8. CHAPTER EIGHT: METEOROLOGICAL, HYDROLOGICAL AND CLIMATE SERVICES TO SUPPORT DISASTER RISK REDUCTION AND EARLY WARNING SYSTEMS IN TURKEY

Potential disasters in Turkey are mostly associated with earthquakes, droughts, heavy rain and floods, landslides, rock falls, forest fires, industrial explosions and fires, extreme temperatures, wind and snowstorms, avalanches, heat wave and fog.

This chapter presents all the findings related to the assessment of the Disaster Risk Reduction (DRR) institutional framework and technical capacities of the Turkish State Meteorological Service (hereafter referred to as DMI) and the Turkish State Hydraulics Works (hereafter referred to as DSI) to support DRR. It highlights that:

- The technical and scientific capacities of DMI and DSI are quite advanced when compared to other south east European countries, but due to lack of comprehensive weather radar network, lightning detection network and relatively low number of on-line automatic stations with new state-of-the-art sensor systems not at the level of advanced EU NHMSs;
- The coordination and cooperation between DMI and DSI are not at adequate level according to general hydrological and meteorological forecasting and DRR;
- Currently there is no national hydrometeorological database;
- There are needs to promote cooperation between DMI, DSI and the industry in order to promote national economic development;
- A new national 112 center is under preparation and it is necessary to link the National Meteorological Service (DMI) and the National Hydrological Service (DSI) strongly to this center;
- Up to now the potential capacity of the Turkish hydrological and meteorological sector has not been utilized by the DRR sector, in order to produce local scale projections of impacts of climate change on different hydrometeorological parameters and their combinations, in order to study the impacts of the climate change to different socio-economic sectors, and to integrate climate change into national strategic planning;
- 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.

8.1. Turkey's vulnerability to hydrometeorological hazards

8.1.1. Natural hazards in Turkey

Potential disasters in Turkey are mostly associated with earthquakes, droughts, heavy rain and floods, landslides, rock falls, forest fires, industrial explosions and fires, extreme temperatures, wind and snowstorms, avalanches, heat wave, fog, transportation accidents and terrorist attacks. Given the size of Turkey and the fact that the main hazard type is earthquake, most disasters are localized in certain provinces and do not affect the entire country. However, there is no information for the vulnerability of social groups such as women, the elderly, minorities, etc.

Disasters are one of the biggest obstacles to the sustainable development and social security of Turkey. Measured in terms of direct economic losses, natural disasters have, on the average, accounted for 1% of GDP. The majority of the population lives in earthquake-prone areas, where major economic investments and significant vital infrastructure and related construction take place.

Floods are among the most frequent and costly natural disasters in Turkey in terms of human suffering and economic loss. The historical flood database for the period between 1955 and 2009 provides information for 4,067 flood occurrences in Turkey, causing 1,400 deaths and serious damage to 30,800 dwelling units.

Landslides, rock-falls, avalanches, and other disasters of hydro-meteorological origin have also caused the loss of many lives and considerable economic loss during the last 50 years. From 1955 to 2009 landslides affected 5,472 settlements and killed 200 people. In this period 68,300 dwelling units were relocated to safer places. Landslides frequently affect inner and eastern Anatolia, and particularly the Black Sea regions in Turkey.

There have also been thousands of people affected and some hundred people killed by extreme winter conditions, cold waves and heat waves during the years (EMDAT database), even though the direct economic losses of heat waves are not taken into account.

8.1.2. Sectoral analysis of the vulnerability to hydrometeorological hazards

In Turkey a systematic analysis of economic losses due to disasters and emergencies has never been done. However, according to some available estimation, during last 50 years the damages to private houses have been almost US$ 10 billons. Considering that about 8% of the people affected by disasters are victim of floods, the damages related to floods for houses only can be estimated at US$ 0.8 billion.

Geographically, there is a large variation in annual precipitation, evaporation and surface run-off parameters, in Turkey. Precipitation is not evenly distributed in time and space throughout the country and the rivers often have irregular regimes. There are 25 hydrological basins in Turkey for a total surface water run-off of 193 billion m^3/year. 31% of the potential is constituted by the Euphrates (Fırat) and the Tigris (Dicle) Rivers both of which have their sources in the eastern part of the country. Taking into consideration the population of 2007 which is 70,6 million, the quantity of water per capita per year is 1,586 m^3. Countries regarded as being rich in water resources have 8-10 thousand m^3 water per capita per year. The available water per capita per year in Turkey is about 1/5 of the water-rich countries. In Turkey, 74% of the water resources are being used in irrigation sector. Therefore, in the drought period shortage in water supply in some proportions is very important for economical aspects. Although the demands (except the strategic ones) in the drought periods can be fully met technically by constructing storage reservoirs, this solution is not accepted as a rational solution economically and evaluated as waste of resources. In these periods the demands must be met by making shortages in water supply. Due to its location in the Mediterranean Basin, Turkey will be one of the most affected countries by climate change, according to United Nation Water Report published in 1994. IPCC (Intergovernmental Panel on Climate Change) 4th Assessment Report states that annual amount of precipitation and the number of precipitation days are very likely to decrease and the risk of summer droughts is to

increase in most of the Mediterranean Region. Flood is the second biggest hazard in Turkey, which causes higher economic loss after earthquakes. According to the records based on annual flood inventory studies, economic losses related to the flood disasters reaches 100 million US$/year and in the last 15 years, about 500,000 ha urban and agricultural areas were affected by floods. From this point, geographical, meteorological and physical characteristics as natural effects and human activities as socio-economic effects constitute the sensitivity level of Turkey to flood risk.

Almost one thirds of the total surface area of Turkey (77,95 million ha) can be classified as arable land. The country's large agricultural sector accounted for 29.5% of the employment in 2009. Historically, Turkey's farmers have been fairly fragmented. According to the 1990 Census, 85% of agricultural holdings were under 10 hectares and 57% of these were fragmented into four or more non-contiguous plots. Many old agricultural attitudes remain widespread, but these traditions are expected to change with the EU accession process. Under the available technology, 8,5 million ha area is estimated to be economically irrigable. Thus Turkey gives great importance to integrated regional development projects. The Southeastern Anatolia Project (GAP), Eastern Anatolia Project (DAP) and Konya Plain Project (KOP) can be mentioned among them. According to future projections, the share of irrigation use will decrease from 74% in 2008 to 64% by 2023. On the other hand, the domestic and industrial use would increase to 16% and 20% in this period, respectively. The water requirement increases steadily and the agricultural sector is the major consumer of water in Turkey with about 34 billion m^3/year while the water volume to be utilized by this sector would be expected at the level of 72 billion m^3/year by 2023. Agriculture sector nevertheless still remain particularly vulnerable to drought, both meteorological and hydrological, and the climate change projections indicate that the risk of summer droughts is likely to increase.

8.2. Institutional Framework of Disaster Risk Reduction in Turkey

8.2.1. Legal framework and policy supporting DRR in Turkey

Disaster Law (N.7269, 1959) is the main legislative document, which relates to all disaster related activities, and responsibilities at country level. Building on this act, the Regulation Concerning Fundamentals of Emergency Aid Organization and Planning Associated with Disaster Act No: 12777, defines the planning rules and the roles and duties of the central and provincial public institutions. In 2009 the Law on Establishment of Disaster and Emergency Management Presidency (5902/2009) established the “Disaster and Emergency Management Presidency” (AFAD) under the Prime Ministry. Moreover, some line ministries are involved in disaster risk reduction and post disaster response and rehabilitation issues. However, there are still some conflicts between laws governing sectoral responsibilities and the Disaster Law.

Other relevant laws are:

- Law on Establishment of Turkish State Meteorological Service, numbered 3127, dated 1937;
- Law on Establishment of DG for State Hydraulic Works (DSI), numbered 6200, dated 1953;
- Law on Protection against Floods, numbered 4373, dated 1943;
- Law on Precaution and Aid Against Disasters Effecting Common Life, numbered 7269, dated 1959;
- Law on Development Plan, numbered 3194, dated 1987;
- Prime Ministerial Circulars, namely River Beds and Floods, numbered 2006/27, dated 2006;
- Prime Ministerial Circulars, namely Rehabilitation of River Beds, numbered 2010/5, dated 2010;
- Law on Municipalities of Greater Cities, numbered 5216.

In addition to this law, some ministries like the Ministry of Environment and Forestry (MEF) and Ministry of Health, etc. are involved in disaster risk reduction and post disaster response and rehabilitation issues. However, there are still some conflicts between laws governing sectoral

responsibilities and the Disaster Law as well as what type of planning processes are necessary for DRR which need clarification.

The Crisis Management Center in the Prime Minister's Office and provincial crises centers operate in case of an emergency at national and local level. According to the extent and severity of disaster, the operating administrative level becomes higher. The system may be termed both central and decentralized but is coordinated from central bodies.

Disaster risk reduction policies are included in Turkey's 8th and 9th National Development Plans. In the medium term program covering the years 2008-2010, there are also references to disaster risk reduction activities.

In the National Millennium Development Goals Report of Turkey, under Goal 7 (Ensure Environmental Sustainability) atmospheric pollution, deforestation, protection of biodiversity issues are addressed and uncontrolled increases in building stock is defined as a negative factor in promoting measures against disaster caused by the impact of natural hazards.

Disaster mitigation activities and studies on current or possible natural disasters in Turkey are carried out according to the Act No: 7269. Regulation Concerning Fundamentals of Emergency Aid Organization and Planning Associated with Disaster Act No: 12777, taking its basis from this Act, defines the planning rules and the roles and duties of the central and provincial public institutions.

The Agricultural Drought Coordination Board has been established with the Cabinet decision (2007/12477) of the 07 August 2007. The Board is coordinated under The Ministry of Agriculture & Rural Affairs (MARA). It constitute the Legislative framework for the Turkey Agricultural Drought Action Plan (TAKEP), which has been published by the Official gazette on 2nd March 2008. The Policy objective is to establish strategies and measures to minimize the impact of drought on farming and food security. Drought risk assessment issues are not included in the mandate of AFAD, because the Disaster Law does not consider drought among disasters. Floods risk assessment is included in the mandate of AFAD.

