
Tornado or cyclone	No			
Strong wind	Yes	RHMSS	I	
Storm surge	No			
Heatwave	Yes	RHMSS	I	
Cold wave	Yes	RHMSS	I	10,4
UV Radiation	Yes	RHMSS	I	
Drought	Yes	RHMSS	I	0,1 – 0,2
Marine hazard	No			
Sandstorm	No			
Landslide or mudslide	Yes			0,3 – 0,4
Avalanche	No			
Airborne hazardous substance	Yes	RHMSS	I	1
Waterborne hazards	Yes	RHMSS	I	30-50
Hydrometeorological hazards for aviation	Yes	SMATSA	III	21-66
Hydrometeorological hazards to road and rail	Yes			31
Forest or wildland fire	Yes	RHMSS	I	105
Smoke, dust or haze	Yes			
Earthquakes	Yes			
Tsunamis	No			
Volcanic events	Yes			
Dispersion of insect pests	Yes			
Hazard for allergic reactions	Yes			

The RHMSS Hydroalarm is developed as a part of Hydrometeorological Early Warning System and European Flood Alert System (EFAS).The early warning for hydrological sector is based on NWP modelling of precipitation, taking into account other parameters, predicting of heavy precipitation which may lead to flooding. The flood warnings are divided into two phases:

- First flood alert is announced when water stages in the river reach established threshold which is determined for every river section;
- Second flood alert is announced when water stages reach established threshold which is one meter below the embankment crown.

Ice events forecast for Danube, Tisa, Sava and Great Morava rivers are issued in winter.

A forecast of Fire Weather Index is issued today at 13 hours in the CET in winter time and at 14 hours at summer and it is valid from noon until the day after next day at noon. FWI forecast is for information only.

For other hazards, such as airborne hazardous substances (i.e. nuclear, biological, chemical, etc.), waterborne hazards (i.e. nuclear, biological, chemical, oil spills, etc.) or others are charged by other state organizations. However, RHMSS is actively involved in the process of monitoring and detection of these phenomena.

7.3.5.2. Warning dissemination mechanism

RHMSS is in constant operational cooperation with the competent services of the issuance of warnings and alarming. Information and forecasts about the state of water regime and the weather and climate, early warning and warning are sent through TV and radio stations, by phone, by fax and E-mail (special bulletins), Website, SMS to the public and the following institutions:

a) Meteorological warnings:

- Ministry of Interior (Sector for Emergency Management);
- Emergency services (Center for informing and alerting of the City of Belgrade);
- Serbian Government;
- Media (radio and TV stations);
- Local authority and public utilities;
- Other departments of RHMS of Serbia (hail suppression department, hydrological department, agro-meteorological department, air and water quality control department).

b) Hydrological warnings:

- Ministry of Interior (Sector for Emergency Management);
- Ministry of Agriculture, Forestry and Water resources Management;
- Ministry of Environment and Spatial Planning;
- Ministry of Defense and Civil Defence Administration;
- Water management centres at the rivers Danube, Sava and Morava;
- Ministry of Energy and Mining;
- Ministry of Health;
- Public Enterprise ”Electric power industry of Serbia”;
- Republic information centre;
- Belgrade information centre.

RHMSS has not the mandate to cut radio or TV channels, or order the TV channels to add a banner with the given warning on the program. It must be noted, that homepage or website is not an active warning system, but rather a passive information system. In order to provide warnings in a simple, but still effective way, the RHMSS has prepared the National METEOALARM system in accordance to the EUMETNET METEOALARM system. The Meteoalarm system in Serbia has been in use operationally since 2009. RHMSS also receives the flood warnings from the European Flood Alert System (EFAS), as RHMSS has been the member of EFAS since 2007. Four levels of risk are identified. Each colour represents one level of the risk. Green colour means - no warning. Yellow - significant water stage rise or fall. Ice is in movement and covers from 10% to 40% of water surface. Events that could require undertaking of measures for first flood or ice alert. Orange - Very significant water stage rise or fall. Ice is in movement and covers from 50% to 100% (immovable ice) of water surface. Events that could require undertaking of measures for second flood or ice alert. Red - extreme hydrological events and conditions. There is the intention to begin to use the Common Alerting Protocol (CAP) for exchanging public warnings and emergencies.

