5. CHAPTER FIVE: METEOROLOGICAL, HYDROLOGICAL AND CLIMATE SERVICES TO SUPPORT DISASTER RISK REDUCTION AND EARLY WARNING SYSTEMS IN THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA

The Former Yugoslav Republic of Macedonia is highly exposed to natural hazards like flood, drought, heavy rainfall or snowfall, wind storms, heat waves, landslides, avalanches, forest fires, airborne sand from deserts and some epidemics which are directly or indirectly related to hydrology, meteorology and weather conditions.

This chapter presents all the findings related to the assessment of the Disaster Risk Reduction (DRR) institutional framework and the technical capacities of the NMHS of the Former Yugoslav Republic of Macedonia (Hydrometeorological Service, hereafter referred to as HMS) to support DRR. It highlights that:

- Currently HMS does not have the technical, human and financial resources to fully support risk assessment and early warning systems of hydro-meteorological hazards;
- It is critical to upgrade and modernize the national hydro-meteorological monitoring and information exchange network and the forecasting system and to provide sustainable organizational resources, human resources (education and training, IT expertise, international cooperation and networking) and technical resources (upgrade the automatic hydrological and weather radar network, integrate hydrological models in NWP modelling, integrate air pollution dispersion models with NWP modelling) and increase the budget available to HMS for efficient meteorological and hydrological disaster risk monitoring, forecasting and warning;
- It is necessary to enhance investments in climate modelling and analysis in cooperation with SEEVCC to support strategic and sectoral planning for at-risk sectors and investment plans of industry in order to promote economic development of the country;
- Development of Risk Assessment, MHEWS and other capacities to support national risk management could also benefit from regional coordination and cooperation, leveraging expertise, capacities, resources and information across the region among IPA beneficiaries and with various regional centers in Europe.

5.1. Vulnerability to hydrometeorological hazards in the former Yugoslav Republic of Macedonia

5.1.1. General overview of the country's economic sectors

Macedonia is a small economy with a gross domestic product (GDP) of about $9.4 billion (2009). It is an open economy, highly integrated into international trade, with a total trade-to-GDP ratio of 81.6% at the end of 2009. Agriculture and industry have been the two most important sectors of the economy in the past, but the services sector has gained the lead in the last few years. In terms of GDP structure, as for estimations 2010, the service sector constituted by far the largest part of GDP at 58.3%, up from 54.2% in 2000. The industrial sector represents 29.6% of GDP, down from 33.7% in 2000 while agriculture represents only 12.1%. Textiles represent the most significant sector for trade, accounting for more than half of total exports. Other important exports include iron, steel, wine and vegetables, food items, tobacco. The imports include automobiles, machineries and equipments, food products, fuels, and chemicals. Serbia, Montenegro, Greece, Turkey, Russia, Germany, Italy, Belgium, Spain, Bulgaria, Slovenia and Croatia are the predominant trading partners of Macedonia.

5.1.2. Hydrometeorological hazards in the former Yugoslav Republic of Macedonia

Most of the natural hazards in the former Yugoslav Republic of Macedonia are related to hydrometeorology and weather and climate conditions; droughts, winds and storms, heavy rains, river and city floods, flash floods, landslides, wild fires, extreme temperatures… Besides the hydrological and meteorological hazards, there are many other weather depending hazards affecting FYR of Macedonia like allergic reactions to dispersion of pollen, smoke and other air borne pollutants, dispersion of insect pests, slippery roads, diseases and many other things. The analyses conducted within the SEEDRMAP and SEEDMAI programs in 2008 risk analysis, show that regionally, the Former Yugoslav Republic of Macedonia ranks 4th by number of disasters and 4th by degree of disaster consequences in South East Europe. The 2007 UNDP report on the 1993-2007 period counts 16 major disasters caused by natural hazards with 122,000 people affected and US$ 441 million worth of damage.

The frequency and intensity of floods in the past several years in the Former Yugoslav Republic of Macedonia are on the rise. Statistics show that floods are caused by overflow of the large rivers Vardar, Crna Reka, Strumica, Treska, Pcinja, Lepenec and Bregalnica. 44% of all disasters in the 1989-2006 period were floods or flood related disasters. There were two major floods in 1962 and 1979 with damage ranging between 7.2 and 7.4% of the GDP. The 1993-2007 UNDP report, registers seven floods affecting 111,400 people and causing an estimated damage of around US$ 353,600. Only in 2004, intense rainfalls, caused floods and torrents affecting 26 municipalities (mainly in the area of upper Vardar, but also in the central, southern and south eastern part of the country) with estimated damage of 15 million Euros. Most of the damage from floods was caused in rural areas by flooding households and arable land. Concerning the impact of climate change on the Former Yugoslav Republic of Macedonia's water resources and extreme hydrological phenomena, the risks from intensive torrents and prolonged droughts are expected to increase.

Forest fires (95% caused by man) are recognized as one of the risks the Former Yugoslav Republic of Macedonia most often faces. In the 2003-2007 period, 1,329 fires were reported with 94,000 hectares burned. The area affected and the economic consequences of forest fires in the past few years support the previous conclusion. One of the most frequent and often crucial causes is weather, i.e. climate characteristics and extreme temperatures, which cause rapid and easy burning of the dry and flammable material. The Macedonian Forests Public Enterprise manages 935,000 ha or 90% of Macedonian forests and almost all of the state owned forests. Only a small share is managed by the National Parks Directorate and other public utility enterprises.

According to the 2008 SEEDMAI analysis, 13% of all disasters caused by natural hazards are related to extreme temperatures. Extreme temperatures and heat waves or cold waves are caused

by climate effects. They have direct influence (diseases and fatal conditions) and indirect influence (effects caused by extreme weather conditions like floods, droughts or storms) on people's health.

According to climate change studies, projected changing climate and increasing climate variability in the region indicate a growing risk for extreme hydrometeorological and climate-related events in the region. Additionally along modernization of the societies they become more vulnerable to natural hazards. Better use of hydrometeorological data in planning and improvements in early warning systems can help to prevent hazards from becoming disasters.

5.1.3. Sectoral analysis of the vulnerability to hydrometeorological hazards

In Macedonia, the most sensitive economic sectors to hydrometeorological hazards are: the water management, the agriculture and forestry and the tourism sectors.

Water is a critical natural resource. The total water resources of Macedonia are estimated at: 18.8 km^3 from rainfall (with a 733 mm average rainfall); 6.36 km^3 discharged from the river basin areas; 0.52 km^3 groundwater; and 0.42 km^3 from the largest springs. According to the World Resources Institute, the annual water resources per capita for the Republic of Macedonia are about 3 137 m^3/year, while the average value for Europe is 10 680 m^3/year. Irrigation is the major user of the total water demands in the country, about 40%. According to the 2002 census, the number of households connected to public systems for water supply in urban areas is 82% to 100%. In rural areas, this percentage varies from 10 and 100. For urban water supply, both surface and ground water are used, as well as a combination of the two sources. The variations in the hydrological cycles of the rivers in the country are determined by the seasonality of the precipitation and the temperature.

There is a general trend of reduction of the annual values of the average discharges for all river basins in the country. The same trend is defined for the minimum and maximum annual discharges for the whole territory of Macedonia. The reduction of the average annual discharges is the most pronounced for the river Bregalnica at the Stip hydrological station and for the river Strumica at the Novo Selo hydrological station, i.e. in the region with a moderate-continental-sub-Mediterranean climate. The results indicate that river basins with a low precipitation would be severely affected by climate change. The series of average annual discharges for river Bregalnica at the Oci Pale hydrological station is characterized by a descending linear trend. Reduction of the decade discharges for the period 2000-2003 compared with 1961-1970 is 36%. The situation with the average annual discharges recorded for the same river at the downstream hydrological station at Stip shows a more drastic reduction, which, for the period 2000-2003, compared with the decade 1961-1970 is 58%.

The occurrences of extreme hydrological events (floods and droughts) have increased in frequency and intensity over the past decades. For example, during the last three decades regional floods caused by the biggest rivers in Macedonia – Vardar, Crna Reka, Strumica, Treska, Pcinja, Lepenec, and Bregalnica – caused an estimated total damage worth USD 193.8 million. The damage caused by floods directly affects the already fragile agriculture and local rural economies. In June 2004 the occurrence of high, intensive rainfall, caused floods and flash floods in 26 municipalities in the country located in the upper Vardar and in the central south and south-eastern part of the country. Economic losses experienced during the flash floods in 2004 show that 91.3% of the total damage is attributed to the agricultural production mainly in the south-eastern part of the country (Report of the State Commission, 2004). The biggest losses have been experienced in the rural areas where households and cultivated areas have been flooded.

In general, the country has difficulties coping with extreme hydrological events (droughts and floods) due to a lack of finance, technical, and institutional capacities as well as legal instruments.

Agriculture is a key sector in the Macedonian economy. Based on year 2010 data, it currently contributes an estimated 12% to GDP and is the only sector to have increased output since

independence. If the processing activities are also encountered, the agriculture-related contribution to the GDP is some 18%. Within the country, some 50% of the total area of 2.57 million ha is classified as agricultural land. Of this resource 51% is classed as cultivated land and the rest as permanent pastures. The cultivated land is largely centered on valleys or old lake basins and an extensive area of it is irrigated. Although there has been a recent trend toward intensification and specialization, particularly with livestock and vegetable production, private farms tend to be highly diversified and grow a comparatively large number of crops. This diversification is partly due to a tradition of self-sufficiency in basic food needs and partly a risk-aversion strategy in response to climatic variation and unreliable markets. Typically, the smallholder farmer plants cereals, vegetables, fruit trees and livestock for self- sufficiency and, for cash crops, a similar mix, plus tobacco and grapes.

Macedonia is among the most arid areas in Europe. Drought is very frequent and can occur with various duration and severity, causing frequent damages to agricultural sector, mostly expressed as reduced yield. Due to this Macedonia developed irrigation schemes that cover almost one fourth of the arable land in the country (120 000 ha under irrigation) but only 20-30.000 ha are actually irrigated and most of Macedonian agriculture depends on rains and is very vulnerable to drought. In Macedonia there is not an operational monitoring or early warning system to support the agricultural sector in order to cope with drought phenomena. The most vulnerable agricultural zone is Povardarie region, especially the area of the confluence of the Crna and Bregalnica rivers with the River Vardar (Kavadarci as a corresponding meteorological station). Other highly vulnerable zones are: (i) the Southeastern part of the country (Strumica); (ii) the Southern Vardar Valley (Gevgelija); (iii) the Skopje-Kumanovo Valley (Skopje); and (iv) Ovce Pole (Stip).

Frequent and intensive droughts exacerbate social and economic conditions in the rural parts of southern and eastern Macedonia. For example, a prolonged drought in 1993 damaged most of the crop yields and in many cases resulted in a total crop failure. At the countrywide level, the damage caused by this drought amounted to 7.6% of the total national income.

According to the Annual Report of the Ministry of Agriculture, Forestry, and Water Economy (MOAFWE) for the year 2005, the animal breeding sector has been rather stable over the last seven years. Animal production in a broad sense is affected directly and indirectly by climate variability and change. Direct effects are correlated to projected temperature increase and increased heat stress on domestic animals. Indirect effects are correlated to the projected decrease of forage production, as well as in emerging diseases. It is expected that a shortage of locally produced animal fodder will decrease the amount of animal products in the country. It can be foreseen that some tropical diseases, especially those transmitted by insects, will leave their natural basin of endemia to spread to other countries out of their natural habitat.

The total forest land in the country is 11,596 km^2, out of which forests comprise 947,653 ha. The total wood mass is 74,343,000 m^3, and the total annual increment is 1,830,000 m^3 with an average annual increment of 2.02 m^3 per hectare. Some of the main threats and problems in forest management and governance are: illegal logging, forest fires, which have affected nearly 100,000 ha in the last ten years, climate change impact through the increased forests dieback process, insect calamities, and diseases. Based on past experience, as well as on the results from climate change scenarios, climate change impacts on forestry might be manifested through: a more intensive process of morphological changes to oak and fir; increased number of forest fires and burned area, due to the increased percentage of dead trees; and migration of tree species towards higher altitudes. Among the most important factors influencing forest fires, often decisive, are the weather conditions, more precisely the climate characteristics of the region. In the period 1999-2005 a total of 1,191 forest fires were recorded, with a burned area of 59,500 ha. and over 28 million total economic loss. The largest damage occurred in 2000, when the burned area was 46,000 ha. In the summer of 2007 Macedonia experienced extended wildfires, which severely affected forests and other vegetation over an area exceeding 40,000 hectares. One of the contributing factors was climate condition, i.e. a dramatic heat wave and the highest temperatures ever recorded along with the prolonged dry period pushed the usual summer forest-fire season

drastically beyond its usual pattern. It is evident that forest fires not only destroy the biodiversity, change the micro-climate, and create potentials for erosion, but also cause enormous economic losses, which will take decades to be recovered.