Several governmental institutions operate early warning systems in Turkey. The roles of Turkish State Meteorological Services (DMI) and Turkish State Hydrological Works (DSI) in the DRR management are defined in the Law No 5902. On policy level DMI and DSI have a role in the DRR planning through the Ministry of Environment and Forestry as sources of basic hydrometeorological information, but they do not have a role as integrated partners in policy making and strategy planning of the national DRR.

8.2.2. DRR institutional framework

8.2.2.1. List of agencies involved in DRR

The institutions responsible for hydrometeorological risk reduction at national level are:

- Disaster and Emergency Management Presidency (AFAD) under the Prime Ministry. AFAD has been established in December 2009, it is responsible for Disaster and Emergency Management of Turkey (but not for drought issues) and for an effective emergency management and civil protection issues nationwide;
- General Directorate of State Hydraulic Works (DSI) of the Ministry of Environment and Forestry, responsible for monitoring and hazard assessment of flood and hydraulic drought;
- General Directorate of State Meteorological Services (DMI or TSMS) of the Ministry of Environment and Forestry, responsible for monitoring and hazard assessment of meteorological hazards;
- General Directorate of Agricultural Production and Development (TUGEM) of the Ministry of Agriculture & Rural Affairs, is responsible for the Agricultural drought management and coordinator of the Turkey Agricultural Drought Action Plan;

- General Directorate of Agricultural Research (TAGEM) of the Ministry of Agriculture & Rural Affairs;
- General Directorate of Electrical Power Resources Survey and Development Administration (EIE) of the Ministry of Energy and Natural Resources. It has been founded on June 24, 1935 under law No. 2819, being governed by the provisions of private law and administrated in accordance with commercial methods, having the status of a juridical person and being bound to the Ministry of Energy and Natural Resources, carrying out engineering services for the production of electrical energy. EIE is an investor public organization.

In addition, at the local level, all the local institutions are also responsible for risk reduction. These include the Governorates, the District Authorities, the Special Provincial Administrations, the Metropolitan Municipalities and the other Municipalities.

8.2.2.2. Disaster and Emergency Management Presidency (AFAD)

Turkey's Disaster Management System was reorganized after the 1999 earthquakes and in 2009 a new department called "Disaster and Emergency Management Presidency" (AFAD) under the Prime Ministry was established merging under one umbrella organization the former three main disaster responsible organizations. AFAD is responsible for coordinating nearly all phases of disaster management including DRR at national level, and installs rules, regulations, and guidelines for preparation of DRR plans at sub-national levels. The Presidency moreover serves as official HFA Focal Point.

AFAD mandate is to formulate and implement policies and to provide coordination among the Government, NGO and private institutions. The presidency conducts: pre-incident works such as preparedness, mitigation and risk management, during incident works such as response, and post incident works such as recovery and reconstruction. AFAD is authorized for all disasters and emergencies in all country, not only hydrometeorological (at the exception of drought that is not considered as a disaster). It has a coordination role between institutions and organizations, the mandate to produce and implement policies on: (i) preparation and mitigation before the occurrence of events, (ii) response during the event, (iii) recovery after the event, and (iv) and for the effective implementation of these activities across the country. AFAD has the mandate to:

- define the needs of in kind, in cash and humanitarian assistance;
- determine management strategies;
- establish and operate all kinds of information, communication, forecasting and early warning systems;
- make proposals to the relevant authorities with the need of public investment and personnel;
- implement training activities and exercises;
- take the recovery measures to ensure return to normal life after the disaster;
- provide temporary settlement in disaster areas.

AFAD departments are (i) the Planning and Mitigation Department, (ii) the Response Department, (iii) the Recovery Department, (iv) the Civil Defense Department, (v) the Earthquake Department and the (vi) the Administrative Services Department. The Planning and Mitigation Department is heavily involved in DRR and his missions include:

- To prepare disaster and emergency response, risk management and hazard reduction plans which will be applied nationwide;
- To determine possible disaster and emergency areas and to pronounce preventive measures;
- To determine reconstruction, plan and project rudiments of disaster prone areas;
- To determine cash, goods and humanitarian aid rules;
- To work for informing and raising awareness of public about disasters and emergencies;

- To collect and evaluate information about disasters and emergencies occurred within the country and abroad related to Disasters and Emergencies;
- To determine administrative strategies;
- To coordinate forecasting and early warning systems.

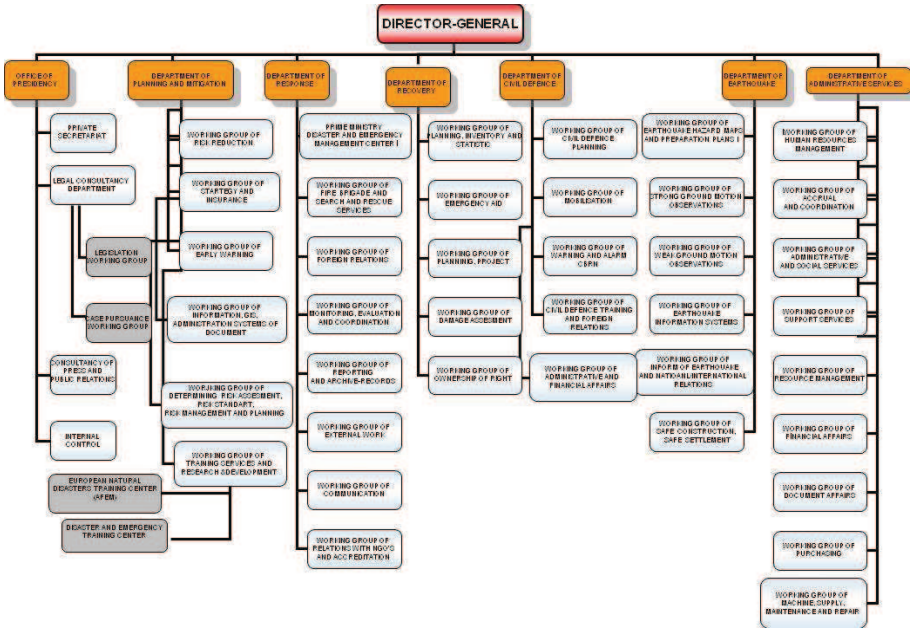

Figure 38. Organization chart of AFAD

8.2.2.3. Turkish State Meteorological Service (DMI)

The Turkish State Meteorological Service (DMI) was founded in 1937. It is the only legal organization, which provides all meteorological information in Turkey. The main objectives of the TSMS are to :

- make observations;
- provide forecasts;
- provide climatological data, archive data, and other information;
- communicate these to the public;
- provide meteorological needs of army and civil aviation.

Currently DMI operates the national meteorological observation network, it is in charge of national meteorological and climatological database. It produces climatological studies on extremes, variability and trends; prepare risk area maps. It also produces weather forecasts, it assesses. detects and predicts meteorological hazards using international and national weather forecasts, satellite data, observations; as well as formulates and disseminates hazards watches and warnings as well as other hazards related information and services to authorities and the public.

8.2.2.4. Turkish State Hydraulics Works (DSI)

The DSI, as the competent water authority, is the main organization responsible for water resources management. All water resources are managed in accordance with Law No. 6200. The DSI was established for the purpose of preventing damage caused by surface water and groundwater and ensuring the utilization of water resources for multiple purposes. In this framework DSI is responsible for the whole country except then for the large urban areas where the responsibility if held by the Municipalities. DSI operates the national hydrological observation network, it is in charge of the national hydrological database, produces annual and monthly reports,

and provides tailored hydrological services to agriculture, energy, environment sectors and to different branches of the services sector.
One of the basic duties and responsibilities of DSİ is building and operating protective structures against floods. It takes the necessary precautions and warns the relevant organizations in the event of flood emergencies. DSI conducts afforestation work and establishes recreation areas and facilities aiming at prevention of erosion, decreasing the sediment amount deposited in dams through rivers, restoring the environment of dam basins and their catchments.

DSI coordinates the preparation of the strategic and action plans for the water sector. DSI has 25 Regional Directorates. Major functions of these offices are firstly collect data in the field of mapping, hydrometric measurements, agricultural economy, land classification, drainage, groundwater and geology, and secondly to evaluate them for the planning, construction and operation of water structures.

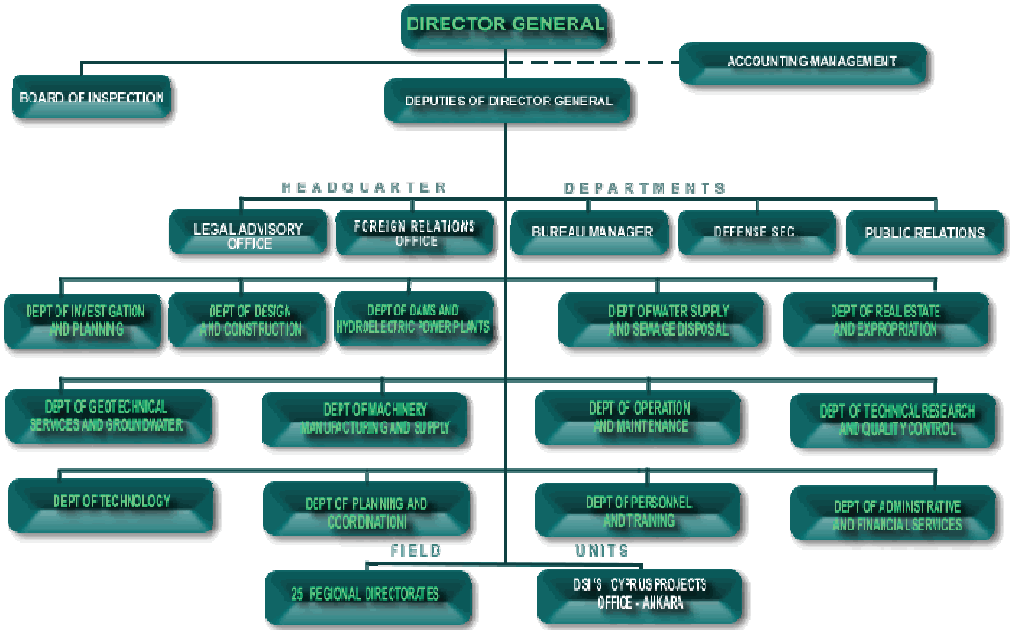

Figure 39. DSI organization chart

8.2.2.5. General Directorate of Agricultural Production and Development (TUGEM)

TUGEM is the coordinator of the Turkey Agricultural Drought Action Plan and particularly for the Monitoring & Early Warning Committee and the Risk Assessment Committee. TUGEM collects drought related data and information produced by different institutions involved in the Committees and the agronomic data coming up from the provincial directories of Ministry of Agriculture.

