4.1.1
ARCHIVE OF LOCAL/REGIONAL/NATIONAL DROUGHT PERIODS AND IMPACTS BASED ON HISTORICAL RECORDS; MITIGATION PRACTICES AND DROUGHT MANAGEMENT FROM ALL COUNTRIES/REGIONS ADDED TO THE ARCHIVE

Agricultural University of Athens

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HMS	F.Y.R.O.M.	[redacted]
INEUM	Albania	[redacted]

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Introduction

In the past few decades it has become evident that all countries in South East Europe are affected by droughts which are becoming more and more long lasting and severe. Drought and its ramifications must be recognized and anticipated for all planning and management efforts in water resources. The first step in studying and responding to drought is the examination of its dimensions. Drought dimensions ideally incorporate the definition, the causes and the impacts of drought. One source of confusion in devising an objective definition may be that drought implies a variety of things to various professionals according to the specialized field of study (meteorology, hydrology, water resources, agriculture etc.).

A second problem is eliciting because the definition of drought is strongly related to the geographical, hydrological, geological, historical and cultural traits of a given locale. A third factor is the difficulty to modify existing drought terminology according to updated techniques and practices (Drought Management, 1986; Salas, J.D., 1986; and Grigg, N.S. and Vlachos, E.C., 1990). Thus, a broader definition of drought in this effort may be: the state of adverse and wide spread hydrological, environmental, social and economic impacts due to less than generally anticipated water quantities (Karavitis, C.A., 1992). Such water deficiencies may originate from precipitation decreases, physical and/or operational inefficiencies in water supply and distribution systems, as well as from incompetent water management. Then, drought is not only the lack of precipitation as it is generally believed, but a complex phenomenon requiring a more complete analysis, evaluation and focused responses.

The scope of this report is to create an archive of local/regional/national drought periods and their impacts based on historical records for the participating in the DMCSEE Project countries, namely Slovenia, Hungary, Bulgaria, Greece, Croatia, Serbia, Montenegro, F.Y.R.O.M and Albania as well as an inventory regarding the mitigation practices and applied drought management responses from all countries/regions to be included to the archive.

In this regard, partners from each participating country reviewed information sources (newspapers and other media, scientific papers, scientific projects etc) in order to create an Archive database on recorded drought periods for South East Europe. In most of the countries available information is strongly related to agricultural drought. Records of yearly crop yields are among the most important sources. Information coming from the newspapers and other media services at that time during the drought period includes data on social, economic, hydrologic and meteorological impacts of the drought phenomenon.

Map of South East Europe

Albania

The Republic of Albania is situated in southeastern east Europe, in the western part of Balkan Peninsula facing the Adriatic Sea (sandy shore) and Ionian Sea (rocky shore). Albania has a surface area of 28,745 km^2. Its terrain is mountainous, where hilly and mountain areas make up to 77% of the country's territory and average. The average terrain elevation is 708 meters about double of the overall European one.

The general length of the state border is 1,093 km, out of which 657 km are land border, 316 km sea border, 48 km river border and 72 km lake border. North and northeast, Albania borders with republic of Yugoslavia, east with Former Yugoslav Republic of Macedonia, while south and southeast with Greece. A number of rivers flow into the sea such as Buna, Drini, Mati, Ishmi, Erzen, Shkumbin, Seman, Vjosa and Bistrica, which constitute an important source of hydro power.

Albania belongs to the subtropical Mediterranean climate. It is characterized by mild winter with abundant precipitation and hot, dry summer. The annual mean air temperature has a wide variation over the territory. All the territory is characterized by the negative trend of annual mean temperature. The negative trend of annual mean temperature comes out as a result of the influence of negative trend of minimum temperatures.

The mean annual precipitation over the Albania is about 1,485 mm/year. The main part of the total precipitation (70%) is recorded during the cold months (October-March). The richest month in precipitation over the whole territory is November, while the poorest are July and August.

In Albania population counts 3.4 million inhabitants. Over 55% of the population lives in rural areas. Density is 121 people /km^2. During 1991-1998, Albania experienced demographic changes dominated by the negative rate of population increase, migration from the villages towards the towns and from the remote areas towards the capital, the massive emigration and the decrease the births. The re-urbanization and the overpopulation are the main existing problems at the local level in Albania.