With its lakes and mountains, more than 1,000 churches and monasteries, and more than 4,200 archaeological sites, Macedonia has a strong tourism potential. Mountain and lakeside tourism are the most attractive and revenue-raising in the country. On the other hand, these destinations are considered particularly vulnerable to climate change, as they are nature-based tourism destinations and all outdoor tourism activities are dependent on favorable climate conditions. The summer season could be extended as a result of the temperature rise, as per climate change scenarios, which could be of benefit, bearing in mind that these sites generate the highest revenues from tourism. But drought conditions could affect lake water levels and water supply. The water consumption needs of tourists have to be considered, especially in the Crn Drim catchment area. Tourism is also a large consumer of water per capita. Bigger water consumption would require provision of a new potable water supply resources, and construction of new sewage systems for both households and industry, especially for the tourist destinations. Inevitably, energy consumption will increase, also as the need for cooling of indoor premises becomes essential with the temperature increase. Increased duration of heat waves can have adverse affects on water quality, and can also be related to the higher risk of forest fires in tourist areas. Scenarios of climate change developed at the national level show an increase in the winter temperature, also accompanied with less snow coverage and later start of the skiing season.

5.2. Institutional Framework of Disaster Risk Reduction in the former Yugoslav Republic of Macedonia

5.2.1. Legal framework

In general, the disaster risk reduction policy and strategic framework in FYR of Macedonia are not defined in a single document (Figure 23). The Law on Protection and Rescue[5] and the Law on Crisis Management[6] are the key laws elaborating disaster risk reduction (DRR) policies. Both laws were adopted within one year (2004-05).

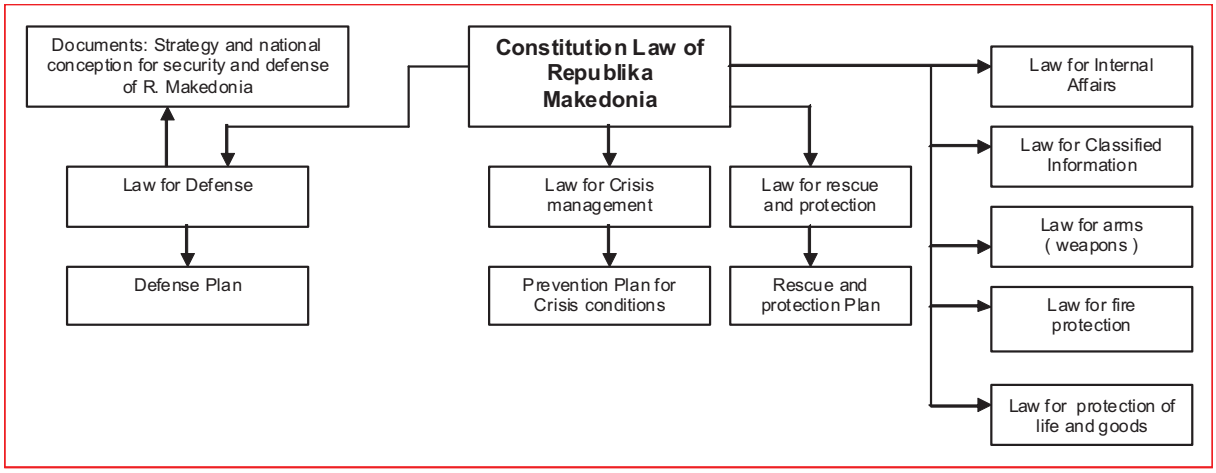

Figure 23. Legal framework for DRR in the FYR of Macedonia

The Law on Defense foresees transformation of the Civil Protection and fire fighting sectors and establishes a Protection and Rescue Directorate as an independent state administration body and a separate legal entity. Part 3 (Crisis Management) sets the foundation for the Crisis Management System (CMS), which is further regulated in the Law on Crisis Management. Then, this document

[5] Law on Protection and Rescue, Official Gazette of the Republic of Macedonia No. 36/04 of 10.06.2004.
[6] Law on Crisis Management, Official Gazette of the Republic of Macedonia No. 29/05 of 04.05.2005

envisages establishment of two new institutions – a Protection and Rescue Directorate (PRD) and a Crisis Management Centre (CMC). Within the relevant laws, they deal with policies, institutional setup, measures and activities for dealing with natural or technical and technologic disasters or states of crisis.

The Law on Protection and Rescue regulates the system for protection and rescues of people and goods against natural disasters, epidemics, epizootics, epiphytotics and other disasters in peace and war. Based on the Natural Disaster and Other Accident Risk Assessment, adopted by the Government, the protection and rescue system participants make Protection and Rescue Plans. Articles 50 to 56 of Chapter VIII (Protection and Rescue Measures) define prevention measures for the protection and rescue system. Article 51 defines the prevention measures that the system participants shall implement: make an endangerment assessment for possible hazards and a Protection and Rescue Plan; incorporate those measures in the regular plans and operations; spatial planning and construction of protection and rescue facilities; establishment and organization of a protection and rescue system; provide financial, human and other resources.

Under the Law on Crisis Management, the Crisis Management System is organized and established for prevention, early warning and handling of crises that put at risk goods, health and life of people and animals, which have been caused by "natural disasters and epidemics or other risks and hazards which directly endanger the constitutional order and security" of the country or any part of it, when a state of emergency or war could not be declared. The CMS includes information collection, situation assessment and analysis, setting goals and tasks, development and implementation of prevention activities, early warning and crisis management. Under Article 2, the CMS is implemented by: the state administration and state authorities (Parliament, President and Government), the armed forces, the protection and rescue forces, the municipal and city of Skopje authorities, the public enterprises, institutions and services (including HMS), companies, civil associations, the Macedonian Red Cross, charity organizations and the media. Article 12 of the Law on Crisis Management establishes a national CMS institutional framework, consisting of a Steering Committee (SC), an Assessment Group (AG) and a Crisis Management Center (CMC). These bodies' role is to facilitate and coordinate the proposal of decisions and to provide for consultations, coordination, timely response, efficiency and adequate use of available resources in times of crisis, as well as to provide for timely quality and realistic assessment of threats from risks and hazards to the country's security.

The main strategic documents that may help assess how much DRR is integrated are: the National Security and Defense Concept (2003), the National Protection and Rescue Strategy (2009), the National Economic, Social and Environmental Sustainable Development Strategy 2009-2019; the Health Strategy 2020; the Strategic Commitment to Environment Protection contained in several documents.[7]; the EU Integration Strategy.[8] These documents define the framework of the national development policy, security and defense policy, and protection and rescue policy.

The National Protection and Rescue Strategy (NPRS) was adopted on 18 February 2009[9]. This document contains the principles, vision and objectives of the protection and rescue system, and guides its development and upgrade in line with international standards. The strategy, more precisely than the Law on Protection and Rescue, defines risk management (prevention, impact mitigation, preparedness and recovery) and sustainable development policy, as integral parts of the protection and rescue system. It requires the existence of a Methodology for the Content and

[7] Second National Environment Action Plan of the Republic of Macedonia (NEAP II, 2006), Environment Monitoring Strategy (2006), Environmental Public Awareness Raising Strategy (2005), Environmental Data Management Strategy (2005), Vision 2008 (2004), Spatial Plan of the Republic of Macedonia (2004), Energy Efficiency Strategy 2020 (2004), and National Health and Environment Action Plan (1999); National Strategy for Environmental Legislation Approximation, September 2007, project, *Ref. No.: 05MAC01/13/001-EuropeAid/121312/D/SV/MK*

[8] Law on Ambient Air Quality (Official Gazette of the Republic of Macedonia number.67/04 и 84/07); and Law on Water (Official Gazette of the Republic of Macedonia No. 87/08).

[9] The Parliament adopts the Strategy and decides on the protection and rescue budget. The Government determines and proposes the Strategy, adopts a decision on establishment of protection and rescue forces, adopts a decision on material reserve, distribution of humanitarian assistance, training and exercise activities, population evacuation and the value of damage.

Manner of Hazard Assessment; Protection and Rescue Planning and Natural Disaster and Accident Assessment, as well as a Protection and Rescue Plan.

The Protection and Rescue Plan, adopted in 2006, regulates management, protection and rescue in local government units, companies, public enterprises, institutions and services.

FYR of Macedonia initiated its National Platform for Disaster Risk Reduction (NPDRR) in December 2007. In July 2011 the third revised edition of NPDRR is adopted. The initial goal of the NPDRR is to provide a link among entities involved in disaster prevention and management.

The obligations and mandates of the HydroMeteorological Service (HMS) are properly described in the new Hydrometeorological Law issued in 2009. The law describes in details the role of the HMS. In preparation of the new law, the WMO recommendations and views have been taken into account. A new strategy for HMS has been adopted for 2008-2011, and it has been published also in official gazette. HMS has the mandate to produce commercial services and products. However, the revenue from commercial services is an income to the budget of the government. The new Hydrometeorological law includes a special topic of DRR, concerning communication and cooperation with CMC in case of hazard. According to the Law, HMS is a part of the National System for prevention and mitigation the consequences of disasters, and other urgent situations for protection of life and goods. In case of weather or flood disaster, HMS is acting according the regulations for crisis management, rescue and protection.

Environmental policies at strategic level are covered by the National Sustainable Development Strategy (NSDS) and by the National Environmental Action Plan (NEAP). In addition, the European Partnership signed in 2004 identifies that National Sustainable Development Strategy is required in priority areas. The country's Constitution and the Law on Environment contain sustainable development principles. In line with UN recommendations from the Rio Conventions and the Framework Convention on Climate Change, the First and Second National Communication on Climate Change have been prepared in 2003 and 2010[10]. Long-term impact of climate change is expected in the most vulnerable sectors: agriculture, forestry, water resources, biological diversity, health and tourism. The sectoral analysis of sensibility to climate change of 2006 was based on the climate change until 2006 and the expected scenarios of climate change for the particular regions in the state (until 2100). The Ministry of Environment and Physical Planning is responsible for coordination of climate change related activities. There is a Climate Change Project Unit in the Ministry of Environment and Physical Planning providing logistics support to the National Committee on Climate Change which is responsible for monitoring and coordination of the Convention implementation.

The Spatial Plan of the Former Yugoslav Republic of Macedonia (SPRM) is a management document and an integrated developmental project defining the spatial organization of the state and the objectives and concepts of spatial development. Item 7.2 of this document defines protection measures against natural disasters in more detail (protection against strong earthquakes, fires, floods and against other weather related disasters).

The National Development Plan 2008-2013 defines the development priorities of the Former Yugoslav Republic of Macedonia, therein recognizing the need to replace the traditional development concept with a new one, bringing economic growth policies closer to modern environment and nature protection standards, energy and resource savings and development of environment friendly technologies. The Development Plan include flood protection which links

[10] The drafting of the Convention on Climate Change began on 4 June 1992 at the Earth Summit in Rio de Janeiro, a conference organized by the United Nations on Environment and Development. It entered into force on 21 March 1994. The Republic of Macedonia ratified it with the Law on Ratification on 4 December 1997 (Official Gazette of the Republic of Macedonia No. 61/97), and entered into force on 28 April 1998. The Macedonian Parliament ratified the Convention on Biological Diversity in 1997 and became member on 2 March 1998. In 2000, the Ministry of Environment and Physical Planning set up a National Committee on Biological Diversity, an obligation arising from this Convention. In 2004 Macedonia ratified the Kyoto Protocol and in September 1998 the Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects.

development to water and calls for the following measures: sustainable water management and use of water resources; ensure sufficient quantities of quality water and mitigate consequences of water shortages; protection against and mitigation of consequences from harmful water effects; protect and preserve water; rationalize and reduce water spending for irrigation; develop water resources, provide new water reserves and quantities. The protection of air quality is discussed in the Plan on the Protection of Environment and Nature.

Macedonia ratified the UNCCD in 2002. The responsible organization is Ministry for environment, HMS in accordance with above Ministry and MAFW is responsible for preparation for National plan against desertification.