8.2.2.6. General Directorate of Agricultural Research (TAGEM)

TAGEM main object is to identify and disseminate tolerant plant species and varieties together with sustainable crop production systems to farmers in order to mitigate the effect of drought. TAGEM provides also services and information to TUGEM in the framework of the TAKEP. TAGEM collaborates with DMI for the development of R&D projects on agrometeorological early warning, crop simulation models and other initiatives. The research center based in Konya was nominated as a drought research center. The Bahri Dağdaş International Agricultural Research Institute studies drought risks in Turkey and is involved in drought monitoring. The institute has been recently reorganized so the roles and responsibilities of different departments haven't been yet defined.

8.2.2.7. General Directorate of the Electrical Power Resources Survey and Development Administration (EIE)

The General Directorate of the Electrical Power Resources Survey and Development Administration (EIE) is responsible for surveys related to electric power and for the rational use thereof. EIE has mandate for floods activities concerning Hydroelectric Power Plant (HEPP) projects. However, EIE does not perform drought related activities. The EIE activities related to floods are to collect, store and publish hydrological data, and to prepare engineering hydrology reports for HEPP projects. The department of Hydrological Surveys of EIE deals with collecting and storing hydrological data, analyzing it and producing hydrology reports. But those activities are just for HEPP project reports.

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

The Crisis Management Center in the Prime Minister's Office and provincial crises centers operate in case of an emergency at national and local level. According to the extent and severity of disaster, the operating administrative level becomes higher. The system may be termed both central and decentralized but is coordinated from central bodies. Each ministry has a unit responsible for disaster management rather than they're being one national coordinating agency with a more complete proper legal mandate and power.

In terms of institutions, the DRR system involves all concerned governmental bodies and is replicated almost identically at the central (Prime minister), provincial (Governor) and local (Sub-governor/Qaimaqam/District Governor) levels.

The National Hydrological and Meteorological Services are responsible for providing data to the DRR system: DMI maintains the national meteorological observation network and produces meteorological analyses, weather forecasts and warnings; DSI operates the national hydrological observation network and provides hydrological services to agriculture, energy, environment and services sectors. Due to a lack of adequate cooperation and coordination between the Hydrological and Meteorological sectors, the hydro-meteorological sector does however not have the optimal capacities to respond to the demands of developing communities.

Several governmental institutions operate early warning systems in Turkey. DMI has short and long term weather predictions and for some cases announces warnings for flooding, severe weather conditions, and heat waves. DSI operates flood early warning and prediction systems mainly established after the 1998 heavy rains and flash floods occurred in NW Black Sea Region. Standard Operating Procedures (SOP) and Quality Management Systems (QMS) between the DMI, DSI and the DRM sector have not been developed.

The organizational structure of DRR at provincial level is under the authorization of the governor. The governor does not have an operational role but coordinates and mobilizes others. Each governorship has its own "Provincial Rescue and Aid Committee" and under this committee there are 9 service groups, which are responsible for only response and recovery activities. The Provincial Directorate for Disaster and Emergency Management are responsible for loss and damage assessment, preparation and application of civil defense plans and for the Management Center for Disaster and Emergency. The municipalities are responsible for mitigation, preparedness, and response measures.

Turkey started studies to establish a National Platform after 2007 Global Platform meeting. The draft scheme of this platform including membership, and short-term programs has been sketched out by NFP. However, Turkey has not established a multi-sectoral National Platform for DRR at the moment.

8.2.4. Roles and responsibilities for flood and drought risk assessment

In Turkey there is a strong institutional basis for the development of risk assessment, indeed AFAD has the competency of coordinating other relevant institution. AFAD is preparing the standards for the risk assessment of all hazards, including floods, even if this process is just starting and will take time. Moreover, recent legislation increased the responsibility of municipalities and AFAD should ensure the efficiency of the mechanism. Actually, the current capacity of DSI and DMI would ensure the provision of useful historical and current data.

AFAD ensures the coordination amongst the Government, NGO and private institutions in order to formulate and implement policies. As it has been established only in December 2009, so the risk assessment is still in progress and even the methodological framework is not completely defined. AFAD plans to develop a national disaster risk information system including a database on disasters.

Despite the legal and institutional framework is quite clear, flood risk assessment is just starting in Turkey and operationally the workflow has many gaps. Regarding floods, according to the current legislation, flood risk assessment should be performed at local level by the local governments for spatial planning purposes, and at national level by AFAD, which has clearly defined the risk assessment in its mandate, for the preparation of Emergency Plans. AFAD is charged also to develop a standard methodology for risk assessment and the guidelines for the local authorities. AFAD is also charged to support local authorities in the implementation of risk assessment if they don't have the technical capacities.

DMI is charged of the meteorological measurements and analysis, so its contribution to floods risk assessment consists in providing meteorological and climatic data, analysis and indexes. DSI is charged to provide to AFAD and local governments flood hazard maps and analysis for implementing the flood risk assessment with suitable precision according to the scale of analysis. DSI is also charged of the flood protection planning, of evaluating the need for structural measures to protect flood prone areas. Moreover the floods risk analysis have many other users, including Municipalities, Banks of Provinces, insurance companies demanding flood investigation for the development of their own plans. AFAD is also charged of hazard impact data management and analysis even if at present a real comprehensive hazard database doesn't exist yet. AFAD collects information about floods from all relevant institution and has agreed protocols for data collection with DSI and Municipalities. Flood hazard analysis and mapping have been provided by DSI till now for specific areas, but starting from 2011 these activities should become systematic.

DMI provides meteorological data to DSI, AFAD and local Governors. DSI is charged of the measurements on streams and uses both its own data and DMİ data to calculate discharges of the rivers and creeks for different return periods. DSI produced and provides to AFAD and local authorities maps of flood prone areas.

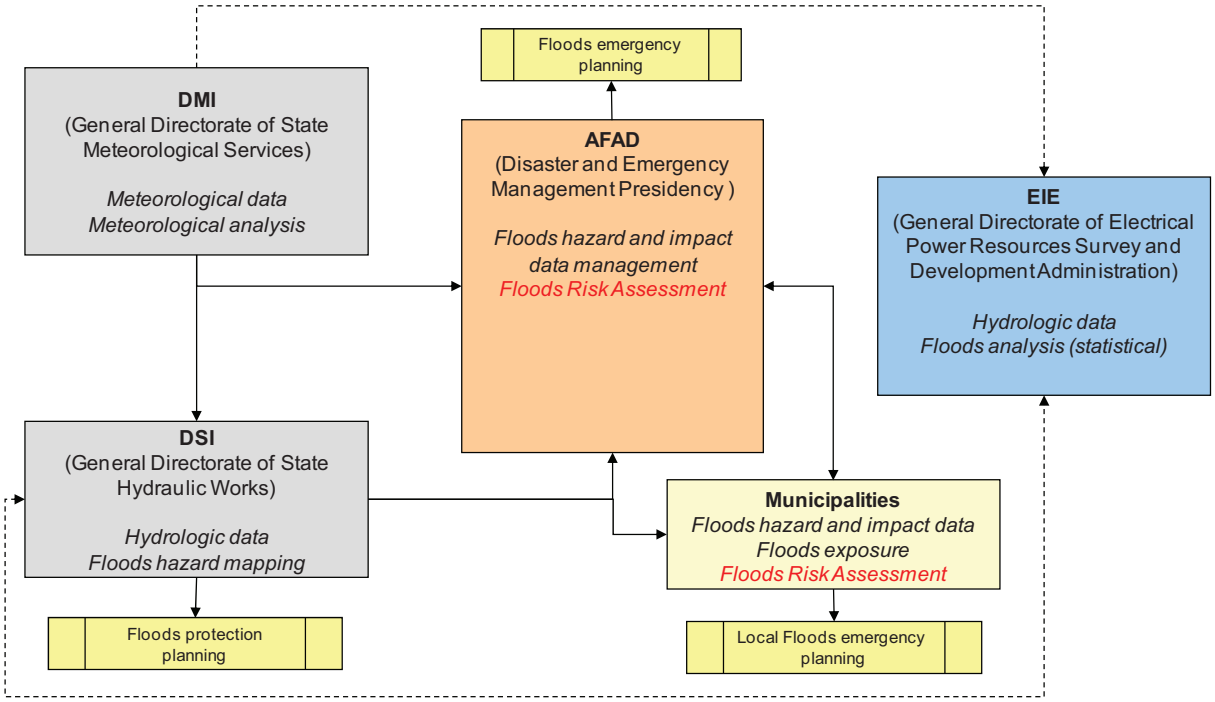

Figure 40. Floods risk assessment work flow in Turkey

Concerning drought, there is not a clear legal and institutional framework for risk assessment and there is not a responsible institution for drought risk assessment for planning purposes. Some institutions are analyzing the different aspects of drought from their point of view (DMI for meteorological drought, MoA for agricultural drought and mainly for current management, DSI for hydrological drought). AFAD does not have mandate for drought risk assessment, even if in the future drought would be considered among the disasters and then included in AFAD mandate. Actually, the existing Turkey Agricultural Drought Action Plan (TAKEP) aims principally to drought monitoring and management. It is however interesting to analyze TAKEP work flow, because it provides the framework for the collaboration of main actors on drought analysis. The main targets of TAKEP are to create public awareness on drought, to sustain agricultural water usage, to take proactive measures, and to implement effective actions to alleviate drought effect during drought period.