7.3.6. Climate change analysis

Within the Belgrade Climate Change Initiative adopted by the UNECE Sixth Ministerial Conference “Environment for Europe” held in Belgrade, Serbia, in 2007, the sub-regional South East European Virtual Climate Change Centre (SEEVCCC) was established in Belgrade hosted by the Republic Hydrometeorological Service of Serbia.

The basic mission of the Centre is the support to the SEE countries in meeting the needs for information on sub regional climate change projections, impact, vulnerability and adaptation options on a continuous basis, through its operational, research, coordination and educational functions. The SEEVCCC in cooperation with Regional Environmental Centre for Central and Eastern Europe has developed the South East European Climate Change Framework Action Plan for Adaptation (SEE/CCFAP-A) for 2009-2015. The SEEVCCC will provide coordination and facilitate implementation of the SEE/CCFAP-A. In addition, within the WMO Regional Association VI for Europe (WMO RA VI) Strategic Plan for the Enhancement of Meteorological and Hydrological Services in the Region, the functions of the SEE-VCCC Centre and its priorities are defined under the WMO RA VI Resolution on Regional Climate Centre Network established in September 2009. . The main objectives of SEEVCCC are to:

- Further strengthening of cooperation between national hydrometeorological services in the sub-region in the field of climate change;
- Support for accelerated transfer of knowledge and technology in the field of regional climate modelling and other techniques of regionalization (downscaling);
- Application of research results in impact studies, vulnerability assessment and adaptation options;
- Support to personnel and institutional improvement of national hydrometeorological services in performing relevant tasks related to climate change, education and public awareness, including their contribution to the implementation of various Conventions (United Nations Framework Convention on Climate Change, UN Convention on Biological Diversity, UN Convention on Combating Desertification).

SEEVCCC has close cooperation with advanced and well known centers like KNMI-ECAD, DWD and ECMWF. Climate change analyses are based on dynamical modelling using the RCM-SEEVCCC coupled atmosphere-ocean model regional dynamical downscaling with the following characteristics:

- ECMWF initial and boundary conditions: 112km resolution;
- SEEVCC model resolution: ~35km atmosphere ; ~20km ocean;
- Model start: 16th of each month;
- Forecast duration: 7 months (~215 days);
- Wall time: 23h for 7months forecast;
- Computer resources, HPXC cluster 3000 BL, 16 nodes – 128 cores and 3 GHz cpu, are currently quite satisfactory, but requires more power and speed when the ECMWF model resolution increases or when the SEEVCCC model resolution needs to be increased.

Up to now the Center has developed long-term research agenda and made effort to strengthen partnership and cooperation with the industry in order to study impacts of climate change on different socio-economic sectors in time scales from nearest decades to hundred years. These studies are essential for strategic planning of the government and different industrial sectors.

7.3.7. Information Technology and Telecommunication capacities

Quick reliable communication system is critical for collection of data, data sharing and dissemination of products and warnings. Internet has become a very important tool among advanced NMHS to disseminate information and warnings. Currently RHMSS uses several types of communication systems to collect data from the observation networks. Use of GPRS system, which allows communication of large amount of data at low costs, is increasing allowing also collecting more data more often than earlier. RHMSS has recently purchased/received significant enhancement to their computing and data management system. However, the system is not yet duplicated or equipped with a proper firewall. Further modernization of the major IT components are expecting from bilateral cooperation with MeteoFrance International.

RHMSS is connected to Internet via wireless broadband with 10 Mbps capacity. The Regional Meteorological Data Communication Network (RMDCN) connection to the WMO-GTS is with 512

Kbps capacity, which is quite low for increasing data and information exchange. Serbia has in use the Terrestrial Trunked Radio (TETRA) system, which was specifically designed for closed communication use by European government agencies and emergency services. Currently RHMSS does not have access to the TETRA system.