5.2.2. Institutional framework

5.2.2.1. List of agencies involved in DRR for hydrometeorological hazards

- Crisis Management Center
- Protection and Rescue Directorate
- Hydrometeorological Service of Republic of Macedonia (HMS) - Ministry for Agriculture, Forestry and Water Management

5.2.2.2. Crisis Management Center

The Crisis Management Centre (CMC) is an independent governmental body and a separate legal entity, a Directorate by position and function. The CMC started its operation in October 2005 and based on the Law on Crisis Management it has the responsibilities to ensure coordination, cooperation and communication of the National Crisis Management System (CMS). The competences of the CMC are the following:

- Providing crisis management support to the National Crisis Management System;
- Coordinating the national measures and activities for crisis prevention, early warning, alarming and response;
- Collecting, processing, analyzing and assessing information/data related to relevant risks and hazards;
- Preparation and updating of a unified assessment of all risks and hazards to the security of the country;
- Providing guidance and proposing measures and activities for the crisis management system entities etc..

On the operational level, CMC is working permanently 24/7 in 8 sectors (Regional offices in Skopje, Tetovo, Kumanovo, Stip, Strumica, Veles, Bitola, Ohrid) and 27 Regional Crisis Management Centers.[11] They are in charge of information, situation monitoring, data and information exchange, and proposal of crisis management and assessment measures. The Regional Centers set up regional staffs, which are composed of representatives from the ministries' local branches and from other state administration bodies, plus one municipality representative and a representative of the city of Skopje in their regional centers. The regional staffs get activated upon a decision of the CMC Director.

The CMC organizes information and alerting for early warning, situation monitoring, timely identification of phenomena and processes, which threaten state security and/or may lead to crisis, to inform the entities of the crisis management system and the population. Thus, the Center operates a single communication and information system with a single country-wide call number for risks, hazards and other accidents. The single communication and information system operates 24 hours a day, seven days a week.

[11] The centers are located in the following municipalities: Berovo, Bitola, Valandovo, Veles, Vinica, Gevgelija, Gostivar, Debar, Delcevo, Demir Hisar, Kavadarci Kicevo, Kocani, Kratovo, Kriva Palanka, Krusevo, Kumanovo, Makedonski Brod, Negotino, Ohrid, Prilep, Probistip, Radovis, Resen, Sveti Nikole, Struga, Strumica, Tetovo, Stip, Gazi Baba, Karpos, Kisela Voda, Centar, Cair and the city of Skopje.

CMC in accordance with prescribed legal obligations is basing its long-term planning process on the principle of the System for Planning, Programming, Budgeting and Execution (PPBE). CMC has adopted a Strategic Plan for the period 2011 – 2013 and one of the strategic priorities is preparation of the Integrated Assessment of all Risks and Hazards on the national and local levels.

Hazard exposure assessment of threats to state security is made and adopted to ensure planned, timely, comprehensive and coordinated adoption of decisions, guidelines and recommendations for protective measures and optimal crisis management. Upon a proposal of the Assessment Group, the Crisis Management Centre makes an assessment and submits it to the Steering Committee (Figure 24). The assessment is then adopted by the Government, which passes a decree on the assessment methodology, its content, structure, storage and updating and defines the entities in the crisis management system which receive the entire or parts of the assessment.

Figure 24. Decision flow within the Crisis Management Center

CMC in partnership with UNDP Macedonia implemented the project "Strengthening of the capacities of the Crisis Management Center". The key products of the project are: desk Review on existing legislation and relevant planning documents concerning the crisis management system, Web Based Gender Repository Database and Web Based System for Learning, Exam and Survey, Guidelines for Preparation of the National Crisis Management Plan, software applications for entry of attribute and spatial data in the GIS data-base and strategic planning, Guidelines for development of methodologies for assessment of risks and hazards and assessment of their implications over the lives and health of the citizens and goods of the country, Guidelines for Preparation of the Unified Risk and Hazard Assessment, historical database for events happened during 50 years, Guidelines for Preparation of the Unified Risk and Hazard Assessment, Preliminary Risk Profile of the Country, local level risk management projects, training drills in educational institutions, small scale disaster risk reduction infrastructure projects, Handbook for local authorities on crisis preparedness published, interactive educational computer game. Risks from floods/droughts were considered accordingly.

5.2.2.3. Protection and Rescue Directorate

The Protection and Rescue Directorate is an independent state administration body and a separate legal entity, which started operations on 16 May 2005. Pursuant to Article 17 of the Law on Protection and Rescue it is made up of a Directorate located in Skopje, 8 regional units and 35

branch organizational protection and rescue units. The Directorate is a professional and operational body in charge of performing specific protection and rescue activities (Article 18). The Main Staff is part of the Directorate composed of government appointed experts, seconded to the Directorate. Regional staffs are also established in charge of the regional protection and rescue forces (permanent forces: the PRD personnel, rapid response teams and territorial firefighting forces; reserve forces: main staff, 35 regional staffs, and forces units/platoons/companies). 5-15 member rapid response teams are also established, which are the pillars of the national protection and rescue forces (Figure 25).

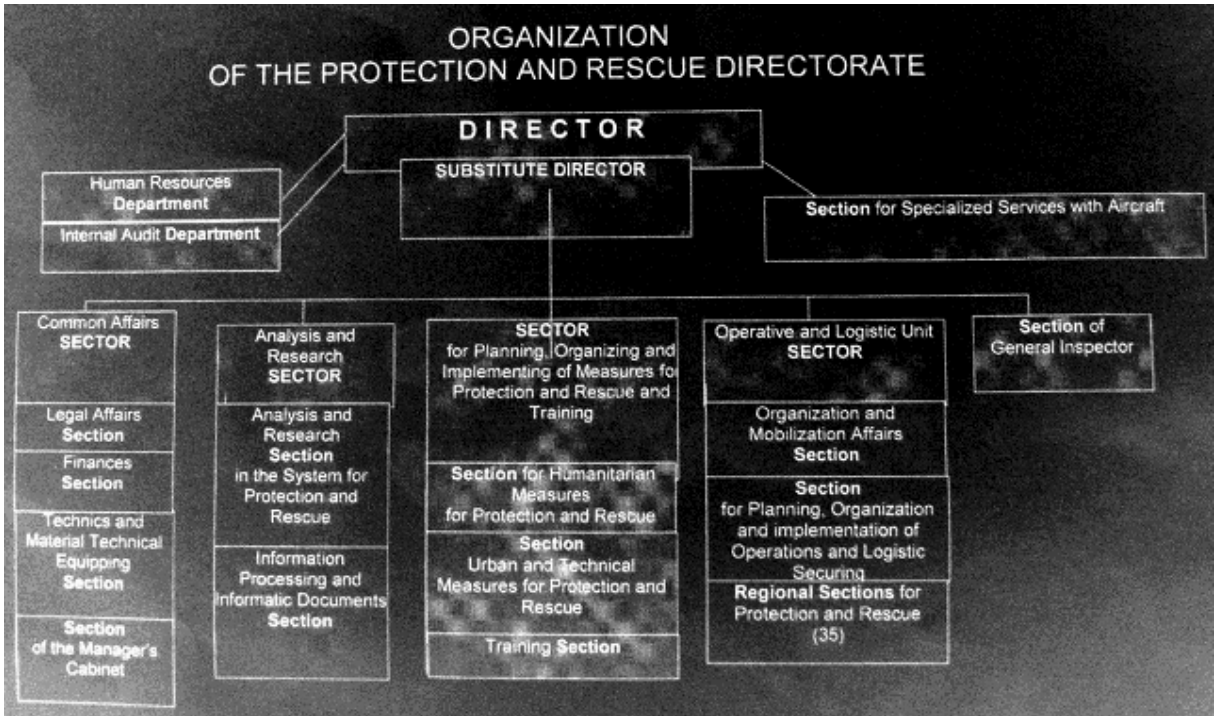

Figure 25. Organizational flow-chart of the NPRD

5.2.2.4. Hydrometeorological Service of Republic of Macedonia

The Hydrometeorological Service (HMS) was officially established in 1947 with the "Declaration of Foundation of Hydrometeorological Service of Peoples Republic of Macedonia". In 1978 it became Republic Hydrometeorological institute, a governmental organization. Since 1991 Hydrometeorological Service represents the national authority for hydrology and meteorology. From 2000, HMS is under the Ministry for Agriculture, Forestry and Water Economy. It is also overseen by the Ministry of Environment.

The roles of HMS in DRR are defined in the law of Hydrometeorological Activity, Part IV, Art 6 – Goals and mission of HMS: Meteorological and hydrological activities include activities concerning development and functioning of hydrometeorological monitoring, researching of the atmosphere, climate, waters and soil as well as application of meteorology and hydrology.

The Hydrometeorological Service (HMS) has the responsibility to operate the observation network and produce meteorological and climatological services in order to enhance people´s security and welfare, economic development and environmental protection. HMS has also many duties concerning environmental sector. Systematic control of surface water quality has been performed since 1964, while monitoring network on air quality dates from 1974. Lately HMS has significantly decreased its activities in the area of air quality, as the role of the Ministry of Environment has been increasing, and currently covers monitoring and dispersion modelling. Current main activities of HMS include air quality monitoring, monitoring of qualitative and quantitative characteristics of

surface water at 20 measuring points and other tasks related to air quality and water quality (Figure 26).

HMS is governmental Service providing basic information in meteorology, hydrology, air quality and water quality. HMS is organized in 5 main departments and 2 main divisions (Figure 27).