The Albanian population is being considered as a young population. The average age is 31.7 years old. After 1990 the Albanian population has faced new phenomena like migration, which greatly affected the distribution by districts and prefectures. Districts in the North have seen a decreasing population, while Tirana and Durres districts have increased their population. In July 2007, Albania's population was 3,600,523, with an annual growth rate of 0.73%.

Bulgaria

Bulgaria, officially the Republic of Bulgaria, is a country in south-eastern Europe. Bulgaria borders five other countries: Romania to the north (mostly along the River Danube), Serbia and F.Y.R.O.M. to the west, and Greece and Turkey to the south. The Black Sea defines the extent of the country to the east.

With a territory of 111,002 square kilometres (Agricultural areas 57%, Forest areas 34%, Settlements and other urbanized areas 4%, Water flows and lakes 2%, Territory for mining and quarrying raw materials 2% and Transport and infrastructure territory 1%), Bulgaria ranks as the third-largest country in Southeast Europe (after Romania and Greece).

The climate of Bulgaria bears the traits of two climatic zones - European moderate continental and Mediterranean continental-subtropical zone. In each of these zones there are two transition subzones (Sabev and Stanev, 1959; Stanev et al., 1991). Sabev and Stanev (1959) proposed further differentiation of these subzones on the whole into 25 climate regions on the basis of humidity and thermal conditions. This differentiation is determined by the latitude, altitude, topography, proximity to the Black Sea and the dominant atmospheric circulation. There is also another classification which divided Bulgaria into 5 climatic regions (Dimitrov, 1979), where the leading factors are mainly geographical:

1. *The region with moderate continental climate* - that covers the Danubian Plain, the lower parts of Western and Middle Stara Planina (the Balkan) and the lower valley areas between the Stara planina and the Sredna gora mountain (e.g. Sofia plain). Average temperature in January is from –1.5 to –3.0°C, and average temperature in July 20–24°C. Maximum temperatures reach 38–40 °C. The annual sum of precipitations is 500–700 mm, with minimum in February and maximum in June.

2. *The region with transitional continental climate* - it covers the whole Thracian Lowland, low subbalkans valleys, the north part of Tundja hilly and low mountainous area and the Eastern Stara Planina (the Balkan). Average temperature in January is from –1.5 to +1 °C, average temperature in July - 22–24 °C, maximum temperatures in summer reach 40 °C. The annual sum of precipitations is like this in the moderate continental climate region. However the differences between maxima and minima of precipitation are smaller.

3. *The region with Continental-Mediterranean climate* - it covers the Strouma and the Mesta valleys, the low parts of Eastern Rodopi and the Strandzha Mountain. The winter precipitations are predominant. The winter is mild, with average temperature in January 1–2 °C, spring comes earlier, and the summer is hot with average temperature in July 24–25 °C.

4. *The region influenced by the Black Sea* - it is the narrow coastal line area. The influence of the Black Sea is expressed mainly by the decreasing of temperature amplitude. Average air temperature in January is 0–3.5 °C, and it is 22–23 °C in July. Intense winter cold is rare in this region and the temperature in autumn is higher than in spring.

5. *The Mountainous climatic region* - it covers areas with altitude over 950-1000 m. Comparing with the other climatic regions, lower air temperatures and significantly higher sum of precipitation are the characteristic for this region. Mountainous climatic region has less importance for crop cultivation in the country.

According to the Statistical Yearbook (2008) the population of Bulgaria is 7 640.2 thousands. It is constituted of the following ethnic groups: 85% Bulgarians, 9.4% Turks, 4.7% Gypsies, 0.9% other groups.