The General Directorate of Agriculture Production and Development (TUGEM) is the coordinator of these activities. Data is collected by the Provincial Directorate of Agriculture and sent to the Data Provider Unit. Then phenological observations and agricultural production information are analyzed by Monitoring & Early Warning Committee, which prepares a report presented to the Risk Assessment Committee. If there is the need, Evaluation reports from Risk Evaluation Committee are submitted to Agricultural Drought Coordination Board. The reports of the working groups are presented to the Ministry every month. DMI Agricultural Meteorology Division participates in both the committees providing each month drought indexes and precipitation analysis at national, regional, watershed and agroecological zones levels. For the Risk Evaluation committee, DMI produces also 3 SPI scenarios (± 20%) for the next 6 months. DSI also participate in the committee, but not AFAD.

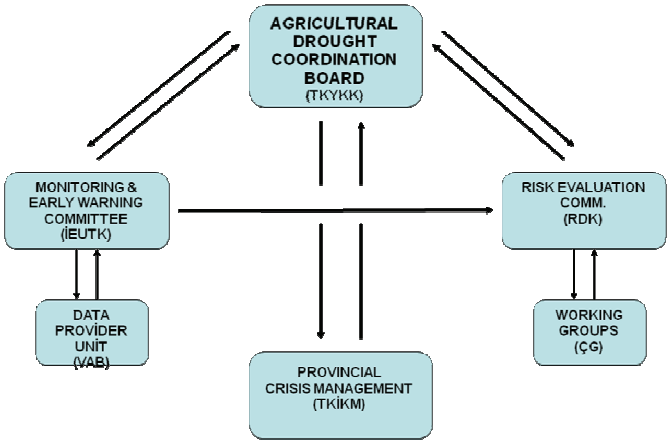

Figure 41. TAKEP workflow

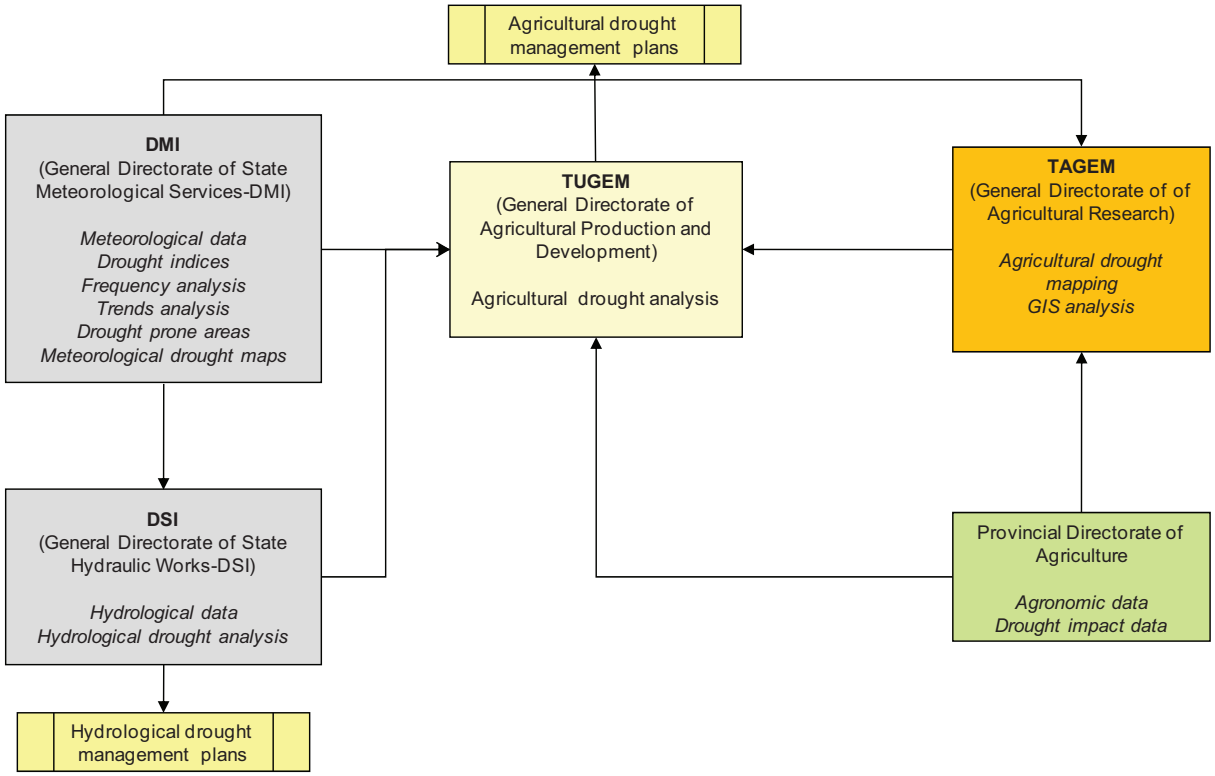

Figure 42. Drought analysis workflow in Turkey

8.2.5. Sources of funding

In Turkey, the State has a legal obligation (Disaster Law, No. 7269) to fund the costs of reconstructing buildings after an earthquake; but the State does not have a similar legal responsibility to provide funding for DRR. After the two major earthquakes in 1999, which caused widespread destruction of the building stock, the Government of Turkey decided to enforce earthquake insurance on a nationwide basis with the sole purpose of privatizing the potential risk by offering insurance.

One of the weaknesses of the insurance pool is that it is limited to earthquakes. It does not cover other disasters such as floods, landslides, or avalanches. Therefore a draft insurance law has been prepared and presented to the Parliament.

Hydro-meteorological risks such as drought, frost, hail, heavy rain, flood and storms cause significant agricultural damages in the country. In order to provide coverage to hydro-meteorological risks which are threatening the agricultural sector, and also with increasing likely effect of climate change dependent on global warming, the implementation of an insurance mechanism has been considered and for this purpose, "Agricultural Insurance Code No. 5363" was brought into effect in 2005. In order to improve and expand agricultural insurances and carry out other technical services “The Agricultural Insurance Pool” was established.

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

8.3.1. Monitoring and observations networks and data exchange

Hydrometeorological observations and especially the upper air observations are essential for global, regional and local weather forecasting and numerical modelling of the atmosphere. Long-time historical time series of accurate quality controlled observations are required for hazard analyses, climatological studies and monitoring of climate change. Real-time observations are critical for:

- prompt reaction in meteorological, hydrological and air quality emergency situation;
- 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.

8.3.1.1. DMI observation network

DMI has quite extensive and versatile observation network (table 52). The number of automatic weather stations (AWS) is 463, and almost 400 of them are in real time data collection through GPRS or satellite. All basic meteorological parameters have been measured by means of electronic sensors at this network. On the other hand, the AWSs used in the network have an open architecture to improve the capability of the system by adding new sensors or upgrading the software for advanced data collection and product generation. 246 new AWOS are being installed. Automatic Weather Observing Data are collected instantly by using TCP/IP technology (GPRS,VSAT, ADSL). Synoptic and Aviation data are collected instantly by using web-based communication software (ADSL).The data collected at the stations are transmitted to operation center at the headquarters of TSMS in Ankara via GSM, satellite or ADSL. In unmanned stations data are directly transmitted from data collection unit (DCU) to the operation center while the data are transmitted to operation center after entering some data manually which can not be measured automatically. Data collected by DMI are:

- Air Temperature (daily max, min and average, hourly);
- Air Pressure (daily average, hourly);
- Air humidity (daily average);
- Cloudiness (daily average coverage);
- Rainfall amount (daily total amount);
- Evaporation (daily total amount);
- Evapotranspiration(daily total amount);
- Soil temperature (5,10,20,50 and 100 cm. depth) (daily average);
- Wind speed and direction (daily and hourly average, daily maximum wind speed, direction and time);
- Global solar radiation (cal/cm2 – hourly and daily total);
- Sunshine duration (hour – hourly and daily total);
- Snow depth (cm. daily);

- Precipitation type, intensity, and duration;
- Phenological data (collected on 250 stations).

Table 52: Observation stations operated by DMI in 2010

Type of observation stations	Number	Connected to WMO GTS	Comments on the network
Atmospheric domain			
Surface synoptic stations (> 8 obs./day)			
Manned stations	132	132	
AWS or AWOS	463	58	
-Cloud-height – automatic			
Agrometeorological stations	250		
Ordinary climate station (3 obs./d)	263	58	
Rainfall station (2 obs./d)			Not operational: 353 sts
Rainfall station – automatic			
Meteorological towers	0		
Upper air radio sond stations	8	8	
Pilot balloon stations	0		
SODAR/RASS	0		
Wind profiler stations	0		
Lidar	0		
Access to AMDAR data	no		
Weather radars	4		Only 3 operational
Hale radars	NA		
Lightning detection stations	0		
Lightning detection hub station	0		
Actinometrical stations	161		
Distrometer	5		
Satellite MSG ground station	1		
Maritime domain			
Marine weather stations	36		
Lake stations	2		
Buoys			
Buoys with meteorological observations			
Tidal stations			
Tidal stations with met. observations			
Environmental domain			
Air quality	7		
Water quality			
Nuclear deposition			
Ozone – near surface	7		
Ozone – upper air	1		
UV radiation	11		

Upper air soundings are essential input data for numerical weather prediction models. DMI has an upper air network composed of eight rawinsonde stations. This network was upgraded with GPS based ground receiving system in 2002. Two observations have been made at each station at 00:00 UTC and 12:00 UTC every day. Rawinsonde Stations are placed in: Ankara, Istanbul, Izmir, Diyarbakir, Erzurum, Samsun, Adana and Isparta. The network is capable of launching two different types of radiosonde from different manufacturers. The TEMP messages generated during the observations are transmitted to the center via ADSL or dial-up connection, and then transmitted to GTS network from the central communication server. Also, atmospheric profile data from ground to upper atmosphere with 1 hPa steps are generated, transmitted to centre and archived in a database. The upper air observations could be significantly improved by implementation of a wind profiler network, which would provide continuous data from the atmosphere, or/and by using the AMDAR data produced by airplane measurement system installed on commercial regular flights.