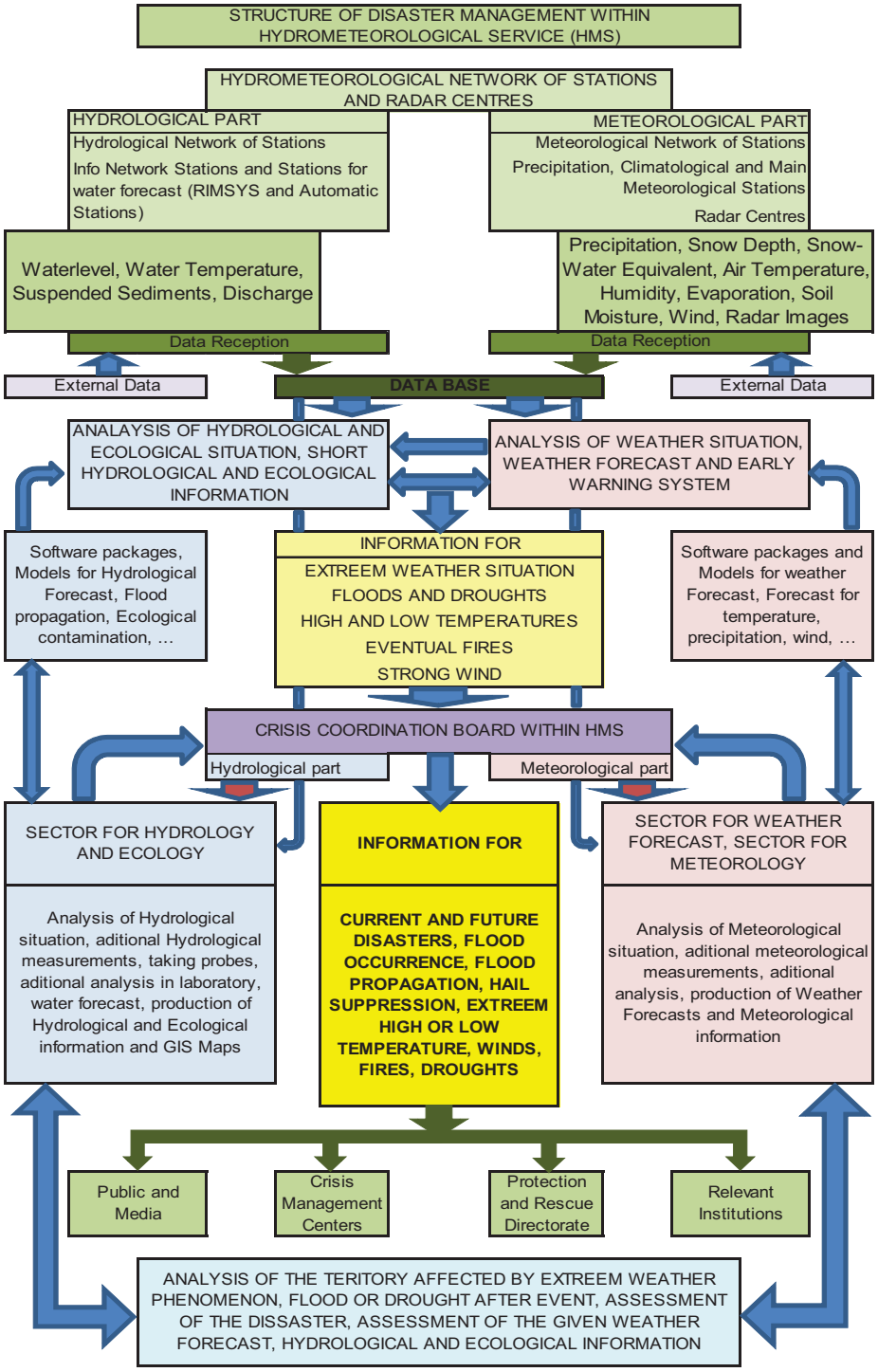

Figure 26. HMS workflow in DRR

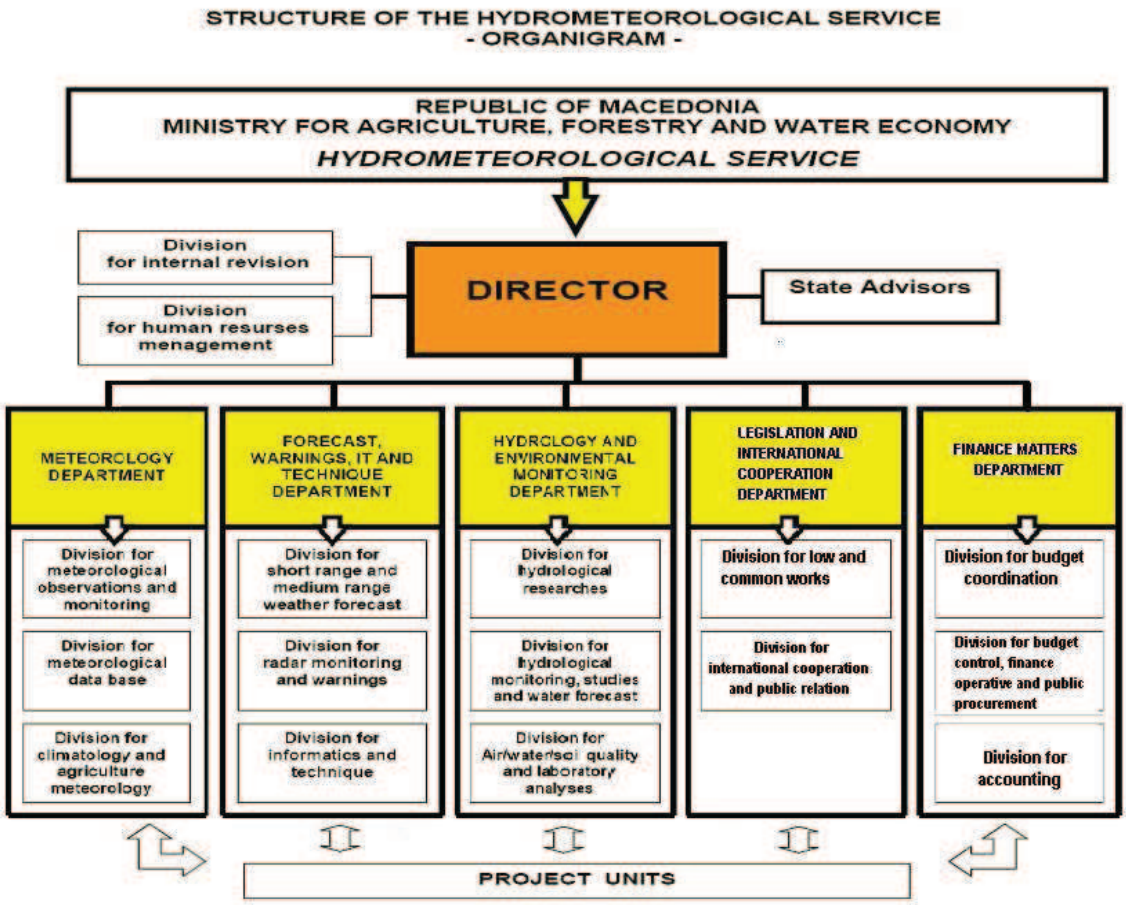

Figure 27. Organizational structure of HMS

FYR Macedonia is member of the WMO. The Permanent Representative (PR) with WMO is currently the HMS Director.

In FYR of Macedonia, there are also other entities, which provide hydrological or meteorological services and operate observations or observation networks. These include:

- Meteorological Office at the Airport, located at Skopje airport, is under Ministry of transport. The Office is financed by the income from aviation, not by the governmental budget. It provides weather services for two airports. The Office operates one AWS (AWOS 2000, includes present weather sensor) at both airports, and uses HMS data via internet for free. The Office is well equipped with satellite data receivers, visualising software and tools, etc. The salary level of meteorologists working for the Office is significantly above the salary level of HMS. There is no cooperation between the Office and HMS. The Office and the observations at the Skopje airport are available 24/7;
- Regarding hydrology and water for rivers lakes and groundwater, the following institutions are also involved: Ministry of Environment and Physical Planning, Water Economy Directorate – Ministry of agriculture, Forestry and water Economy, National Institute of Health protection (NIHP), Water Development Institute, and Hydrobiological Institute;
- According to the air quality Law, Ministry of Environment and Physical Planning is responsible for air quality issues on State level. Ministry operates its own air quality stations: 8 stations in Skopje and 10 outside. Out of these 13 are automatic monitoring stations: 5 in Skopje and 8 outside.

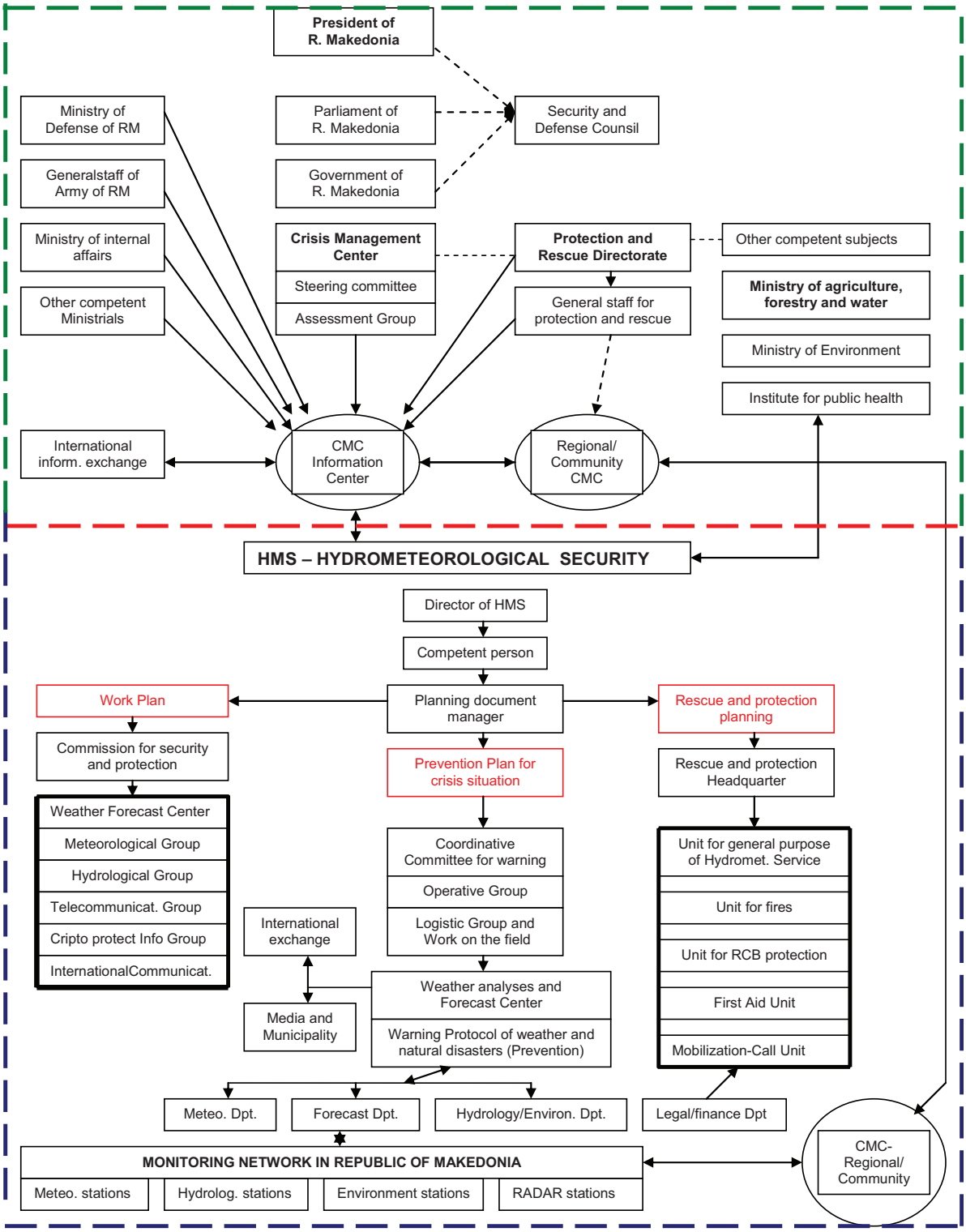

Figure 28. Information flows between HMS and the Crisis Management System

5.2.3. Coordination and cooperation

Standard Operative Procedures have been agreed for communication, coordination and cooperation amongst CMC/PRD (Protection and Rescue Directorate) and subjects of the Crisis Management System for flood protection. The following diagram shows the SOP inside the CMS (Figure 28).

The establishment of the National Platform of the Republic of Macedonia for Disaster Risk Reduction (NPDRR) is for the moment only formal, it is coordinated by CMC but other institutions that should be involved are not participating nor are informed on the platform activities. HMS is formally member of the National Platform of the Republic of Macedonia for Disaster Risk Reduction. HMS has nominated a Disaster Risk Reduction Focal Point, however, operationally the platform is not well established, and it was not quite clear what is the role of the HMS

The HMS has the responsibility to operate the observation network and produce meteorological and climatological services. HMS provides technical and scientific support for other agencies. HMS actually participates in DRR providing basic data, information and weather forecasts to other organizations, at state, provincial and local levels. Thus, the level of integration of HMS into the DRR policy making is not very high. On the contrary, from an operational point of view, HMS is strongly involved in Disasters Preparedness and Prevention activities. As described by the following flow chart, HMS is strongly involved in Early Warning, but also (bottom part of the flowchart) in prevention, providing basic information and services for hazard characterization.

5.2.4. Roles and responsibilities for flood and drought risk assessment

Based on Law on Crisis Management, Chapter III, article 21, para. 2, the Crisis Management Center is responsible for preparation and updating of the Integrated Assessment of all risks and hazards. In relation with the article 45 from the same law and for purposes of coordinated decision-making, issuance of guidance and recommendations for taking measures for prevention, as well as for crisis situation, the Integrated Assessment is being adopted. This document integrates the contribution from the specific assessments that are being prepared by the competent entities from CMS and is providing multi-sector approach in the assessment of the whole spectrum of risks and hazards. Under the Decree, the CMC should consolidate and systematize risk data and analyses into a single database through a multi-hazard assessment process. In this framework, CMC has also the role for coordination with competent institutions for analysis and assessment of vulnerability and exposure related to floods and droughts. The new Regulation on Methodology for Preparation of Integrated Assessment of all Risks and Hazards adopted in January 2011 prescribes detailed framework for analysis and assessment of the vulnerability and exposure including all the elements of the risk (geographic characteristics, population, infrastructure, individual and industrial facilities etc). It is also foreseen to design hazard and risk assessment guidelines and methodologies, with the support of UNDP.

Under the law on Protection and rescue, the PRD makes assessments on natural disasters including floods, and proposes measures for protection and rescue. PRD receives information from the HydroMeteorological service and the Ministry of Agriculture, Forestry and Water Management. The PRD also maintains an inventory of all natural disaster and accident risks and hazards. Using this data PRD produces assessments of vulnerability to natural disasters and other accidents as well (technical, technological and industrial accidents) of the Republic of Macedonia. PRD develops National Protection and Rescue Plans. Assessments and Plans are then adopted by the Government.

The HMS has the responsibility to operate the observation network and produce meteorological and climatological services. HMS provides technical and scientific support for other agencies. HMS actually participates in DRR providing basic data, information and weather forecasts to other organizations, at state, provincial and local levels. From an operational point of view, HMS is strongly involved in Disasters Preparedness and Prevention activities, providing basic information and services for hazard characterization.