Table 48: Equipment in use for data communication and warnings and other products dissemination

Telecommunication Equipment	RD	RI	SD	SI	RW	SW	Remarks
Telephone	X						
Mobile Phone	X						
Telefax				X		X	
Dedicated Leased Lines	X	X	X	X	X	X	
UHF radio transceiver	X						
Data Collection Platforms used to transmit data from AWSs	X						
Global Telecommunication system (WMO-GTS)	X	X	X	X	X	X	WMO Regional Meteorological Data Communication Network
Meteosat Second Generation Satellite system	X	X			X		
Internet	X	X	X	X		X	
Email			X	X			
Print media			X	X		X	
TV –national			X	X		X	
Radio			X	X			
Local radio			X	X		X	
Bulletins			X	X		X	
RD = to receive data/observations, **RI** = to receive information/products, **SD** = to send data/observation, **SI** = to send information/products, **RW** = to receive warnings, **SW** = to send warnings							

Table 49: Number of RHMSS 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	132		11			12						9		3	167
Maintenance	11							1							12
Telecommunication	10							1							11
Data management	14		8			9								3	34
Weather forecasting	18		22												40
Hydrological forecasting	3					7								1	11
NWP	1		6											1	8
R & D	3		10												13
Weather modification	156		35					1						9	201
Environment	20							10				7			37
Agrometeorology	2		3					6							11
IT personnel			2					2					2		6
Commercial services															
Accounting	5											4		2	11
General administration	13													4	17
Other								2							2
TOTAL	**388**		**97**			**28**		**23**				**20**	**2**	**23**	**581**
Female in % of total	30		30			40		40				60			31
Men in % of total	70		70			60		60				40			69

7.3.8. Human resources

The number of RHMSS staff was 582 in November 2010. Since 2007 the total number of staff has decreased by about 100 people. The number of observers is relatively high, as the number of manual observation stations is still quite high in comparison to modern NHMSs. Experts have good theoretical background and awareness of modern observation, production and dissemination technologies. The middle age of the academic staff is relatively high. During the last two decades RHMSS has lost qualified academic staff to other countries. Due to low salary and lack of attractiveness of the sector it has been difficult to get new young talented experts and academics to the RHMSS.

Data management, numerical modelling, digitalizing and visualization are the core areas of modern NHMSs. RHMSS has invested in data management, computing and software experts even if the number of these experts is still quite low compared to more advanced medium size EUMETNET NHMSs.

Table 50: Data management and computing experts of RHMSS

Title	Number	Comments
Communication experts	4	
Main computer experts	5	2 are external collaborators. They are available 24 hours a day.
"Helpdesk" experts	2	
Data base experts	3	Also engaged in quality control.
Quality control experts	3	
Software experts	6	
Web masters	1	External collaborator engaged under contract.

7.3.9. 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.

EU based hydrometeorological organizations provide most state-of-the-art models, software and tools to be utilized by the member NHMSs. The European NHMSs have globally an unique opportunity to benefit from the stat-of-the -art weather forecast modelling, medium-range weather forecast products at 16 km horizontal resolution (in near future at 8 km resolution) including the Extreme Forecast Index (EFI), re-analysing data to be used e.g. for climatological studies and the ECMWF super computer resources. The integration into the European hydrometeorological infrastructure was given the highest priority in the 2007 project in developing the capacities of the NHMSs to implement best European practices and to produce improved products and services in support of national economic development and DRR.

Since 2007 Serbia has become a Co-operating state of ECMWF, a member of EUMETSAT, EUMETNET and EUMETNET METEOALARM and the host of the regional South East European Virtual Climate Change Center (SEEVCCC). Currently RHMSS has good cooperation with RHMI of Republic Sprska and FHMI of Federation of Bosnia and Herzegovina in Bosnia and Herzegovina, NMHS of the former Yugoslav Republic of Macedonia, NHMS of Montenegro, NMHS of Albania NMS of Germany, NMS of France, NHMS of Russia, NMS of Romania, NHMS of Bulgaria, NMS of Hungary and within the area of hail suppression with the Bac-Kiskun county in Hungary. In accordance with these agreements, the exchange of data, forecast products and information, early warning of meteorological and hydrological disasters are carried out.

The exchange of hydrological data and forecasts is carried out on the basis of the responsibility of the Danube countries to exchange hydrological and meteorological data and hydrological forecasts via GTS (global telecommunication system) - that has been stipulated a long time ago by the decisions of WMO and the Danube Commission. Within the Danube Commission, the hydrological data from the Danube basin are exchanged for the navigation purpose. Within the Sava Commission, preparation of operative data exchange from the Sava basin is now in progress for the navigation purpose, flood defense and accidental pollution. There is bilateral water management cooperation with Romania and Hungary; activities are carried out from meteorological and hydrological field that stem from water management cooperation with these countries. The establishment of bilateral cooperation with Croatia is now in progress.