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). It will not be wrong to assert that weather radars, at least for today, are the only and essential instruments as active remote sensing systems which can provide real time (less than 15 minutes depending on the scanning strategy and processing features), accurate and high resolution (up to 150 m) weather information in large scale area (up to 500 km depending on the frequency used) particularly for nowcasting purposes. DMI has been operating a weather radar network of four (4) C-Band weather radars. The first radar of DMI was installed with dual polarization capability in Ankara in 2001. Then the network was formed by adding three weather radars in İstanbul, Balıkesir and Zonguldak in 2003. The project for installation of six (6) radars is still under implementation. It has been planned that the network will have 10 radars by 2011. In addition to the western part, north and south coasts of Turkey will be under coverage of radar network after the completion of that project. DMI has also planning to expand its network to cover whole country by adding new radars. Most probably DMI will be operating a weather radar network of almost twenty (20) radars within next decade. Currently, single and composite images are generated and archived from radar network. These products are available for the public in the web page of DMI. Weather radar network is controlled and operated by the radar operating center from Ankara, and the generations of the radar products and distributions of them to the users are performed from here. The prime communication media between radar sites and the operating center is satellite. The radio-link+terrestrial line is used as back-up of satellite system for the continuous operation of radar network.

DMI has a remote sensing division and has EUMETCAST and Metop/NOAA ground receiving stations. Satellite images are stored and disseminated through the DMI web pages, but used only for weather forecasting.

DMI sends data from quite many stations to WMO-GTS, as shown in Table 52.

8.3.1.2. DSI observation network

DSI has 710 precipitation stations, of which 357 are currently operational (452 in 2011) and 1176 discharge measurements stations (1117 in 2011). Additionally DSI operates 118 lake observation systems (120 in 2011), 150 snow stations (115 in 2011) and 1200 water quality (1000 in 2011) and sedimentation measurement stations (table 53). From those stations, hydrological and meteorological variables such as river flows, groundwater and lake water levels, sediment loads, water quality, amount of precipitation, and evaporations are collected and monitored. The data related to Turkey's ground and underground water sources (quantity and quality data) are centralized mostly via GSM, are quality controlled in terms of time, coherence and consistency and stored in the database. Currently DSI has access to the weather radar data, but DSI does not use the data to calculate precipitation or flood.

8.3.1.3. Maintenance

DMI has been able to recently modernize its calibration system, including a new wind tunnel for wind gauge calibrations. The Calibration Center of DMI works in accordance with TS EN ISO/IEC 17025:2005 standards and has been accredited since 30th of April, 2010 in the fields of temperature, relative humidity, pressure, wind speed. Other laboratories working in accordance with TS EN ISO/IEC 17025:2005 standards are the precipitation Laboratory and the solar Radiation Laboratory. However, as the whole calibration system is new it was not yet in full use in 2010. The strategy of calibration, including the frequency of calibration, of meteorological sensors is not yet defined. The strategy of selection and use of wind sensors is not yet decided. Anyway, as many of the stations are, and will be, located at sites with cold climate, it is necessary to take into account use of ice-free sensors, in order to ensure the quality of data (DMI has been mainly using cup anemometers in the network. There are a few ultra-sonic wind sensors which have been used for testing).

Table 53: Observation stations operated by DSI

Types of observation stations	Number		Connected to WMO GTS	Comments
	2010	2011		
Atmospheric domain				
Surface synoptic stations (> 8 obs./day)				
Manned stations				
AWS or AWOS				
-Cloud-height – automatic				
Agrometeorological stations				
Ordinary climate station (3 obs./d)				
Rainfall station (2 obs./d)	357		452	Not operational: 353 sts
Rainfall station – automatic				
Meteorological towers				
Upper air radio sond stations				
Pilot balloon stations				
SODAR/RASS				
Wind profiler stations				
Lidar				
Access to AMDAR data				
Weather radars				Only 3 operational
Hale radars				
Lightning detection stations				
Lightning detection hub station				
Actinometrical stations				
Distrometer				
Satellite MSG ground station				
Hydrological domain				
Hydrometric stations				
Discharge station – manual	1176	1117		
Discharge station – automatic				
Water level post – manual		120		lake gauge stations
Water level station – automatic				
Snow level gauges		115		
Water quality stations		1000		

8.3.1.4. Other observing networks

The General Directorate of the Electrical Power Resources Survey and Development Administration (EIE) has an observation network all over Turkey for hydrological data collection purposes. and collects: (i) water level on rivers and lakes, (ii) discharge measurements at Stream Gauging Station's(SGS), (iii) water equivalent of snow depth, (iv) sediment and (v) water quality. The data such as water level on rivers or lakes, discharges, snow depth, sediment and water quality sampling collected on the field are sent to the Administration Center in Ankara to be processed for quality control and validation. Only some Stream or Snow Gauging Stations are connected to EIE with GSM lines. Data is stored in a central database. Finally the data such as daily and monthly discharges, instantaneous peak discharges, lake level, snow-water equivalent, sediment and water quality of stations are published for general usage. EIE has a data catalogue, does not utilize remote sensed data or geographical data. EIE utilizes weather and climate data for just HEPP projects purposes. EIE does not utilize meteorological short-medium term forecasts. Mainly meteorological data, or sometimes hydrological data, during the engineering hydrology calculations of HEPP project are provided by other entities such as DSI and DMI. The data exchange follows official procedures ensuring free data exchange subordinated to copyright. Contrariwise, provision of data to third parties is prohibited. Actually, there is no regular data sharing with national organizations, neighboring countries or international organizations, but data sharing does not conflict with EIE's general policies.

8.3.2. 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. The DMI meteorological database includes following data:

- Climatological data (1926-Today);
- Ravinsonde data (1971-Today);
- Synoptic data(1980-Today);
- AWOS data (2003-Today);
- Aerodrome AWOS data (2003-Today);
- Metar data (03/2000-Today);
- Taf,Sigmet,Airmet data (2008-Today);
- Open Screen Observation Data (1999-Today);
- Sea Surface temperature data(Beginning– Today);
- Inversion analyze data (2006-Today);
- UV-B Data; From 1997 to Present;
- Ozon Data; From 1994 to Present;
- Precipitation Water Analyse Data; From 1999 to Present;
- Radar Data (2008 – Today);
- Satellite Data (2008 – Today);
- Model Data (2006 – Today).

Regarding validation and quality control, manual Climatological data are controlled by using Quality control software monthly. Automatic Weather Observing are controlled by using Quality control software and the human resources for quality control are 6. Synoptic and Aviation data are controlled by using Quality control software instantly.

For data management, data from 206 AWS are collected through a data Collection database that is MS SQL Server RDBMS and data from other 150 AWS are collected through ORACLE DB. All data are finally archived through a data archiving database, which is SYBASE RDBMS. These data include meteorological data (air temperature, air pressure, relative humidity, wind speed and direction, precipitation, solar duration and radiation, soil temperature) and meteorological information which are obtained from processed data. Archived data consist of ground level and various atmospheric level (standard atmospheric levels and significant levels in the atmosphere). Meteorological data are archived in relational database (Sybase ASE 15 and Informix 7.31 RDBMS). Data warehouse software (Sybase IQ15) is used to process meteorological data for production of meteorological information. Archived data are updated 20 - 22 days of every months after passing through data quality control system.

Turkey Meteorological Data Archiving and Management System (TUMAS) is the main repository of meteorological data at DMI. TUMAS uses Sybase RDBMS and MARS software which is used in ECMWF for achieve and retrieve data which are stored in different media (disk storage system, tape library). MARS software is installed in TUMAS and mainly works for archiving/retrieving data from/to disks or tapes. TUMAS has a web interface where all data are provided to internet users. Access to TUMAS is based on membership and provides access to achieved meteorological data http://tumas.dmi.gov.tr/wps/portal .

For example, DMI has an agreement with AFAD for providing data about extreme events. AFAD stores and uses this data internally for risk management and reduction. The feedback received from the users via Internet ensures the effectiveness of the dissemination mechanism. Moreover, in order to support the users of produced information, symposia are regularly organized in order to provide users with information about the products and about their use. Regional workshops are also organized for presenting the information products and collecting feedbacks. In the framework

of the Ministry of Environment and Forestry it is planned to develop a WebGIS portal for the dissemination of geographical information, including DMI and DSI ones.

In TUMAS – mars section, all data is archived in bufr and grib format. Because MARS software does not support data except bufr or grib format.

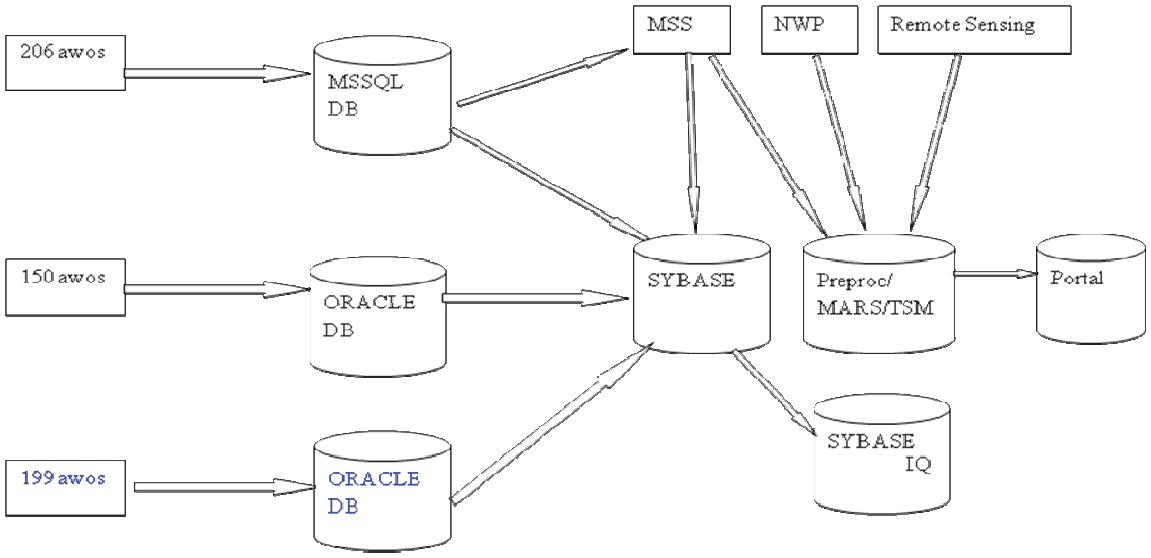

Figure 43. DMI data flow

The data dissemination through TUMAS implies some restrictions to users. Data are charged to private person and entities. Other users receive data free of charge by DMI data dissemination and exchange policy. Synoptic and Aviation data are shared via GTS with all WMO member countries in the framework of WMO Data Exchange Policy. DMI shares meteorological data with all related national organizations.