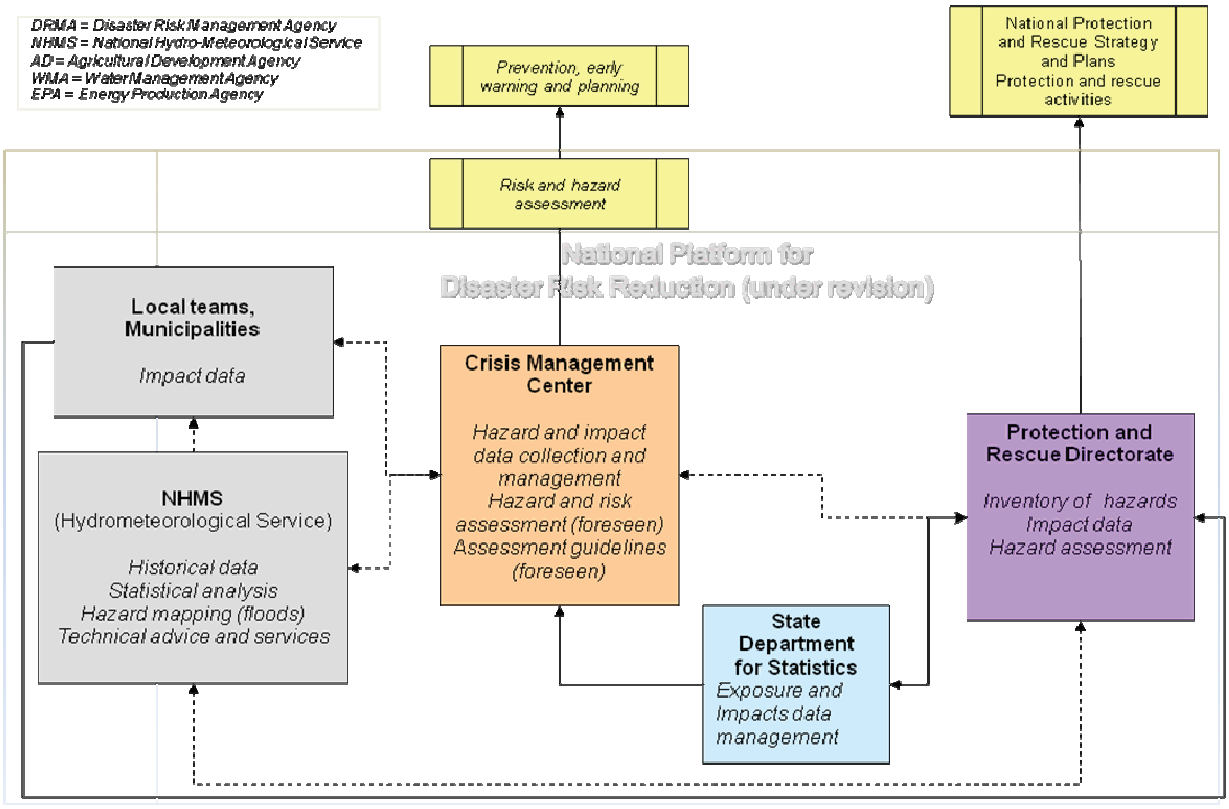

Figure 29. Work flow for drought and floods risk assessment in FYR of Macedonia

According to the law on protection and rescue, local governments set up commissions to assess disaster damages on the field and submit reports to Government Committee. The Governmental Commission submits information to the Government, which decides the refund rate of damages. Impact data on agriculture are collected by local commissions for drought assessment. The ministry of Agriculture has information about affected areas for floods and yields for droughts. These data are not systematized in a database. The impacts of floods are collected by local commissions at municipality level with the participation of PRD local teams, using damage assessment methodologies defined by the Ministry of Finance. The damage assessments are sent to central level for analysis and stored by Ministry of Finance, Department of Statistic, Local authorities and Municipals. Other line Ministries participate in the Crisis Management System and provide sectoral information to CMC.

Both, the CMC and the PRD are the key institutions for floods risk assessment. For floods risk assessment, there are several overlaps and lack of coordination between the two institutions. On the one hand, the protection and rescue system, which has been redefined in 2005 with the establishment of the PRD, addresses risks and hazards from natural and technological disasters in peace, emergency and war situations. With the development of the protection and rescue system measures and forces, the PRD has national and local operational capacities. On the other hand, the CMC is responsible for crises that threaten the basic values, interests and goals, and the constitutional order and security. CMC has developed multi-hazard and inter-sector approach in risks assessment. Both institutions have activities concerning floods risk assessment and their specific roles are not clearly defined, causing overlaps between these two institutions. Moreover there is the need to improve the operational linkages between the institutions involved in the CMS for inter-sector cooperation and collaboration.

The National Protection and Rescue Strategy (NPRS) is expected to bring better risk assessment, extended monitoring and forecasting and warning communication. It gives high priority to compatibility and regional and sub-regional information sharing on natural disasters and other

accidents, by improving existing mechanisms and use of better communication technologies. The strategy implementation measures foresee local and national activities, such as: full cooperation among entities to reduce vulnerability, preparedness to involve all available resources in dealing with hazards, development of risk assessment programs and operational plans, upgrade of the National Protection and Rescue Plan, inclusion of natural disaster hazards assessment in development plans, etc. The Strategy envisages establishment of an IT center and application of modelling and simulation methodology and technology in protection and rescue. The Strategy sets general guidelines but fails to provide an action plan containing developed measures and indicators for monitoring. In this framework, PRD makes hazard assessments but not yet risk assessment or vulnerability analysis because of lack of methodologies. However, PRD foresees to develop an information system ensuring suitable information both for disaster managing and for planning. This system should include data from the State Statistical Bureau as (population, households, assets, and infrastructures), the Ministry of Agriculture, Forestry and Water Management (land use, crops areas, forests, orchards). This system will not only underpin the warning and forecast of hazard impact, but also the vulnerability analysis for risk assessment and as consequence the plans for protect and rescue.

CMC indicates that there is a lack of organized system for floods/droughts assessments, of methodologies for floods/droughts mapping and of technical knowledge and expertise and human resources. In this framework there is the need for:

- Improvement of the mutual cooperation, communication and data and information sharing between CMC and CMSs entities; this includes the development of SOPs for timely information and cooperation of the institutions and a clear attribution of tasks and duties;
- preparing guidelines and methodologies for hazard and risk assessment;
- establishment of the permanent process of data analysis and processing;
- establishment of integrated hazard mapping process;
- establishment of proper dissemination process for results of risk assessment;
- capacity building in drought and floods hazard and risk assessment.

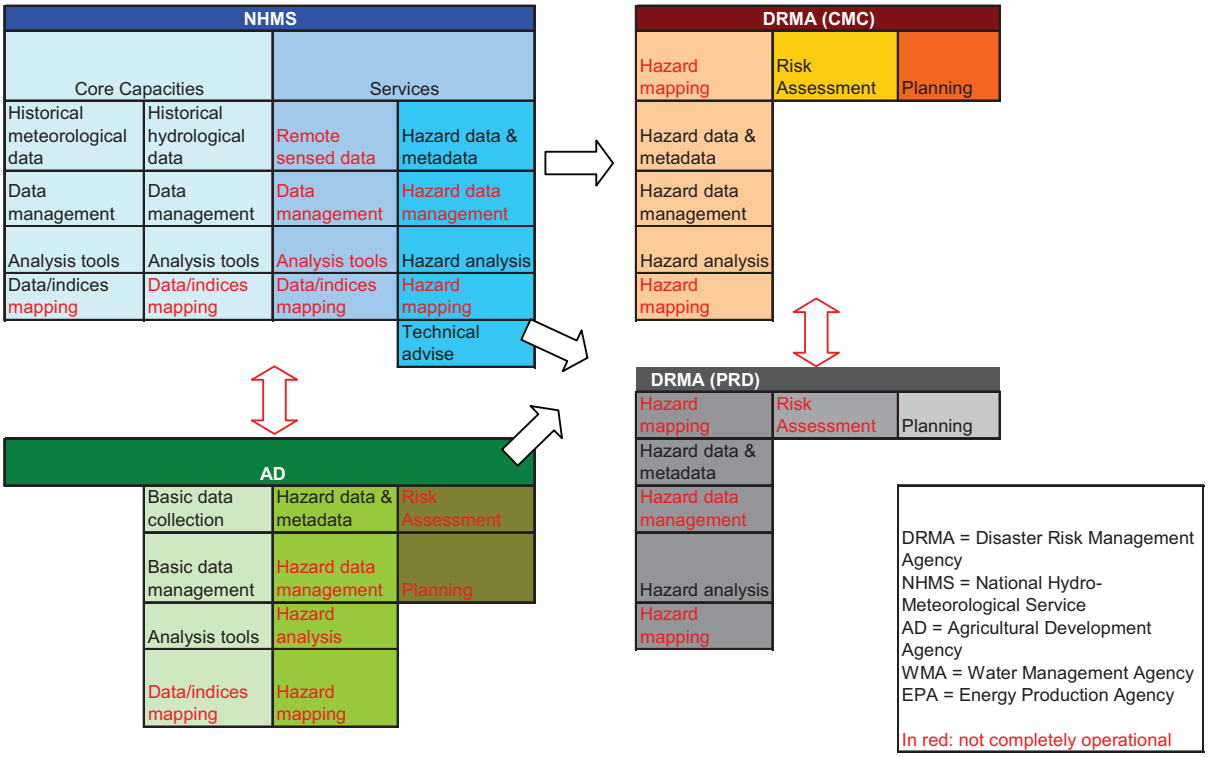

Figure 30. Operational linkages for flood and drought risk assessment

The integration of the hydrometeorological sector in planning of national DRR is at early stage. HMS has well defined role and duties in DRR principally as data and information provider. HMS needs to reaffirm its role in the flood/drought prediction and risk assessment in the state legal framework. The role of HMS could be emphasized becoming an independent Governmental organization, which could increase the status level of HMS. HMS provides also technical and scientific support for other agencies, but not systematically. HMS does not receive specific requests for providing services and never receives feedback from users. The chain should be better structured ensuring bi-directional flows and effective cooperation with institutions that deal with risk or hazards assessment. However, HMS does not have all the technical, human and financial resources to implement all the activities at desired level. Particularly, the hydrological division of HMS suffers of a chronic lack of human resources, hampering even the development of fundamental institutional activities. The Division estimates to be understaffed at 50% of its optimal level. The Ministry of Agriculture needs to be involved in drought risk assessment.

5.3. Technical Capacities of Hydrometeorological Services to support Disaster Risk Management

5.3.1. Monitoring and observations networks and data exchange

Hydrometeorological observation networks are established not only for national needs but also to be a part of the WMO Global Observation System (GOS) comprising of standardised measurements taken at constant hours using surface observation and monitoring stations, upper air observation, hydrological measurements and satellite observations. Historical data is essential for climatological studies, hazard analyses 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.

The hydrometeorological network of HMS is described in Table 27. Currently HMS has 20 meteorological manned synoptic stations (measurements and observations every hour) and 2 automatic weather stations (AWS) (data received every full hour). The AWSs measure the ordinary parameters, but they do not have ceilometers (cloud height), present weather sensors or on-line video monitoring. Agrometeorological stations are manned and measure also the basic meteorological parameters. Manned stations can be activated to send data more frequently when needed e.g. for DRR purposes. Many of the equipment used at the manned stations are obsolete and needs to be replaced by new sensors. Currently ice free sensors are not used at any meteorological stations.

Upper air soundings are essential for global, regional and local numerical weather prediction models and for daily forecasting. Currently HMS operates one previous generation (Vaisala Loran C) sounding station located at the Skopje airport. The soundings are made once a day.

Weather radars are very powerful tools for aviation meteorology, tracking precipitation areas, to measure intensity of precipitation, flood forecasting and for short term weather forecasting (nowcasting). The weather radars, the WSR-74 S/X (1985) located in Gurishte and the MRL-5 (1990) located in Topolchani, are both digitalized but they represent very old radar technology.

The hydrological RIMSYS system, established in cooperation with Switzerland in 2008, provides real time information about water level and water temperature for rivers in the former Yugoslav Republic of Macedonia. Currently the hydrological network consists of 11 automatic stations with

GSM transmission of the data. It may be noted, that there are very few stations at the upper reaches of the rivers.

Satellite data in form of pictures is received through the MSG ground station. HMS does not have capacity to analyse the digital data and produce other products. Satellite data is used mainly for weather forecasting purposes but not e.g. for drought monitoring or snow surface/height analyses.