Croatia

By its position, Croatia belongs to the Central-European, Adriatic-Mediterranean and Panonian-Danube basin group of countries. It borders Slovenia (667.8 km) to the northwest, Hungary (355.5 km) to the north, Serbia (317.6 km) and Montenegro (22.6 km) to the northeast and southeast, and has the longest border with Bosnia and Herzegovina (1011.4 km). The national sea border is 948 km long and stretches along the outer edge of the territorial sea. It is followed by protected ecological and fishing zone reaching the continental shelf border between Croatia and Italy [1]

Croatia has a total area of 87,661 km^2 from which the 56,594 km^2 is the land area and the remainder of 31,067 km^2 is water. Croatian coastline is a total of 5,835 km; 30.5% is mainland and 69.5% consists of islands. The largest area (around 50%) includes lowlands (below 200 m in height), 25% constitutes hilly area, 15% is mountainous region (above 500 m) and 10% is the coastal area.

The area of Croatia can be divided into three major geomorphologic and consequently agricultural regions:

- The Panonian and Peri-Panonian area (P) comprises the lowland and hilly parts of eastern and northwestern Croatia; mountains higher than 500 m are rare and of an insular character.
- The hilly and mountainous area (G), which separates Panonian Croatia from its coastal part, is less developed.
- The Adriatic area (J) includes the narrow coastal belt separated from the hinterland by high mountains. This is predominantly a karst area with very dry summers.

Croatia has 16 rivers longer than 100 km and they all flow either to the Adriatic or the Black Sea basin. The longest Croatian rivers are Sava (562 km) and Drava (305 km). There are only 14 lakes in Croatia with the area bigger than 0.5 km^2 and almost half of them are men-made in 20th century. The largest lake Vrana has an area of 30 km^2. Utilized agricultural land (arable land, vineyards, meadows and pastures, orchard and olive plantations) covers 46.2% of the Croatian territory while total area of forest land (with macchia and bushes) encompasses 40% of the mainland.

The climate of Croatia is determined by its position in the northern mid-latitudes and the corresponding weather processes on a large and medium scale. The most important climate modifiers over Croatia are the Adriatic Sea and the Mediterranean, the Dinaric Alps with their form, altitude and position relative to the prevailing air flow, the openness of the north-eastern parts to the Panonian plain, and the diversity of vegetation.

The mean annual air temperature in the lowland area of the northern Croatia is 10-12°C, at the heights above 400 m is lower than 10°C, while in the highland it is 3-4°C. In the coastal area the mean temperature is 12-17°C. The mean annual amount of precipitation in Croatia ranges from 300 mm to slightly over 3500 mm. The smallest annual amounts fall on the outer islands of the southern Adriatic (Palagruža, 311 mm) and in the eastern Croatia (Osijek, 650 mm). About 800 mm to 900 mm of precipitation can be expected on the islands and the coast of central and northern Dalmatia as well as on the west coast of the Istrian Peninsula. The precipitation amount in the Panonian area decreases from the west to the east. The precipitation amount is increased from the coast to the inland. Most of the precipitation is recorded on the slopes and peaks of the coastal Dinaric Alps (from 3000 to 3500 mm).

According to the Croatian Bureau of Statistics 4.437,460 (2001 census) people live in Croatia. During the last decade of the 20th century the population of Croatia has been stagnating because of the Croatian War of Independence. During the war, large sections of the population were displaced and emigration increased. The mid-year estimate of 2009 gives the population of 4.429.000 with the negative natural population growth of -1.8 per 1000 inhabitants. Average population density is 78.4 inhabitants per km^2. Central part of Croatia is the most populated (115 inh./km^2), while the least populated is the mountainous part of

Croatia (13 inh./km²). Within total number of inhabitants, 51.1% lives in 124 cities. The 2051 projection of population is 3.714,300.

F.Y.R.O.M.

F.Y.R.O.M. is a landlocked country located in the central Southeastern Europe Peninsula at latitude of approximately 42° north and longitude of 22 ° east. It is one of the successor states of the former Yugoslavia, from which it declared independence in 1991 with an area of 25.713 km^2 (land surface 24.856 km^2 and water surface 488 km^2). F.Y.R.O.M. is bordered by Kosovo to the northwest, Serbia to the north, Bulgaria to the east, Greece to the south and Albania to the west. The terrain is mostly hilly- mountain with average elevation of 829m. From the aspect of relief, F.Y.R.O.M. is a mountainous country. Mountains cover 79% of the total area, participation of plains is 19.1% and to the water surfaces belong 1,9%. It has sixteen mountains higher than 2,000 m and more than 50 lakes.