The data management facilities and computing power has significantly increased during the very last years. DMI has good computing resources for data management: HP DL380, HP ML370, HP LH6000R, IBM x3650, IBM x3755 and IBM p series P560. Disk space currently available: 11,6 TB SCSI and 11.8 TB SATA. The IBM TS3500 tape system capacity is 290 TB. for archiving all measurements and observations which are made by DMI.

The DSI hydrological database consists of precipitation and hydrological (discharge, water level from rivers and lakes, water quality) measurements. DSI has a big database in form of hard copy. Water database project has been started to produce a digital database. This database will also include water quality data.

Currently there is no common database of DMI and DSI data.

8.3.3. Hazard analysis and mapping to support risk assessment

Hydrometeorological hazard maps are required as basic information for flood risk assessment and consequent planning activities both at local and national level. According to current legislation and strategic planning, AFAD initiated the definition of risk assessment standards for the full spectrum of disasters. Moreover, AFAD is charged to develop risk assessment guidelines for local governments, which have launched risk assessment studies at local level.

AFAD collects data on flood events such as affected area for inventory studies. The data of past floods till 2009 were collected by General Directorate of Disaster Affairs (without spatial or

geographic reference) and since 2009 are collected by joint investigations based on a proper protocol with DSI. Moreover some flood information is received from local governors. Flood extent is collected only since 2009. This data are centralized and archived in a database (up to 2009 the National Disaster Inventory System), which is mainly designed for impact data. The database contains physical information about the flood only since 2009. Even if AFAD receives meteorological data and data about meteorological extreme events from DMI and hydrological data from DSI, this data is not associated to the floods events in the databases. This data till now have not been used for floods mapping. As stated above, in the coming years all disaster related institutions would share their data with AFAD by a legal arrangement to analyze the risks. Then AFAD will keep and evaluate data that will come from all related institutions. A multihazard database should be developed for this purpose.

At AFAD, analysis on hazard data is generally limited to earthquakes. Concerning floods, hazard maps have been prepared for West Black Sea Region only (floods of 2010, maps produced by DSI). Flood analysis is made according to the event, the extent of the flooded area, the number of the affected buildings and the number of victims. Starting from 2011 AFAD and DSI should start the activities on flood data collection and hazard mapping on a systematic way. Actually AFAD didn't produce any flood risk information, because it is a new organization and it is in the phase of the determination of the procedures, standards and methodologies. Concerning the risk information dissemination, AFAD's primary stakeholders are city Governorates. So, AFAD will provide guidelines and technical support to local authorities and will receive back the local risk assessments. AFAD has technical capacities in GIS and databases development and management (Department of Data Processing).

AFAD collects floods impact data. AFAD has two different databases for hazards. The first is the National Disaster Inventory System (developed by the Turkey National Disaster Archive Project – TUAA - former General Directorate of Disaster Affairs). This database has been developed according to the EM-DAT criteria. Concerning floods, this database includes (i) date and place of the event, (ii) affected area, (iii) affected buildings, and (iv) affected people (number of dead, number of injured people). This database doesn't have geographic references, except the name of the locality. The other database is the one archiving the data that is being collected since 2009 in collaboration with DSI, which has also geographic reference. This database contains many information related to the recent floods of the black sea region occurred in September 2010. AFAD uses this data to determine the country-level strategy for disaster and emergency situations.

DMI collects meteorological and climatological data, which are useful for drought characterization and mapping. DMI collects also phenological data on 250 stations. This data are stored in a database and could be used as drought indicators. On the basis of this data DMI analyses the meteorological extreme events in terms of frequency, intensity and distribution of the occurrences. Meteorological drought is analyzed using rainfall and drought indexes. DMI produces Standardized Precipitation Index, Percentage of Normal Index and climatic classifications using the Aydeniz Method. DMI analyses the extreme meteorological events in terms of frequency, distribution, intensity and return periods of the occurrences. Trends of precipitation, temperature and growing season length have also been analyzed. DMI also produces climate extreme indices by using RClimDex software. The Agrometeorological Division of DMI has the following analysis tools (also available on-line):

- Frost forecast and warnings for agriculture, including a warning dissemination system through SMS;
- Harvest time forecasting programme, producing i) forecasted harvest time, ii) current cumulative temperature, iii) long-term average cumulative temperature and iv) long-term average harvest time;
- Wheat forecasting yield (Agrometshell run by TAGEM).

DMI has GIS expertise (ArcGIS and Q-GIS) and organizes GIS training courses for WMO member countries of the VI region (connected to the FFGS project in the Research Division). DMI does not

have a real geodatabase, but a centralized geographic layers archive. DMI produces maps of meteorological drought using drought indexes and frequency analysis. DMI has an agreement with the Ministry of Agriculture for producing Palmer drought index for the identification of the drought prone areas (meteorologically). DMI does not integrate any other non-meteorological information. Further analyses on drought are performed by the Ministry of Agriculture.

DSI performs hydrological analysis using its own hydrological data and meteorological data provided by DMI. DSI (through its Provincial directorates) collects floods severity and extent information, which is stored at DSI and also shared with AFAD. This information is mainly used for calibration of flood models. DSI keeps a database, which has records on river floods and flash floods. The DSI hazard database consists of data since 1954. DSI produced in the past maps of floods prone areas, which are still used by AFAD and City Governorates. For the inundations of September 2010 in the Black Sea region, DSI produced detailed floods maps. For some other small basins DSI has modeled the floods with HECRas Model in order to identify the potential water level for different returns periods. Currently, DSI is launching an initiative for the implementation of flood hazard mapping on 3 pilot regions. In perspective this maps should cover the whole country and be the basis for floods risk assessment. Concerning hydrological drought, DSI calculates the water balance region by region (average values and deviation) using precipitation, streams and surface water, in order to assess the water needs and eventually plan water retention or inter-basin water transfer infrastructures.

TUGEM collects and records all kinds of data that can affect plant growth on drought events like meteorological and precipitation data, phenological observations, agricultural production information. There are no protocols for hazard data management or for sharing data between the organizations. TUGEM collects some drought/floods impact data on agriculture from the Provincial Divisions, but they are mainly organized in forms and not as a database of events. Monthly syntheses per province are included also in the Monitoring and Early Warning Forecasts committee reports. Committees have been working for 2 years and the monthly reports are available. TUGEM, in the framework of the Risk Evaluation Committee, produces drought maps. TUGEM uses seasonal or monthly climate forecasts (downscaled ECMWF) from DMI for preparing the monitoring and risk evaluation reports. TUGEM analyses meteorological data and water capacity of dams for irrigation in risk assessment reports. TUGEM has not GIS specialists but relies on TAGEM specialists for analysis of water sufficiency index and remote sensed vegetation monitoring.

TAGEM generally collects vegetation data for cereals and legumes together with rainfall, temperature and humidity at monthly bases. TAGEM has GIS capacities and uses NDVI for vegetation monitoring. TAGEM has not yet established any methodology for agricultural drought risk assessment but its GIS & RS department should be responsible for this kind of analysis. The department produces for TUGEM and the TAKEP drought indices, vegetation indexes using GIS and remote sensed images for vegetation monitoring. TAGEM runs also the AgrometShell crop simulation model in the framework of a FAO project, which involves also DMI. Wheat yields are forecasted monthly starting from April.

At EIE annual instantaneous peak discharge values of SGS's are available, but EIE does not have any products such as hazard mapping, indices or risk mapping. EIE has produced floods analyses have been done only for HEPP projects. The performed analyses are: frequency analysis (2,5,10, 25, 50 100, 500, 1000, 10000 year-return period of discharge) and discharge of dams spillway. These analyses have been developed using mainly MS-excel and EIE does not have any numerical hydrological/hydraulic model.

8.3.4. Forecasting

8.3.4.1. Weather forecasts

DMI has quite good weather forecasting system based on use of numerical weather prediction (NWP) models. Weather forecasts are published for 1-5 days and disseminated to media and

through the DMI web pages. Now casting are not produced operationally as there is not a sufficient weather radar network available.

DMI operates several NWP models: MM5, an open code model from NCAR and Penn State University (USA), and ALARO (ALADIN consortium). The horizontal resolution (mesh size) of MM5 is 13,5 km and 4,5 km consequently. The MM5 and ALARO are run 4 times daily, with boundaries from ECMWF and ARPEGE (MeteoFrance), which are used to forecast 0-72 h. The ARPEGE model has been developed jointly by Météo-France, and the European Centre for Medium-range Weather Forecasts (ECMWF) under the acronyms ARPEGE and IFS (integrated forecast system). This model includes, inter alia, an atmospheric general circulation model (GCM) which is intended by the French climate modelling community to be used for studying the anthropogenic climate impact. A preliminary version of this model has been available since 1992. DMI does not use data assimilation in its models.

Figure 44. Area modelled by the ALADIN NWP model - 4.5 km horizontal resolution

DMI has purchased a supercomputer system in 2009 and installation was completed by the end of 2009. The system consists of a SGI Altix 4700 (having 512 Intel-Itanium cpus and 1 TB memory.), 30 TB disk space for NWP model runs and more than 25 TB disk space and several smaller service and management servers.

Various software, including Metview-4 from ECMWF, are used for visualization of NWP data.

8.3.4.2. Hydrological forecasts

DSI does not run any hydrological models. Currently DSI does not produce numerical forecasts. However, DSI provides tailored hydrological services for different sectors. In hydropower sector the efficiency of the power plants could be improved if better hydrometeorological services could be provided.