Main air quality monitoring networks are operated by HMS and Ministry of Environment. Modernization and automation of the Macedonian air quality monitoring network has been going on within an EU twinning project coordinated by the Finnish Meteorological Institute (FMI).

Table 27: Observation stations operated by HMS

Type of observation stations	Number			Comments of 2010 network
	2007	2010	2011	
Atmospheric domain				
Surface synoptic stations (> 8 obs/day)	23	22	20	
Manned stations	20	20	14	
AWS or AWOS	3	2	6	
Cloud-height – automatic	0	0		
Agrometeorological stations	0	9	24	
Ordinary climate station (3 obs./d)	18	16	16	Obsolete equipment
Rainfall station (2 obs./d)	165	145	150	
Rainfall station – automatic	0	0		
Meteorological towers	0	0		
Upper air radio sonde stations	1	1		1 sounding per day
Pilot balloon stations	0	0		
SODAR/RASS	0	0		
Wind profiler stations	0	0		
Lidar	0	0		
Access to AMDAR data	No	no		
Weather radars	3	2		Data availability 50%
Hale radars	NA	6		
Lightning detection stations	0	1		Old system
Lightning detection hub station	0	0		
Satellite MSG ground station	1	1		Only 1 operational
Hydrological domain				
Discharge station – manual	110	NA	35	
Discharge station – automatic	0	0		
Water level post – manual	150	NA	110	60% operational in 2011
Water level station – automatic	NA	17	17	Water level + temperature
Maritime domain				
Maritime/lake stations – manned	0	2		
Maritime/lake stations – automatic	0	0		
Buoys w/ meteorological observations	0	0		
Tidal stations	0	0		
Tidal stations with met. Observations	0	0		
Environmental domain				
Air quality monitoring stations	20	23		
Water quality –ground water	115	?		
Nuclear deposition				
Ozone – near surface	0	0		
Ozone – upper air	0	0		
UV radiation	0	0		
GAW station	1	1		

Data from only 3 stations are sent through the WMO Global Telecommunication System to international use. The National Meteorological Telecommunication Networks (NMTN) is based on Internet TCP/IP communication protocol and use of Virtual Private Network (VPN). HMS sends data to WMO GTS through the WMO RAVI Regional Meteorological Data Communication Network (RMDCN) using the TCP/IP protocol with a 128 Kbps connection. Outside the GTS system HMS does not exchange data with the neighbouring countries. Precipitation data hail information from the 2 radars and the RIMSYS hydrological data are available in near-real time on the HMS Internet pages. Hail radar images for single radars are available on HMS web pages for the day when the radar is in operation.

Agrometeorological stations are manned and measure also the basic meteorological parameters. Manned stations can be activated to send data more frequently when needed e.g. for DRR purposes HMS receives crop condition data from the local units of Ministry of agriculture, forestry and water supply, once per week by phone, free of charge for information of HMS agrometeorological Division. The Hydrology Sector receives data by the ELEM (Electric Power Company) which control Dams, by fax or post, free of charge.

HMS does not have adequate calibration systems and thus the measurements do not meet the WMO standards.

5.3.2. Hydrometeorological 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. Collected Meteorological parameters are: Air temperature, precipitation, relative humidity, atmospheric pressure, sunshine duration, wind speed and direction, soil temperature and soil moisture, evaporation. Data are kept in two forms:

- Notes on paper (special record book and forms) and (data archive is not protected and not preserved at risk of loss or deterioration);
- Electronic form (from the EXCEL spreadsheet format and in a separate database CLIDATA). The HMS digital meteorological database includes data for the years 1949 – 2010 from Main Meteorological Stations (SYNOP stations) and from Regular Climatological Stations. HMS is currently digitalizing data from additional stations. Until this moment less of two thirds of the total amount of meteo data are digitized.

Validation is done both manually during the primary data processing and in CLIDATA using the control entries on the basis of formulas embedded in the database. Safety of data in CLIDATA are implemented in two levels: (i) First level is the standard structure: administrator - clients and different levels of freedoms secured with password; and (ii) Second level - a permanent backup of the operating system (Windows server 2003) and data server. Meta data are available for few meteorological stations and should be prepared for all stations of the meteorological network. Available metadata information includes: coordinates, altitude, address, name of the observer, measuring program, beginning period, and basin. There are some interruptions of metadata changes in location, instruments, station type, etc.

Collected hydrological parameters are: water level; discharge; water temperature; suspended sediments. All data are collected in HMS and controlled by technician and engineers, and are stored on the HydroPro Data Base since 2004. Older data are still in Excel files. A backup system has been recently installed.

Lack of budget and human resources hampers the capacity of HMS to ensure comprehensive, quality controlled meteorological and hydrological databases. As a consequence: the hydrological database is complete from 2004 to now, older data are on excel or in analogical. The meteorological database needs to be quality controlled and it is not complete (2/3 digitized). There is no phenological data base because of the lack of an appropriated software.

5.3.3. Hazard analyses and mapping to support risk assessment.

Long time series from representative hydrometeorological are essential for statistical analyses of hydrometeorological extremes and hazards and risk assessment. Analyses are important for planning within different industrial and economic sectors and for DRM.

HMS has historical hourly or 3-hourly data from hydrometeorological measurements, which can be used to build different types of statistical analyses of different hazards. However, HMS has suffered from insufficient user friendly software for climatological analyses. In order to remove that obstacle HMS is member of the METVIEW project and HMS will receive METVIEW hardware and software from ECMWF in early 2011. Metview is an interactive meteorological application, which enables operational and research meteorologists to access, manipulate and visualize meteorological data. The system is based on the ECMWF standards for graphics (Magics) and data access (MARS) but can also access locally stored data. HMS staff has already participated the METVIEW training in March 2010.

HMS performs meteorological and agrometeorological analysis, including dry period, heat waves, temporal distribution of precipitation, measurement and calculation of soil moisture, calculation of potential evapotranspiration (Penman-Monteith, Thornthwaite), calculation of De Martonne aridity index, Lang's rainfall index, drought index by Gracanin, Standardized Precipitation Index.

Hydrological analyses performed at HMS are: (i) Graph-analytical method for flood analysis in the River Vardar Catchment using real time estimation of the precipitation on the catchment with radars and meteorological stations network, (ii) Statistical and Stochastic Analysis for high water pick and flood frequency analysis, Unit Hydrograph and Synthetic Hydrograph analysis, MPF method, and (iii) Statistical and Stochastic Analysis for low water and low water frequency analysis.

In the past the Hydrology division collected data on floods events and has also produced floods maps. Moreover, some data exist on paper for great floods in 1962 and 1979. But actually, the division is not in condition of performing such measures because of lack of human and financial resources. Today, HMS has not any specific database for hazards data but can only perform on-demand analysis based on its historical database such as:

- For droughts: tables, graphs (drought index, high temperature, heat waves, dry period, sum of precipitation, etc);
- For floods: tables, graphs and basic maps for floods.

New threshold values have been produced in cooperation with CMC and adopted in order to classify the hazards. Production of some hazard maps is done by orders from government. Up to now HMS has produced hazard maps of flood hazards, hail hazards and chemical and biological waterborne hazards. However, statistical analyses to characterize the hazards have not been performed.

Concerning data analysis, HMS does not use modern software and technology for data analysis or presentation. The Hydrology division has some spatial analysis capacities, but the meteorological division does not have any capacity in GIS or spatial analysis. Capacity building activities are foreseen on the SAGA GIS software in the framework of the DMC-SEE Programme. HMS does not use any remote sensed data or information. Up to now drought indexes and SPI are calculated for the stations because of the lack of interpolation tools or capacities, but some activities of capacity building are foreseen in the framework of a bilateral cooperation with Hungary. Moreover the number of drought indices calculated could be improved, also using remote sensed data. HMS has some GIS capacities but lacks of software (official licenses) and human resources. HMS does not run any numerical hydrological model, water flow or discharge models are only graphic analytical tools.

CMC is developing the official hazard database for recording events, occurrences and conditions caused by natural and man-made accidents and disasters that have happened in the country in the

past 50 years - droughts are not included. NPRD has an inventory of information about flood events (only "main" floods), mainly reports with some kind of characterization of the event. Moreover, PRD each year makes an assessment of problems and risks concerning rivers, hydraulic infrastructures, and irrigation schemes. The information is then passed to the government for planning the intervention of prevention against floods. CMC needs the involvement of HMS in the Crisis Management System for hydrological analysis and floods characterization. There is the need of a direct technical link for exchange of data in real time between CMC and HMS. CMC needs also education and training for analysis and assessments of risks from floods/droughts and for risk modelling. CMC indicates also that there is a lack of methodologies, SOPs and expertise and knowledge in the field of hazard impact data collection and management. It indicates the need of education, training and access to data and information for strengthening the drought/floods impact data collection and analysis.

Lack of state-of-the-art software for processing hydrometeorological data hinders utilization of the data available and production of products and services.

Impact data, collected by local commissions, are stored by the Ministry of Finance, the Department of Statistic, Local authorities and Municipalities. NPRD receives hazard information from its 35 regional offices, which fully cover the country, and work closely with local government. These data cover just some of the needs of making the hazard assessment and plans for protection and rescue. PRD does not store the data in an organized database, but only keeps the reports of past events. Ministry of Agriculture collects data on crop damages caused by floods and drought participating in the local commissions for damages assessment. In case of drought, crop yields are collected; in case of flood the area flooded fields. The CMC is using the data and information from the competent institutions as an input in its assessments and reports.

Up to now none of these agencies is producing floods or drought maps. HMS has prepared in the past some flood maps. CMC and PRD produce reports and annual analysis, but specific hazard mapping capacities are lacking. At the CMC, within the Department for Operations and Operations Logistic there is a GIS Unit, but with very limited technical knowledge and expertise. This unit is recording in GIS only the events that have happened. At the moment, CMC is preparing methodologies for hazard mapping and for risks assessment and it is expected that in the mid-term it could be able to prepare this information products. PRD has very limited analysis capacities that could be exploited for drought or floods risk mapping.

5.3.4. Forecasting

HMS has operational production of 12 h, 24 h, 2 days, 3 days and 5 days weather forecasts. Nowcast (very short term) products are produced when required. The weather forecasts disseminated through Internet are given for the present day and for the next day, only. Tailored weather forecasts are produced occasionally for agriculture, water management and health sectors, and to the Crisis Management Center Directorate, Directorate for Protection and Rescue, and Fire brigades.

Table 28: Types of forecasts produced by HMS

Forecast type	Weather			hydrological			Environmental		
	Provide	n/d	on web	provide	n/d	web	provide	n/d	Web
Nowcasting	If needed		yes	no			no		
12 hours	yes		yes	no			no		
24 hours	yes		yes	no			no		
48 hours	yes		yes	no			no		
3-,4-, 5-days	yes		yes	no			no		
one week				no			no		
10 days	no		no	no			no		
monthly outlooks	no			no			no		
seasonal outlooks	no		no	no			no		

HMS operational NWP model is non-hydrostatic WRF-NMM numerical weather prediction model, which is freely available through internet from USA. The model domain over Europe is run on 13 km horizontal resolution, and separately over the Former Yugoslav Republic of Macedonia on 3 km resolution. The time step used is 1 hour. The models are run twice a day: 00 and 12 local time. The boundary conditions are taken from the global NCEP model operated by NOAA, USA. As the ECMWF starts to produce global NWP model data at 8 km resolution it is vital to invest in IT capacity to utilize this data and the WRF data for better forecast products and to use this NWP digital data for mesoscale modelling. The forecasters have appropriate access to hourly data from synoptic and automatic meteorological and hydrological stations.

HMS does not run any numerical hydrological, water flow or discharge models. Flood forecasting activities are carried out with classical methods using real time estimation of the precipitation on the catchment with radars and meteorological stations network.

HMS has provided hail suppression services for 30 years. Hail forecasts are based on hail radar observations and weather forecasts. For prediction of dispersion of airborne pollutants HMS has the capability to operate the numerical WRF mesoscale model, but HMS does not have any dispersion models for air or water borne pollutants.

Today it is necessary to have capacity to link also environmental forecasting models to NWP models. For prediction of dispersion of airborne pollutants HMS has the capability to operate the numerical WRF mesoscale model, but HMS does not have any dispersion models for air or water borne pollutants.