Table 51: International and regional cooperation activities of RHMSS

International and regional organisations and cooperation mechanisms	RHMSS status
WMO	member
WMO RAVI	member
RMDCN	member
IOC	no
UNISDR	cooperation
UNDP	cooperation
Red Cross	cooperation
EUMETSAT	member
ECMWF	Co-operating State
EUMETNET	member
METEOALARM	member
ECOMET	no
EUFP7 projects, networks	
EU JRC	
EFAS	member
EU PHARE	
EU CARDS, IPA	yes
EUCLID	no
EUR-OPA	Through Ministry of Interior
DMCSEE	yes
SEEVCCC	RHMSS is the host institute
SAVA Commission	member
NWP consortium	none
NMHS bilateral MoU	Republic Sprska and Federation of Bosnia and Herzegovina of BiH, FYR Macedonia, Montenegro, Albania, Germany, Russia, Bulgaria, Romania, France, Hungary

Within the Drought Management Center for South East Europe (DMCSEE) activities, RHMSS participate in the DMCSEE project in the frame of a transnational cooperation in Southeastern Europe as partner (RHMSS has signed the Cooperation Agreement).

SEEVCCC hosted by RHMSS as a member of WMO Pilot implementation plan for RA VI RCC Network provide operational climate services, monitoring and forecasting functions as well as highly recommended research and capacity functions aiming to strengthen capacity of NMHSs. In cooperation with WMO, SEEVCCC/RHMSS hosted a Regional Climate Outlook Forum (RCOF) for South East Europe (SEECOF).

European Union research and networking programs create consortiums of excellence, and provides good opportunities to NHMSs to network with more advanced NHMSs and commercial R&D companies and to strengthen their human and technical capacities. Up to now RHMSS has not exploited these opportunities due to quite poor understanding of the possibilities, lack of

networking with active EU research units and capacity of preparing applications and project proposals.

RHMSS participation in research and development programmes and projects concerns:

- Project DMC-SEE through the program of Transnational cooperation in SE Europe: RHMSS provide upgrading and verification of operative functioning of RHMSS system for monitoring and early warning against drought; analysis of drought vulnerability of certain areas and creation of risk maps;
- National Project: Hydrological Flood forecasting system for small and medium sized catchments in Serbia –RHMSS bilateral cooperation with Norwegian Water Resources and Energy Directorate (NVE);
- Program of transnational cooperation in SE Europe, Regional project: Assessment of flood risk for areas along the Danube that are prone to floods and creation of flood zone maps (DANUBE FLOODRISK Project);
- National project: Further improvement and development of Flood Forecasting Services in Serbia – RHMSS bilateral cooperation with NVE;
- Participation in the creation of hydrological and meteorological information required by the National Water management master plan;
- Participation in national multi-disciplinary research project related to climate change impact, vulnerability and adaptation, national spatial and protection planning against natural hazards and disasters.

7.4. Technical recommendations to strengthen NMHS capacities in support of DRR

The technical and human capacity and scientific skills of RHMSS are at a high level compared to most of the NHMSs in SEE countries. However, lack of modern weather radar technology, automated hydrological measurements, state-of-the-art communication facilities, experts and insufficient level of governmental appreciation and financing limits the capacity of RHMSS to produce state-of-the-art products and services for disaster risk reduction per the following technical recommendations:

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

1. The competence for issuing warnings has been defined by law and bylaws. Since these legal regulations are new, sets of bylaws and relevant technical regulations need to be reached for the purpose of governing all the technical issues in the process of making, issuing and dissemination of warnings;
2. There are needs to have ISO standardization for different activities within RHMSS.

Operational relationships with other agencies

3. There are needs to promote cooperation and strategic partnerships with other technical agencies in Serbia and with advanced EU NHMSs;
4. There are needs to foster the visibility of RHMSS in general and within the DRR management.