Three natural lakes have also a great significance for the hydro-geography of the country, and they are: Ohrid Lake (elevation 695m) with total area of 358 km^2 (F.Y.R.O.M. part 229,9km^2) and with maximum depth of 285m; Prespa Lake (elevation 853) with total area of 274,0 km^2 (F.Y.R.O.M. part 176,8 km^2) and with maximum depth of 54m and Dojran Lake with total area of 43,0 km^2 (F.Y.R.O.M. part 27,4 km^2) and with maximum depth of 10m. In order to utilize the hydrological potential of the rivers in F.Y.R.O.M., 20 large and over 100 small reservoirs have been constructed, with total volume of 2400 millions m^{3}of water. The largest are Kozjak Lake on the river Treska with total volume of 550 millions m^3, then Spilje Lake on the rivers Crn Drim and Radika with 520 millions m^3, followed by Tikvesh Lake on the river Crna with 475 millions m^3. In F.Y.R.O.M. 4414 springs with total yield of 991,9 millions m^3/annum have been registered. Out of them only 58 have the yield over 100 l/s, and out of them only three are located in the central part of the river Vardar basin and the others are in the west part of the country. The water treasure in F.Y.R.O.M. according to the Physical Plan of the country has been estimated as: 18,8 billions m^3 from precipitation, 6,22 billions m^3 as discharging water from the watersheds, 0,52 billions m^3 as groundwater and 0,42 billions m^3 from the bigger springs.

According to the global specific indicators F.Y.R.O.M. is relatively poor in water. The concept of sustainable development has shown the quantity of 3000 m^3 of water annual per resident/inhabitant. Analyzing the average annual discharges, in the surface watercourses the available quantity is 3250 m^3 annual per resident. But, in dry seasons, which duration is longer and longer each year, the available quantity is only 950 m^3/s. Under the consideration that 16% of available waters are output water (coming from other countries, and can not be use with certain quantity and quality) then F.Y.R.O.M can be been recognized as poor in water. (MOEPP, 2005).

F.Y.R.O.M. has different climatic characteristics caused by direct climatologically influences from north by moderate continental and from the south by Mediterranean, in the high mountain regions by mountain climatic influence. The annual cycle of temperature regime shows two distinct separated seasons: warm and dry summer and relative cold winter connected with transitional spring and autumn. Mean summer temperature is from 24.3°C to 20.6°C, while absolute maximum temperature is 44.5°C to 40.0°C. Mean winter temperature vary from 4.9°C to 0.9°C, but absolute minimum reaches values from -29.4°C to -13.0°C. Huge difference in the spatial and temporal distribution of types and quantities of precipitation can be noticed. Average annual sums of precipitation in mm (period 1961-90) on the territory of F.Y.R.O.M. are below 500 mm in the central part of the country; in the north-western part higher than 1000 mm, while some annual amounts of precipitation in dry period are around 250 mm. In most parts of the country the autumn is warmer than the spring and the greater part of the annual precipitation sum falls in the cold part of the year.

Greece

Greece is located at the southeast end of Europe and it is the southernmost country of the Balkan Peninsula. The country is located between several countries and seas. Namely, in the north it borders with Albania, FYROM, and Bulgaria. To the east Greece borders with Turkey. To the south and west Greece is surrounded by the Mediterranean Sea (the Ionian Sea is west and the Libyan sea to the south). The country is comprised of the Greek peninsula as well as of the adjacent approximate of 3,000 islands archipelago. The terrain is predominantly mountainous with 27 peaks higher than 2,033 m.

Greece has a total area of 131957.4 km^2 from which the 28.71% is plain, 29.01% is semi mountainous and the rest 42.28% is mountainous (ESYE, 1991). The arable (under cultivation) lands in Greece possess 50684.6 km^2 which is the 38.4% of the total, while the under water bodies area is only 1790.1 km^2 (1.4%). Pastures (grasslands) in Greece take 14451.6 km^2 (11.0%) and forests take 57968.9 km^2 (43.9%). Urban areas cover 2307.5 km^2 (1.7%) and 4779.6 km^2 (3.6%) are covered by other land uses (ESYE 2000).