The computing resources are divided to run the NWP models for two domains with two server systems: (i) the Macedonian region Core 2, 2 Gb RAM, disk space 320 Gb and (ii) the European region 2 x Quad Core, Intel Xeon, 4 Gb RAM, disk space 2 X 320 Gb. The computing capacity for numerical weather predictions is quite limited.

Up to now HMS does not have proper software for visualization of NWP products in form of maps, or to produce automatic tailored products/layouts for different end-users. Products cannot be sent automatically.

5.3.5. Warning products and services

5.3.5.1. Warnings and mandates

HMS has the responsibility of issuing warnings, which are defined in the law, through the media (Table 29). The warnings given by HMS are based on observations, radar data, satellite data and numerical weather predictions. In the case of potential danger the Director of HMS is informed, data is sent to the CMC, government, and others, and a special document is prepared to the public.

HMS is the only NHMS in SEE which produces warnings also for pollen. HMS produces specialised warnings to the health sector. But neither HMS nor CMC has a clear picture how to produce warnings of airborne pollutants using numerical models.

5.3.5.2. Warning dissemination mechanism

Warnings produced by HMS are sent directly by phone, fax or e-mail to authorities and institutions according to a fixed contact list. Manual sending system is still in use, no automatic sending system is available. Data, forecast products and warnings (METEO ALARM) produced by HMS are available and visible at the Crisis Management Center (CMC) in real time.

The TETRA (TErrestrial Trunked Radio) is available for communication between authorities. However, HMS does not have access to the authority communication system.

Table 29: Warnings for natural and technical hazards in the FYR of Macedonia, based on Annex 2

Hazard	Exists in the country	Warning by	Type	Info of risks
Heavy precipitation	Yes	HMS	I	Yes
Flash floods	Yes			
River flooding	Yes	HMS	I	Yes
Coastal Flooding	No			
Hailstorm	Yes	HMS	I	Yes
Thunderstorm or lightning	Yes			
Heavy snow	Yes	HMS	I	Yes
Freezing rain	No			
Dense fog	Yes	HMS		
Tornado or cyclone	yes			
Strong wind	Yes	HMS	I	
Storm surge	Yes			
Heatwave	Yes	HMS	I	Yes
Cold wave	Yes	HMS	I	
Drought	Yes			
Marine hazard	No			
Sandstorm	No			
Landslide or mudslide	Yes			
Avalanche	Yes			
Airborne hazardous substance	Yes			
Waterborne hazards	Yes			
Hydrometeorological hazards for aviation	Yes	AWS	III	I
Icing of roads				
Forest or wildland fire	Yes	HMS	I	
Smoke, dust or haze	Yes			
Earthquakes	Yes			
Tsunamis	No			
Volcanic events	No			
Smoke from volcano abroad	Yes			
Dispersion of insect pests	Yes			
Desert locust storm	No			
Hazard for allergic reactions	Yes	HMS		

Warnings to the public are given via radio and TV within the ordinary weather forecast presentations. HMS does not have the mandate to give warnings e.g. as info stripes on ongoing TV programmes. Currently the cooperation with media is not at an optimum level. HMS plans to establish a studio for weather and warning presentation for TV and other media. However, advanced EUMETNET NHMSs do not invest anymore in this type of dissemination of information.

HMS disseminates alarms/warnings of harsh weather and pollen also through its web pages using the EUMETNET METEOALARM colour code. However, the Former Yugoslav Republic of Macedonia is not a member in the European METEOALARM system.

HMS disseminates free of charge real time data through its web page. Policies for data dissemination and exchange, according to the Hydrometeorological Law, allow HMS to provide data to other entities (e.g. data to CMC, Protection and Rescue Directorate, Ministry of agriculture, forestry and water supply, Ministry of transport and communication, Ministry of environment and physical planning.). After processing and controlling, data are issued to various customers and clients. The degree of processing depends on specific customer requirements. Data analyses are available on demand by request of any user. For Governmental institutions and for scientific research they are free of charge, for other users they are charged according to a cost list. Special tailored forms are delivered to NPRD and CMC, following agreed SOP, by Fax, E-mail or by hand if

necessary. There is no feedback mechanism ensuring that the information responds to real users' needs. For the hydrological data an interactive system has been developed in the framework of RIMSYS system, established in cooperation with Switzerland. The system allows data dissemination through the web, providing real time information about water level and water temperature for rivers. Currently, RIMSYS includes 17 automatic stations with GSM transmission of the data. Up to now HMS does not have proper software for producing automatic tailored products/layouts for different end-users. Products cannot be sent automatically. The basic reasons are the lack of modern technology and human resources.

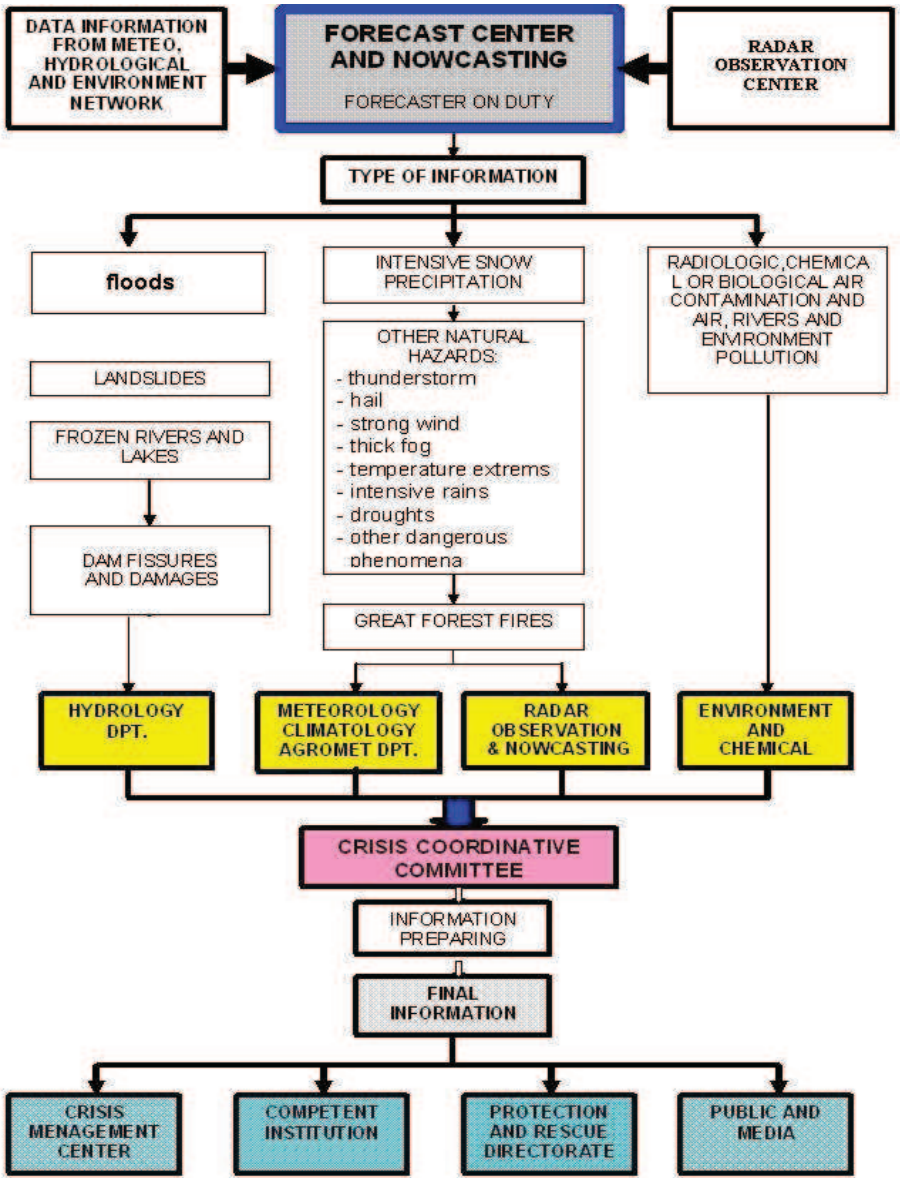

Figure 31. HMS decision flow for early warning

The National operations Center of CMC has a permanent direct link with the HMS through which relevant data is obtained regularly for the analysis of risks of flood and drought. Additionally, these data is being analyzed by CMC for the purposes of assessment, early warning and alarming. CMC and HMS have signed Agreement for cooperation. Standard Operations Procedures (SOPs) regulating the type of data and information, mode and procedures for their submission to CMC and for mutual cooperation are under preparation. Data dissemination and exchange is based on the Regulation for type of data and information, mode and procedures for their submission to CMC. In

addition, within its regular work CMC is preparing Daily Reports (for internal use of CMS entities) and Weekly Reviews posted on the CMC web site (www.cuk.gov.mk), as well as monthly, quarterly, semi-annually and annually analytical reports (for internal use of CMS entities). Internal information within the CMS is disseminated through mail, fax, phone and e-mails. NPRD receives information from HMS and the Ministry of Agriculture, Forestry and Water Management, but such information does not meet the needs of PRD. Information received is processed and delivered to its 35 regional offices, to the Government and the public.

5.3.6. Climate change analysis

The main role of HMS in climate change issues is to produce background material and analyses based on observations. However, currently HMS does not have adequate human capacity to produce highly scientific support to Government and industry concerning magnitude of climate change, changes in climate variability or impacts of climate change on different socio-economic sectors. It can be expected that the Former Yugoslav Republic of Macedonia could significantly benefit from the new South East European Virtual Climate Change Center (SEEVCCC), which was established in 2008 within the Serbian National Hydrometeorological Service.

5.3.7. 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. The national data from hydrological and meteorological stations is mainly collected via telephone (fixed line) or UHF radio. Currently HMS does not have capacity to on-line data collection and tools for automated production and dissemination of products and warnings.

Table 30: Equipment in use for data communication and warnings and other products dissemination

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

5.3.8. Contingency plans

In general the NHMSs need to have a clear contingency plan which ensures continuity of monitoring, data handling, data sharing and production of forecasts and warnings in case of power supply breaks, natural or technical hazards, strikes and troubles. Currently HMS lacks a proper comprehensive contingency plan and capacity to ensure proper operation during contingent breaks.

5.3.9. Customer service and visibility

In order to ensure their existence and to sustain development, it is necessary for the NHMSs to have customer orientated strategy and tailored products and to have a wide visibility and appreciation among the public, industry and government.

HMS forecasters present the weather forecasts on the TV (even if brief study among the public showed that public does not know who produces the forecasts) and produces weather forecasts for radio stations and the newspapers. HMS promotes its visibility through annual briefing meetings with the media.

Today Internet is very important method to disseminate information and to make the brand of the NHMS well known. HMS has renewed its home page, and provides weather services and other information in three languages. The layout could be better, forecasts and radar images could have more space and the pages could be more user-friendly. The number of daily visitors is not recorded.

Table 31: Number of HMS 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		
Met obs. network	51	5						2			1				59
Hydro. obs. network	9				4										13
Telecommunication	4	1						2							7
Data management	5		2												7
Weather forecasting	7	10													17
Hydrological forecasting	4				2										6
Climatology															
Agrometeorology															
NWP															
R & D		4						3							7
Environment	7							4			4				15
Weather modification	34	1						1			3				39
IT personnel	4	1						2							7
Commercial services															
Human resources	3										1				4
Accounting	5										2				7
General administration	17			1				1			3			3	25
Other											2				2
TOTAL	**150**	**22**	**2**	**1**	**6**			**15**			**16**			**3**	**215**
Female in % of total	20	60	50	0	35			35			60			35	30
Men in % of total	90	40	50	100	65			65			40			65	70

5.3.10. Human resources

HMS has a relatively large staff: 214 people (31% women, 69% men). Of these 129 are working with meteorology, 19 with hydrology and 14 with environmental matters. The average age of the staff is over 50 years. As the number of manned stations is relatively high an important part of the staff are observers, which have practically disappeared from more advanced NHMSs due to

automated observation and measurement systems. The number of meteorologists, hydrologists and ICT experts is quite low. The educational level of the staff is quite low (mainly BSc level or less), with respect to requirements produced by advanced observation and ICT technology, numerical modelling, R&D and customer relationships.

The number of forecasters provides a possibility to run a 24/7 forecaster service. However, the data management and operation of the NWP systems is the core of NHMS operation. Currently HMS´s human capacity in data management and main computer experts do not allow 24/7 technical operation or production of sophisticated services, as HMS has only 2 main computer experts, 1 data base expert and 1 software expert and 1 communication expert, while there are no "helpdesk" or quality control experts.