Monitoring and observations networks and data exchange

5. There are urgent needs to modernize the weather radar network in Serbia and to establish regional data exchange system in order to produce regional near real-time composite pictures;
6. There urgent needs to enhance the financial resources to maintain and upgrade the surface observation networks and increase the number of on-line meteorological and hydrological stations;
7. There are needs to establish the second upper air station and to implement the AMDAR system;

8. There are urgent needs to enhance regional real-time data exchange of hydrological and meteorological measurements.

Forecasting

9. There are needs to promote production of regional weather radar composite pictures to promote short term weather forecasts;
10. There are needs to promote use of weather radar data as input for numerical flood models;
11. Implementation of data assimilation in NMP modelling would promote quality of weather predictions and thus also other forecasts;
12. Membership in an international NWP model consortium would promote NWP modelling of RHMSS;
13. There is a need to improve the automatic analysing and editing tools to help the work of forecasters;
14. There are needs to promote provision of technical advice and specifications to enhance products and services to industry and disaster risk reduction applications;
15. There are needs to ensure adequate replacement of computers and components as the life cycle of them is quite short.

Hydrometeorological data management systems

16. There is an urgent need to initiate a data rescue programme to digitise and quality ensure the historical data;
17. There are need to enhance the capacity to use more data in real-time.

Hazard analysis and mapping to support risk assessment

18. There is the need of wide capacity building programs in vulnerability and risk assessment of all types of hazards;
19. There are needs to promote hazard mapping and risk analyses through digitalization of historical data;
20. There are needs to receive guidance and training in hazard analyses;
21. 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;
22. There is the need to develop a shared methodology for drought risk assessment and assessment of vulnerability to drought in agriculture;
23. There is the need to develop a shared methodological framework for the integration of climate change products in floods risk assessment;
24. There is the need of integrating climatic change analysis in disaster risk reduction and particularly in drought and floods risk assessment through guidance and training in the use of climate change information;
25. There is the need of agreed and shared methodologies for impact assessment and collection and management of structured and harmonised data on disasters impact necessary for vulnerability assessment;
26. There is the need of Training in GIS and remote sensing applications in agrometeorology.

Information technology and telecommunication issues

27. There is a need to improve the dissemination tools to enhance the quality of data available on internet, to produce automatically tailored ready-to-print products to media and to have automatic translation of forecasts to different languages;

Warning products and services

28. There are needs to provide further education and training for forecasting of natural and manmade hazards;

29. There are needs to enhance exchange of information (analysis, forecasts, bulletins) of airborne and waterborne pollutants;
30. There is a need to improve the warning dissemination mechanisms by utilizing the available infrastructure of the competent authorities;
31. There is a need to improve the degree of exchange with users, through the development of a drought information delivery system in the form of interactive service and through joint projects with the aim to demonstrate the benefits of drought information usage and to raise the overall awareness about importance of effective drought monitoring, risk assessment, preparedness and management;
32. There is a need to enhance the awareness of the public of warnings.

Climate change analysis

33. There is a need to develop climate change impact studies in cooperation with DRR, industry and other sectors taking into account also shorter timeframes with regard to investments.

Human Resources

34. There are needs to enhance the educational (academic) level of the staff;
35. There is a need to enhance the R&D capacity and participation in EU R&D projects;
36. There is an urgent need to employ meteorologists, hydrologists, NWP experts, ICT experts and data management experts;
37. 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.

Regional cooperation

38. 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;
39. Risk assessment at regional, national and local level is the foundation for development of agreements and implementation plans;
40. 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;
41. 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 established NWP model consortium or become members of existing NWP model consortiums. Linkages between NWP models and hydrological models should also be developed for a better flood forecasting;
42. A regional harmonization of watch and warning systems should be promoted;
43. Cross-border exchanges of real-time data, forecasts and warnings should be increased;

7.5. Recommendations from the Serbia 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 Belgrade, on 25-26 October 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 encourage all existing disaster risk reduction actors in Serbia, as defined by the existing legal framework, to work together and invest additional efforts in recognizing and fulfilling existing disaster risk reduction tasks and responsibilities.

Recommendation 2: To strengthen coordination, strategic planning and management of disaster risk reduction at the national level through the establishment of the National Platform as a multi-stakeholder national mechanism that serves as an advocate of disaster prevention and disaster risk reduction; provides coordination, analysis and advice on areas of priority; and undertakes strategic DRR planning and management.