However R&D projects are currently being implemented in tis area. In the context of flood monitoring and early warning system, DMI carries out the project, “Capacity Improvement For Flood Forecasting And Flood Control in the TR-BG CBC Region”, on EU funds. Hydrometric and meteorological stations in both Turkish and Bulgarian territories have been installed and a flood model has been set up and initiated. Thanks to this model, a flood can be forecasted 57 hours in advance. Another relevant project developed by DMI and DSI is the “Development and Implementation of International and Regional Flash Flood Guidance and Early Warning Systems in the Black Sea and Middle East Regions”. The project is implemented in collaboration with WMO, HRC, NOAA and USAID as main donor agency. In this framework discharge models will be applied in 2 pilot basins. The flash flood system functions at one level as a disaster mitigation tool by mitigating loss of life and injuries, and by rapidly targeting disaster response agencies to potential

problem areas. On another level it can be used to provide maps of flash flood probabilities. These maps can be used to provide a risk assessment tool for spatial planning and guidance for planning flash floods prevention measures. Two pilot basins will be modeled using discharge 2 dimension models calibrated using information about past floods. Then the models will be used for the characterization of the basin in probability classes of flood occurrence under different return periods. This flood hazard maps would be used for the flood risk assessment by local authorities and AFAD by overlying the exposure maps (infrastructures, assets, etc.) that in the meanwhile Municipalities should have prepared.

8.3.4.3. Marine Environmental and Special weather forecasts

Daily 24 h marine forecasts (gale, weather, wind, wave and visibility) are produced for 6 h intervals for following areas: East Black Sea, West Black sea, Marmara, North Agean, South Aegean, West Mediterranean and East Mediterranean. DMI uses the METU-3 model, linked to the ECMWF model, for wave modelling.

For prediction of dispersion of airborne pollutants DMI has the capability to operate the DREAM model, linked to the NCEP weather prediction model. DSI is a partner in an EU twinning project for Buyuk Menderes River, to model dispersion of waterborne pollution and water quality.

DMI produces specialized weather forecasts to several sectors: agriculture, road transport (2/day), water transport (2/day), air transport, tourism, energy production (1/day), water management and fire brigades (1/day). However, e.g. the services for road transport and energy are quite limited compared e.g. to products provided by advanced EU NHMS, which partially depends on lack of good coverage of weather radars, lightning detection network and lower number of on-line weather stations. There is potential to enhance commercial scientific services to all sectors. In order to promote cooperation with different economic sectors it is necessary to enhance R&D activities and cooperation with high-tech EU companies and NHMSs and to implement state-of-the-art analyzing, production and dissemination tools.

8.3.5. Warning products and services

8.3.5.1. Warnings and mandates

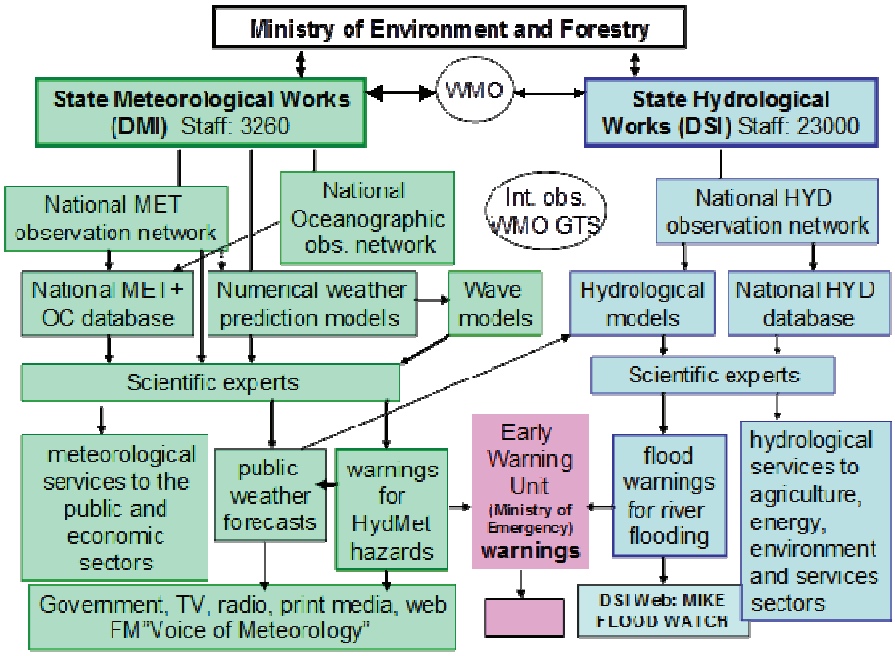

Figure 45. Production of hydrometeorological warnings in Turkey

In Turkey science based warnings for hydrometeorological events are given separately by DMI and DSI. The DMI warnings are based on numerical weather predictions from global models run by international centers, and local scale NWP models run by the DMI numerical center, real time satellite information and meteorological observations. DSI does not operate numerical models, and does not have access to the DMI NWP products. Additionally the new 112 system will obviously become one additional body for preparing and dissemination of warnings. However, currently the 112 system does not have any expertise in meteorology or hydrology.

Table 54: Warnings for natural and technical hazards in Turkey based on Annex 2

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

There is certain cooperation and data exchange in production of hydrometeorological warnings by DMI and DSI, as shown in figure 45. However, currently the level of coordination between activities of DSI and DMI is not sufficient and due to lack of an active cooperation among hydrologists, meteorologists and disaster managers, early warning for hydro meteorological disasters especially for floods cannot be implemented properly.

As seen from table 54, there are many hazards related to meteorology and hydrology for which no warnings are currently given, flash flood being the most significant. However, warning for heavy precipitation issued by DMI may also include warning of potential flash flood. In order to promote flash flood forecasting and warning DMI is member of a recently started regional Flash Flood Warning System project financed by USAID and led by Hydrology Research Center, USA. The warning system will be based on analysis of satellite data, DMI NWP models and real-time precipitation data from the DMI observation network. There is a flood warning systems under preparation for 2 regions (Istanbul region).

8.3.5.2. Warning dissemination mechanism

Currently part of the warnings are disseminated directly to end-users, partly through authorities. The 112 center is still not fully operational. DMI disseminates warnings using media, SMSs to phones in hazardous region, internet and own radio station. DMI has an own 24/7 radio station which provides weather forecasts hourly, and warnings when needed (in Ankara FM 92.4 MHz, in Istanbul 103 MHz). DSI does not disseminate their results through media, but to the DSI regional directorates, who then warn the local city governors if needed. It also issues warnings on its own intranet pages: MIKE FLOOD WATCH.

8.3.6. 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.

Equipment in use at DMI and DSI for data communication and products and warning dissemination is described in Table 55. The public switched telephone network (PSTN) is the network of the world's public circuit-switched telephone networks. It consists of telephone lines, fiber optic cables, microwave transmission links, cellular networks, communications satellites, and undersea telephone cables all inter-connected by switching centers which allows any telephone in the world to communicate with any other.

Table 55: 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				
Mobile Phone				
SMS			DMI	
GPRS	DMI			
PSTN	DMI			
Telefax				
Dedicated Leased Lines				
UHF radio transceiver				
High frequency/Single side band radio				
HF Radio Email				
Aeronautical Fixed Telecommunication Network				
Very Small Aperture Terminal				
Data Collection Platforms used to transmit data from AWSs				
Global Telecommunication system (WMO-GTS)				
Meteosat Second Generation Satellite system				
Other satellite systems				
Internet	DMI		DMI	
Email				
Post/mail				
Print media				
TV –national				
TV-commercial				
Radio			DMI	
Bulletins				
Printed text				
Manual collection	DMI			

8.3.7. Climate change analysis

Two different regional climate models have been run by DMI. These are RegCM3 of the International Centre for Theoretical Physics (ICTP) and PRECIS of Hadley Centre of the UK Met Office. IPCC-SRES A2 and B1 scenarios of ECHAM5 global model outputs were completed for 1961-1961(RF) and 2001-2099 period by using RegCM3 in 27 km resolution. The other global model, Hadam3P, output A2 and B2 were completed for 1961-1990 and 2071-2100 period by using PRECIS in 25 km resolution. Whole regional climate model studies and result will be shared on Eastern Mediterranean Climate Centre web page for benefits of neighboring countries. It can be expected that also SEE countries could significantly benefit from the Eastern Mediterranean Climate Centre (EMCC), which was established in 2009 by the Turkish State Meteorological Service in coordination with WMO.

8.3.8. Human resources

DMI has quite large staff compared to advance EU NHMSs: 3260 people (10% women, 90% men). 12 people are involved in operational numerical weather prediction (NWP) models. This together with the number of main computer experts allows a 24/7 NWP operation. DMI has relatively good IT staffing: 8 main computer experts, 8 helpdesk experts, 10 database experts, 6 QC experts and 20 software experts working mainly with internet, NWP and other similar products. The IT sector is operational 24/7.

DSI has about 23000 staff, of which 2500 with academic degree. About 20% of the staff are women. DSI uses about 10% of the national research budget.

DMİ has been serving as WMO RA VI Regional Training Center since 2001. During the past 10 years, tens of courses and workshops have been done such as telecommunications, satellite meteorology, climate indices, regional climate model, weather radar, AWOS, Agricultural Meteorology, NWP studies, and climatological applications and hundreds of participants have been benefited from these courses. These capacity building studies are contributing enhanced social and economic resilience and decision making in many climate-sensitive sectors such as water, agriculture, fisheries, health, forestry, transport, tourism, energy and disaster risk management in neighboring countries and their sustainable development.

Taking into account the increasing cooperation with the commercial sector and growing demands from the DRR and for international cooperation and participation in R&D projects it is vital to take these into account in the training program for scientific experts, mid management and top management.

DSI has a training center on Sedimentation, which gives training for technicians and scientists. This center will become UNESCO Category II Center.

There is a need to promote the DSI training program to include topics relevant to the DRR and cooperation with the different socio-economic sectors.

8.3.9. International and Regional Cooperation

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

EU based hydrometeorological organizations provide most state-of-the-art models, software and tools to be utilized by the member NHMSs. The European NHMSs have globally an unique opportunity to benefit from the stat-of-the -art weather forecast modelling, medium-range weather

forecast products at 16 km horizontal resolution (in near future at 8 km resolution) including the Extreme Forecast Index (EFI), re-analyzing data to be used e.g. for climatological studies and the ECMWF super computer resources. EUMETNET provides cooperation with most advanced NHMSs; harmonization of observation and production of services; support to implementation of new technologies through joint projects, verification and exchange of experiences; and low membership fee.

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.

DMI participates actively in international cooperation and a member of several organizations and initiatives as shown in Table 56. The international activity of DSI is at much lower level. DSI participates in cooperation with JICA in the Seyhan River project on Flood Control and Early Warning System.