The climate is typical northern Mediterranean with most of the precipitation falling during the winter months and increasing from southeast to northwest. The average annual rainfall ranges from 350 mm/yr to 2,150 mm/yr, with an approximate average of 760 mm/yr (Karavitis, C.A., 1999). The climate of Greece is classified as Csa Climate (Koeppen-Geiger classification); a warm temperated mediterranean climate with dry, warm summers and moderate, wet winters with the warmest month above 22°C on the average.

Greece belongs to the Mediterranean European countries and has a Mediterranean climate with mild winters and hot and dry summers. However, the climate in Greece varies from region to region. The north-western part of Greece is usually cold during the winter and snowfalls are not uncommon, especially in the higher elevations. For the south of Greece and the islands, the winters are milder. Summers are usually hot, and in July and August temperatures reach 30 to 35°C and sometimes even more. The islands have smaller differences of temperature during the day than the mainland. Western Greece is receiving more precipitation than the eastern part. The Ionian islands and southern Crete have very small differences between winter and summer temperatures. The Aegean islands have less rainfall and they experience strong winds in summertime known as the Etesies (Meltemia).

The greatest rivers in Greece are located in the northern regions of Macedonia and Thrace. Greek territories form the lower parts of the watersheds. The upper and greater parts of the watersheds fall into the neighboring countries. Nevertheless, the management of these common water resources needs to be implemented by the principles of international cooperation, and is still pending.

The water quality can be generally described as satisfactory (Karavitis, C.A., 1999). However, pollution exists in some places due to the high use of fertilizers and pesticides, as well as municipal and industrial effluent. Problems might escalate as the rate of exploitation increases. The coastal waters of Greece are primarily devoted to tourism. The quality of such waters is generally considered excellent, but high pollution exists in some areas (Athens and Thessaloniki metropolitan regions). Legislation for the protection of the environment is incremental. European Union legislation has also to be fully implemented in Geece as by all member states, and thus may create additional constraints..

Hungary

Hungary, officially the Republic of Hungary is an independent, democratic republic in Central Europe, in the Carpathian Basin. It is bordered by 7 countries: Austria, Slovakia, Ukraine, Romania, Serbia, Croatia, and Slovenia. Its capital is Budapest, which is the most populous city in the country.

Hungary's territory covers 93,030 square kilometres. The total length of its national borders amounts 2,246 km. 73% of the country consists of lowlands and plains (up to 200 m above sea level) 20% of hills or foothills (mostly up to 350 m a.s.l.) and 7% of the territory is occupied by medium-height mountains (lower uplands to 750 m a.s.l. and mountains up to 1,014 m a.s.l.) and their valleys. The highest point in the country is Kékes (1,014 meters above sea level) in the Mátra Mountains northeast of Budapest. The lowest point is in the vicinity of Szeged (79 meters above sea level). The territory of Hungary is divided into six physiographic macro regions: the Alföld (Great Hungarian Plain), the Kisalföld (Little Hungarian Plain), the West Hungarian Borderland, the Transdanubian Hills, the Transdanubian Mountains and the North Hungarian Mountains with its inter- and intramontane basins.

The two most important rivers of the country are the Danube and the Tisza. The Danube extends over 17 countries and has a total length of 2,860 km, of which 410 km lie in Hungary. The whole of the Carpathian Basin, including Hungary belongs to the catchment area of the river (817,800 km^2). The largest left-bank tributary of the Danube is the Tisza. Its entire watershed (157,135 km^2) is found within the Carpathian Basin. Lake Balaton is the largest shallow water lake in Central Europe, and an important tourist destination of the country. The lake has a total surface area of 588.5 km^2, of which only 17 km^2 is covered by reeds.

On 1 January 2009, Hungary's population was estimated at 10,030,975. This is 6 percent less than in 1980, when the Hungarian population has reached its maximum (10.7 million). The number of females per 1,000 males in 2008 was 1,106. Life expectancy at birth was for men 69.19, for women 77.34 years (in 2007). In March of 2009, the rate of unemployment in accordance with the EU-member state definition was over 9%, which is unprecedented for 15 years.