Recommendation 3: To further facilitate and enhance establishment of mirrored/similar/same mechanisms at the regional and local levels through strengthening and reinforcing local capacities, institutions and governance capabilities.

Recommendation 4: To develop the National Strategy for DRR and protection in emergencies and corresponding Implementation/Action Plan as a first mutual step undertaken by the key disaster risk reduction actors, e.g. the Sector for Emergency Management of the Ministry of Interior, the Republic Hydrometeorological Service of Serbia, the Republic Seismological Institute , line Ministries and respective public enterprises, the Serbian Red Cross, research and education institutions, NGOs, civil society and business community toward integration of disaster risk reduction into the development policies, strategies and sectoral plans, followed with the implementation of the National Strategy.

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

Recommendation 5: To enhance the early warning system and the establishment of the 112 system based in the Ministry of Interior through modernization of the continuous and real-time collection and information sharing by expanding the hydrological, meteorological, air, water, land, and biodiversity quality monitoring networks, establishing an integrated protection and rescue system and ensuring functional horizontal and vertical links among all disaster risk reduction actors.

Recommendation 6: To strengthen technical and human resources of the Republic Seismological Institute of Serbia, and enhance the modernization and improvement of the seismological monitoring network and data transmission system and of the Republic Hydrometeorological Service of Serbia in operational monitoring, warning, forecasting and mapping of hydrological, meteorological, climate-related and ecological risks.

Recommendation 7: To increase the awareness of the citizens and media regarding the early warning system and the Single European Emergency Call Number 112 as well as to raise public awareness and to inform and educate the population on disaster prevention measures.

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

Recommendation 8: To encourage mainstreaming of disaster risk reduction into national educational curriculum by establishing Curriculum Revision Working Group composed of the representatives from the Ministry of Education, from the Sector for Emergency Management of the Ministry of Interior, the Republic Hydrometeorological Service of Serbia, the Republic Seismological Institute of Serbia, other respective line Ministries, the Serbian Red Cross, NGOs, international organisations, expert organizations and individuals as well as research and education institutions.

Recommendation 9: Coordinated DRR research should be undertaken to improve methods for predictive multi-risk assessments and socioeconomic cost–benefit analysis of risk reduction actions at all levels. These methods should be incorporated into decision-making processes at regional, national and local levels. Strengthen the technical and scientific capacity to develop and apply those methodologies, studies and models, including the improvement of regional monitoring capacities and assessments.

HFA priority 4: Reduce the underlying risk factors

Recommendation 10: To incorporate disaster risk assessments into the urban and spatial planning and management of disaster-prone human settlements, in particular highly populated areas and quickly urbanizing settlements. The issues of informal or non-permanent housing and the location of housing in high-risk areas should be addressed as priorities. Also, to mainstream disaster risk considerations into planning procedures for major infrastructure projects, including the criteria for design, approval and implementation of such projects and considerations based on social, economic and environmental impact assessments.

Recommendation 11: To develop national capacities for climate services to support medium and long-term sectoral planning through strong collaboration and cooperation across line ministries and with the Republic Hydro-meteorological Service of Serbia, and through enhanced regional cooperation with other South Eastern European and EU countries and Centres.

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

Recommendation 12: To further strengthen operational cooperation of the Sector for Emergency Management of the Ministry of Interior and the Republic Hydro-meteorological Institute of Serbia through joint training and improvements to the standard operating procedures across agencies linked to the different threat levels and lessons learnt from each disaster event.

Recommendation 13: To strengthen technical and human resources of the Sector for Emergency Management, build capacities of the operational units within the Sector and strengthen regional cooperation and collaboration on the technical level through joint training.

Recommendation 14: To enhance the development of the National Training Centre of the Sector for Emergency Management, i.e. to augment the implementation pace of the National Training Centre Action Plan (as defined by the USAID funded PPES Program) and promote education and training of individuals to properly respond in case of disasters.

Recommendation 15: To proceed with the establishment of the Regional Centre for Emergency Management in Serbia, which will serve as a training centre and as preparedness and response coordination and management centre in the South Eastern Europe, where multi-hazard rescue teams and first responders of different expertise will be situated with all necessary personal and team equipment and emergency relief goods, and which will be part of the network of regional centres of excellences promoting regional cooperation in disaster risk reduction in South Eastern Europe.