Table 56: International and regional cooperation activities of DMI and DSI

International and regional organization and cooperation mechanisms	DMI status	DSI status
WMO	member	Hydrological advisor
WMO RAVI	member	no
IOC	member	
ICAO	member	no
UNDP	cooperation	some cooperation
UN ISDR	cooperation	some cooperation
EUMETSAT	member	no
ECMWF	member	no
EUMETNET	no	no
METEOALARM	no	no
ECOMET	member	
EUFP7 projects, networks		
EU JRC		
EFAS	no	
EU PHARE		
EU CARDS		yes
EUCLID	no	
EUR-OPA	member	
DMCSEE	member	no
SEEVCCC		no
DRRSEE	member	no
SAVA Commission	no	no
NWP consortium	ALADIN	no
NMHS bilateral		Bulgaria
NHMS MoU		

8.4. Technical recommendations to strengthen DMI and DSI capacities in support of DRR

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

1. There is a need to better integrate the hydrological (DSI) and meteorological (DMI) sectors into the DRR planning process;
2. It would be vital to establish a 24/7 multihazard early warning center (center of excellence) at DMI through gathering experts from relevant institutions;

3. There are needs to clarify the mandates and communication routes for alerts, advisories, warnings and alarms to different levels all the way down to the grass root level (individual people) using state-of-the-art communication systems.

Operational relationships with other agencies

4. There is urgent need to promote cooperation between DMI, DSI and General directorate of Electric Power resources.

Monitoring and observations networks and data exchange;

5. There are urgent needs to enhance and modernize the weather radar network and produce real-time composite pictures of precipitation;
6. There is an urgent need to enhance the number of on-line stations in the meteorological, hydrological and maritime observation networks;
7. It would be vital to enhance the production and use upper air data by using wind profilers and/or AMDAR data.

Forecasting

8. There are needs to promote nowcasting and numerical mesoscale modelling;
9. There are needs to promote data assimilation in NWP modelling;
10. There are needs to promote seasonal forecasting;
11. There are urgent needs to implement hydrological models to be used over the country;
12. There are needs to promote assortment of numerical models (hydrological, dispersion of airborne pollutants, drift models, wave,..) and link them to the NWP models;
13. There are needs to promote the computer back-up system of NWM modelling;
14. There are to enhance investments in climate change modelling and forecasting and analysis to support strategic and sectoral planning for at-risk sectors and investment plans of industry in order to promote economic development of the country.

Hydrometeorological data management systems

15. It is critical to establish a national hydrometeorological database;
16. There are needs to strengthen the data management capacity to promote data assimilation to be used in NWP modelling.

Hazard analysis and mapping to support risk assessment

17. There is an urgent need to establish a national combined hydrometeorological database;
18. There is a need to develop hazard analysis and mapping (through GIS tools) based on historical hydrological and meteorological data and climate change projections to support risk assessment;
19. There is a need for strengthening the collaboration amongst AFAD, DMI and DSI in order to improve the risk assessment capacities end the quality of products provided by different institutions;
20. There is a need for a comprehensive methodology for flood risk assessment, including the specifications of information to be provided by relevant institutions, the characteristics of hazard database, containing not only impacts but also physical dimensions of the hazard, etc.;
21. There is a need to better define the institutional framework for drought risk assessment, with clear share of roles and responsibilities amongst different institutions and gathering the analysis of different aspects of drought under the coordination of AFAD;
22. There is a need of training DMI experts of Agrometeorological Division in remote sensing applications.

Information technology and telecommunication issues

23. There is a need to modernize the data communication systems to a level of advanced EUMETNET NHMSs.

Warning products and services

24. There is an urgent need to establish a warning system for floods and flash floods;
25. There are needs to enhance drought warnings;
26. Implementation of the METEOALARM system would promote dissemination of warning information.

Climate change analysis

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

Human Resources

29. There is a need to ensure the adequate human resources for DMI to have the capacity to manage the operational and DRR tasks;
30. There is a need to enhance the human resources in the IT sector.

Regional cooperation

31. 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;
32. 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;
33. To improve their forecasting capacities, SEE countries should increase their cooperation with global, regional and specialized Centres (eg ECMWF) producing NWP, by developing their NWP capacities and become members of NWP model consortiums. Linkages between NWP models and hydrological models should also be developed for a better flood forecasting;
34. A regional harmonization of watch and warning systems should be promoted;
35. Cross-border exchanges of real-time data, forecasts and warnings should be increased;
36. There is the opportunity to strengthen regional collaboration through the exploitation of DMI capacities, resources and facilities for training of experts from NMHS of SEE countries.

8.5. Recommendations from the Turkey 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 Ankara, 11-12 October 2010. During this meeting, high-level participants endorsed the assessment, as well as the set of recommendations emanating from it and presented hereunder.

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

Recommendation 1: To improve and strengthen national and local government mechanisms to institutionalize lessons learned from previous disasters and incorporate them into DRR policy, planning and programming in Turkey.

Recommendation 2: To facilitate and support establishment of mirrored/similar/same mechanisms at the county and local self-government levels through strengthening and reinforcing local capacities, institutions, and governance capabilities.

Recommendation 3: To establish a "National Platform for Disaster Risk Reduction".

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

Recommendation 4: To establish and invest in fully operational 24/7 hydro-meteorological services (technical and human resources) as well as in the seismological sector to support risk assessment and early warning systems and promote operational monitoring, warning, forecasting and mapping of meteorological, hydrological and seismological hazards.

Recommendation 5: To prescribe a new law for hydro-meteorological services in Turkey.

Recommendation 6: To create appropriate mechanisms to increase coordination between the three hydro-meteorological organizations as a short term action.

Recommendation 7: To strengthen technical and human resources of the Meteorological, Hydrological, and Seismological Services in operational monitoring, warning, forecasting and mapping of seismological, hydrological, meteorological and ecological risks, and also enhance the modernization and improvement of the monitoring networks and data transmission systems.

Recommendation 8: To enhance the early warning system and interoperability of the System 112 through modernization of the continuous and real-time collection and information sharing by expanding the hydrological, meteorological and air-quality monitoring networks, establishing integrated fire-protection system and ensuring functional horizontal and vertical links among all disaster risk reduction actors.

Recommendation 9: To further strengthen operational cooperation of the Disaster and Emergency Management Presidency, Hydrological and Meteorological Services through joint training and improvements to the standard operating procedures across agencies linked to the different threat levels and lessons learnt from each disaster event.

Recommendation 10: To integrate policy, planning and programming in adaptation to climate change with DRR strategy.

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

Recommendation 11: To integrate DRR into the education system in Turkey at all levels –primary, secondary, and university.

Recommendation 12: To increase the awareness of the citizens and media regarding the early warning system and the European Emergency Number 112.

Recommendation 13: The Ministry for National Education is mandated to mainstream disaster risk reduction into national educational curriculum by establishing Curriculum Revision Working Group composed of the representatives from the Ministry for National Education and Sport, from the Disaster and Emergency Management Presidency Meteorological and HydrologicalService,

Universities, other respective line Ministries, the Turkish Red Crescent Society, expert organizations and individuals.

Recommendation 14: To establish a National Training Centre for DRR and disaster and emergency management practitioners and community members, using the existing European Natural Disaster Training Center (AFEM) and/or Disaster and Emergency Training Center at DEMP as a foundation.

Recommendation 15: To proceed with the establishment, in Turkey, of the Centre of Excellence for a Training of Fire Fighters and coordination of response to forest fires in the countries of South Eastern Europe, including the harmonization of the development of fire-fighting brigades in the countries of the region through standardization of equipment and procedures, thus promoting regional cooperation and collaboration in disaster risk reduction in South Eastern Europe.

HFA priority 4: Reduce the underlying risk factors

Recommendation 16: To systematically integrate measures aimed at reducing disaster risks into policies, plans and programs for sustainable development and poverty reduction.

Recommendation 17: To support the development of studies and research around the reduction of specific risk factors that affect Turkey.

Recommendation 18: To develop national capacities for climate (hydrological and meteorological) and geological (including seismological) services to support medium and long-term sectoral planning, as a critical aspect of disaster risk reduction.

Recommendation 19: Enhanced investments are needed in climate data rescue, climate and geological modelling, forecasting and analysis to support sectoral planning in at-risk sectors.

Recommendation 20: To improve networking with international institutions present in the region and to promote the increased involvement of such organizations in the strengthening of DRR in Turkey.

Recommendation 21: To develop national capacities for climate services to support medium and long-term sectoral planning through strong collaboration and cooperation across line ministries and with the Meteorological and Hydrological Service, and through enhanced regional cooperation with other South Eastern European and EU countries.

Recommendation 22: To enhance investments in climate modelling and forecasting and analysis to support strategic and sectoral planning for at-risk sectors.

Recommendation 23: To develop the disaster risk reduction Strategy and corresponding Implementation/Action Plan as a first mutual step undertaken by the key disaster risk reduction actors, e.g. the Disaster and Emergency Management Presidency, the Hydrological and Meteorological Service, seismological observations and survey, line Ministries and respective public enterprises, the Turkish State Meteorological Service, civil society and business community toward integration of disaster risk reduction into the development policies, strategies and sectoral plans, followed with the implementation of the said Strategy.

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

Recommendation 24: To strengthen disaster preparedness for effective emergency response at all levels and to promote disaster prevention in Turkey.

Recommendation 25: To promote the engagement of the media in order to stimulate a culture of preparedness and strong community involvement through sustained public education campaigns and public consultations at all levels of society.

Recommendation 26: To increase the involvement of the private sector in activities aimed at DRR with special emphasis placed on insurance companies for the purpose of building on achievements already made in promoting public private partnerships (PPP) to better engage the private sector in DRR activities.

Recommendation 27: To strengthen regional and international links to support more effective wild fire risk preparedness and prevention in Turkey.

Recommendation 28: To increase the use of simulation exercises (including drills, orientations, functional and table-top exercises) as a regular feature of emergency response and preparedness training in Turkey.

Recommendation 29: To proceed with the establishment, in Turkey, a "National Exercise Simulation Center" (NESC) at DEMP Headquarters.