Currently HMS does not have adequate human resources (scientists and experts) to fully respond the level of demands from a DRR system at typical level of an advanced EU country, or to develop and enhance its services to better support national development. Also the training of the HMS staff in DRR and hazard forecasting has been quite limited.

5.3.11. International and Regional Cooperation

Successful operation of NMHS is based on international cooperation. Weather forecasts and forecasting of natural hazards are based on products from global and regional scale state-of-the-art numerical weather prediction models, use of satellite data and sharing of data from conventional and modern remote sensing systems. Regional, local and mesoscale numerical weather prediction models are developed by international consortiums, to which membership provides better and more services than to non-members.

Table 32: International and regional cooperation activities of HMS

International and regional organization and cooperation mechanisms	HMS status
WMO	Member
WMO RAVI	Member
RMDCN	Member
IOC	No
UNDP	Yes
UN-ISDR	Yes
Red Cross/Red Crescent	No
EU	Some
EUMETSAT	Partner
ECMWF	Cooperative member from Jan. 2011
EUMETNET	Member
METEOALARM	Member since 2010
ECOMET	No
EUFP7 projects, networks	Not yet
EU JRC	
EU PHARE	Yes
EU CARDS	yes
EUCLID	No
EUR-OPA	No
DMCSEE	Yes
SEEVCCC	No
SAVA Commission	Cooperation
NWP consortium	None
NMHS bilateral	All SEE countries, USA,
NMHS MoU	Finland

EU based hydrometeorological organizations provide most state-of-the-art models, software and tools to be utilized by the member NHMSs. The integration into the European hydrometeorological infrastructure was given the highest priority in the 2007 project in developing the capacities of the NHMSs to implement best European practices and to produce improved products and services in support of national economic development and DRR.

The Former Yugoslav Republic of Macedonia has become a Co-operating State of ECMWF and EUMETNET in 2011. The negotiations of membership in EUMETSAT are going on at governmental level.

European Union research and networking programs create consortiums of excellence, and provides good opportunities to NMHS to network with NMHSs and commercial R&D companies and strengthen their capacities. Up to now HMS has very poorly exploited its possibility to participate in the EU R&D projects, COST actions and networking programmes. HMS is partner in the DMCSEE project financed by EU.

CMC has bilateral collaborations with homologues in Turkey, Bosnia and Herzegovina, Slovenia, Croatia, and Montenegro. At international level CMC collaborates with UNDP, UNISDR, and WMO.

HMS is open for international cooperation in order to promote the capacity and modernize its products.

At national level, there is the need of a better and clearer attribution of tasks and responsibilities of any organization involved in DRR in order to develop and promote the use of common methodologies and integrated policy approach. At regional level there is the need for the establishment of a regional network for cooperation.

5.4. Technical recommendations to strengthen HMS capacities in support of DRR

Currently HMS does not have adequate technical, human and financial resources to fully support risk assessment and early warning systems. It is critical to upgrade and modernize the national hydro-meteorological monitoring and information exchange network and the forecasting system and to provide sustainable organizational resources, human and technical resources and increase the budget available to HMS for efficient meteorological and hydrological disaster risk monitoring, forecasting and warning. The following technical recommendations:

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

1. There are needs to further improve the legal and institutional DRR framework;
2. There are urgent needs to re-organize the HMS to better support the substance areas of the organization, and to promote the capability to better implement the obligations and mandates given in the law;
3. There are urgent needs to upgrade the financing of HMS.

Operational relationships with other agencies

4. There are needs to improve cooperation with other technical agencies, including the Crisis Management Center and the National Protection and Rescue Directorate, through the understanding of their specific needs, the development of specific SOPs for warning and other products and services, as well as feedback mechanisms.

Monitoring and observations networks and data exchange

5. There are urgent needs to implement a proper calibration and maintenance of sensors in order to meet the WMO standards of measurements;
6. It is necessary to upgrade and modernize the weather radar network with 2-3 modern radars;

7. Investments in implementation of two daily upper air soundings would benefit the regional and local weather forecasts;
8. There are needs to strengthen and modernize the meteorological and hydrological surface networks and to increase the number of automatic stations; especially additional rain gauge and water level automatic stations on upstream catchments;
9. There are urgent needs to enhance international and regional data exchange.

Forecasting

10. There is an urgent need to take in use hydrological models;
11. There is an urgent need to establish a warning system for floods and flash floods;
12. There is a need to promote NWP modelling through membership in a European NWP consortium;
13. There is an urgent need to become a member of the SEEVCCC cooperation to promote national bases to adapt to climate change;
14. There is need to implement analysing, editing and visualization tools.

Hydrometeorological data management systems

15. There is an urgent need to initiate a data rescue programme to digitise and quality ensure the historical data;
16. There is a need to develop the technical capacities for data management and to adopt automatic quality control systems of hydrometeorological data. Specifically, the following tools and appropriate training would be required: New version of CLIDATA and training, update of HYDROPRO hydrological data base and training and additional component of the DEMAS Software for collecting Hydrological Data from automatic stations (DEMAS db);
17. There is a need to develop an agrometeorological database, including also phenological data.

Hazard analysis and mapping to support risk assessment

18. There is a need to define standard methodologies for hazard characterization and mapping, and for hazard risk assessment;
19. There is a need to develop hazard analysis and mapping based on historical data and climate change projections to support risk assessment;
20. There is a need to strengthen the systematic collection of drought/floods impact information on a state level with standardized procedure and long-lasting approach;
21. There is a need to strengthen GIS, spatial analysis and remote sensing capacities for hazard analysis and mapping, including GIS software and training, access to an officially agreed DEM;
22. There is a need to strengthen the agrometeorology capacities of HMS to support drought risk assessment (calculation of drought indices, water balance model, crop coefficients, use of remote sensing information in agrometeorology).

Information technology and telecommunication issues

23. There are needs to improve and modernize the communication facilities by introducing modern technology for information dissemination and its automatization.

Warning products and services

24. There are needs to further improve the warning products;
25. There are urgent needs to promote cooperation with the media;
26. There are urgent needs to establish a feedback mechanism from end users or stakeholders ensuring that information reached its target audience in a timely manner, suitable format and with requested contents.

Climate change analysis

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

Human Resources

30. There are urgent needs to increase the human capacity with meteorologists, hydrologists, NWP model experts, ICT experts, data management experts and marketing experts;
31. There are needs to increase the number of staff with academic MSc and PhD degrees;
32. There are urgent needs to promote training of the mid-management in leadership, project management, cooperation with industry and participation in EU R&D projects;
33. There are needs to establish a systematic training programme for whole staff by adapting the trainings systems in use in some of the advanced EUMETNET NHMSs.

Regional cooperation

34. There are urgent needs to promote cooperation with SEE NHMSs;
35. There are urgent needs to enhance data exchange, warning and watch coordination and cross border training activities;
36. 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;
37. 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;
38. To improve their forecasting capacities SEE countries should increase their cooperation with global, regional and specialized Centres producing NWP, by developing their NWP capacities and become members of NWP model consortiums. Linkages between NWP models and hydrological models should also be developed for a better flood forecasting.

5.5. Recommendations from the Former Yugoslav Republic of Macedonia 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 Skopje, on 15 November 2010. During this meeting, high-level participants endorsed the assessment, as well as the set of recommendations emanating from it and presented hereunder.

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

Recommendation 1: Integrate the DRR concept in Republic of Macedonia's key strategic documents and development and sectoral policies; Incorporate development and sectoral policies in a clear and comprehensive framework, i.e. produce a DRR Strategy which will link national, regional and local development priorities to natural disaster risk prevention and reduction; When

incorporating DRR in national, regional and local sectoral policies institutions shall follow the DRR concepts and definitions accepted in the ISDR and use commonly accepted terminology.

Recommendation 2: When incorporating DRR in the various sectoral policies, use harmonized methodology and coordinated approach, emphasizing the proactive approach to promotion of development, adaptation to climate change and reduction of natural disaster risks.

Recommendation 3: Initiate adaptation/amendment of legislation to implement national and sectoral policies for accident and disaster risk reduction for later national and local implementation; In a coordinated approach, mutual coordination and respect of each others' advantages the actors of the Crises Management and Protection and Rescue systems (CMC and DRP) shall remove shortcomings causing overlaps of institutions' national or local responsibilities or activities.

Recommendation 4: The National DRR platform should blend into the current regulatory and institutional framework and continue its role as a public awareness promoter and a forum for harmonization and coordination of sectoral policies. The national platform shall improve its comparative advantages as an active and flexible forum for cooperation and initiation of projects and ideas that will facilitate efficient functioning of the DRR system.

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

Recommendation 5: CMC shall prepare a natural disaster risk analysis and monitoring methodology. In cooperation with other actors of the system, it shall organize appropriate training on that methodology; Improve cooperation between key institutions such as the CMC, PRD, HMS and IEEES for more efficient information exchange, implementation of standard operating procedures and their harmonization with the methodologies, procedures and recommendations of the UN/ISDR, DRR, WMO and of the European institutions engaged in this fields.

Recommendation 6: In cooperation with the other entities of the system, the CMC shall finalize the establishment of an early warning system, which will be based on natural and manmade disaster risk analysis, monitoring, and information sharing. The CMC shall continue with the introduction of the European Emergency Number 112; In preventing natural meteorological disasters, it is crucial to increase the technical capacities and expertise of the national hydro meteorological service, particularly in early warning on meteorological and hydrological disasters by improving weather and water measurement, analysis and forecasting.

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

Recommendation 7: The Protection and Rescue Directorate and the Training and Exercise Centre shall increase their capacity for efficient training of the central, regional and municipal headquarters, of the rapid response teams, the professional and volunteer firefighters, the command staff and the rescue and protection forces.

Recommendation 8: Establish partnership between educational, academic and research institutions and the Crisis Management System entities which promote and implement the DRR concept. The Ministry of Education and the Education Development Bureau, in cooperation with the educational and academic institutions, the CMS/PRS entities and CKRM, shall introduce continuous DRR education and training and shall support national and local projects in cooperation with UNDP and other relevant international institutions. Introduce compulsory and elective DRR courses in primary, secondary and higher education that will develop a culture of prevention and care for the relations between man, environment and development (as called upon by the UN in Approaching United Nations Decade of Education for Sustainable Development 2005-2014).

HFA priority 4: Reduce the underlying risk factors

Recommendation 9: Establish a comprehensive risk identification, analysis and monitoring process, including community risk exposure and community risk vulnerability assessment methodologies, for specific risks. The CMS entities shall develop appropriate risk exposure and vulnerability assessment methodologies, paying thereby attention to the socio-economic and gender aspects Separate funds shall be allocated within the existing budges to finance the DRR policy nationally and locally and to strengthen regional cooperation.

Recommendation 10: Enhance the cooperation between HMS and the other entities to fully use HMS's potential for monitoring and early warning on the impacts of hydrological, meteorological and environmental risks (data, analyses, human resources, reporting).

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

Recommendation 11: Strengthen technical and human resources of the hydro-meteorological sector to support risk assessment and early warning systems by promoting operational monitoring, warning, forecasting and mapping of meteorological and hydrological hazards. It is critical to upgrade and modernize the national hydro-meteorological monitoring and information exchange network and the forecasting system and to provide sustainable organizational resources, human resources (education and training, IT expertise, international cooperation and networking) and technical resources (upgrade the automatic hydrological and weather radar network, integrate hydrological models in NWP modelling, integrate air pollution dispersion models with NWP modelling) and increase the budget available to HMS for efficient meteorological and hydrological disaster risk monitoring, forecasting and warning.

Recommendation 12: Strengthen human resources for hydrological data management and analysis, modelling and water forecasting with at least 6 hydrologists (Construction Engineers – hydrology major); Strengthen human resources for automatic hydrological and meteorological observation station maintenance with 3 electronics technicians; Make organizational changes within HMS with emphasis on water forecasting and flood protection and meteorology (measurement instruments calibration); Modernize the Hydrological Information and Forecasting System.

Recommendation 13: Strengthen, modernize and regularly maintain hydrological and meteorological monitoring, and regularly upgrade measurement networks with modern monitoring, data collection and transfer systems using plans and standards; Include weather radars in hydrological monitoring as technically most efficient measurement tools for rain analysis and water and flood forecasting,, especially for early warning on flash floods.

Recommendation 14: Make hydrological models for water and long distance wave travel forecasting for rivers Vardar and Strumica, Crn Drim and their tributaries. Put in place a hydrological warning and alarming system, containing information on extremely dangerous water thresholds and hydrological maps for risky floodable areas in urban and rural areas.