Hungary's climate is influenced by its latitudinal position, location of the country amidst a belt of westerly winds, the cyclonic activity of the temperate climate zone, and finally by its distance from Eurasian continental interior, the Atlantic Ocean and the Mediterranean Sea. Due to these factors the climate of the country shows large variability. Despite the small territory and relatively low relief, regional differences can be significant. Hungary is under the varying influence of the continental, oceanic and Mediterranean climates, any of which could be temporally dominant. The Carpathians, Alpine and the Dinaric mountain ranges are high enough to substantially modify the flow of air masses.

The annual mean temperature has a north-west-south-east gradient, slightly modified by local topography. The country predominantly exhibits an annual average of between 9-11 °C. Climatologically, the coldest month is January (below 0 °C mean temperature) and the warmest is July (17-21 °C mean temperature), although in certain cases, any of the winter month can be the coldest and generally July or August is the warmest. The absolute maximum temperature was 41.9 °C on 20 July 2007.

Precipitation shows large temporal and spatial variability. Monthly precipitation could be zero in any month and any place, but it could equally be near to, or above 200 mm. The annual precipitations show a south-west-north-east gradient, which is the effect of the Mediterranean Sea. Its amount varies mostly between 500 and 750 mm. Summer is the wettest season and winter is the driest one. The most frequent precipitation quantity is 200-300 mm in the six months of the winter season and 300-400 mm in the remaining spring and summer months. The spring and summer period offers a much more fragmented picture because of the large amount of convective precipitation. The increasing temperature reduces the snow/rain ratio in winter and it adds to the precipitation intensity, especially in the summer, further deteriorating the surface water balance and water supply situation.

The proportion of the country's productive land (agricultural lands, forests, reeds and fishponds) decreased from 94% to 83.5% over the past 100 years, primarily as a result of urbanization (urban growth, infrastructure development, etc.). The share of the agricultural land area (encompassing arable lands, gardens, vineyards, orchards, meadows and pastures) has also decreased, while afforestation has accelerated.

Montenegro

Montenegro is an Adriatic-Mediterranean Dinaric country of Southeast Europe. It covers the total area of 13,812 km^2, and the total sea area of some 2540 km^2. According to the census in 2003, Montenegro had the population of 620,145, meaning that the population density is 44.8 inhabitants per 1 km^2. Three regions are distinguished because of the natural characteristics, way of the spatial use and development, economic activities and different comparative advantages for development: coastal region, central region, northern region.

Montenegro is an extremely hilly-mountainous country in which are the highest and the most unapproachable parts of the Dinara mountain's system. The lower part of Montenegro is narrow Adriatic seaside on the most southern part of the country, on the foothills of Orijen, Lovcen and Rumija. From the south-east of the Adriatic seaside towards the inland are: the valley of the river Bojana, the Skadar Lake basin, the valleys of the rivers Moraca and Zeta, which deeply enter the inner part of the land. Through these valleys and basins pass the fertile and narrow plains of Montenegro (10.3%).

Approximate structure of use for the total territory of the Republic (13.812 km2) is:

- agriculturall and approximately 5.140 km2 or 37.5% of the territory;
- woods approximately 6.622 km2 or 45% of the territory, and
- settlements, roads, stony areas and other categories approximately 2.442 km2 or 18% of the territory.

Regarding the level of the forest density (40%) compared to the European countries, higher forest density than in Montenegro have Slovenia (50%), Finland and Sweden.

Montenegro has only 741 km^2 agricultural land of higher quality (5, 4% of the territory) what indicates that it has special importance for Montenegro. The major part of higher quality land, (75,6%) is in the following municipalities: Podgorica 17%, Pljevlja 14,5%, Bijelo Polje 14,2%, Berane 9,5%, Bar 7,4%, Nikšić 7,3%, Ulcinj 5,7%; other municipalities 0,8 - 3,9%. Based on the data from 2005, arable land and gardens cover 460 km^2, orchards around 110km^2, vineyards around 40 km^2 and meadows around 1300 km^2. Total surface of arable land is 1890 km^2 or 0.31 ha per inhabitant. Montenegro is among the countries with insufficient arable land. If only fields, orchards and vineyards are considered as cultivable land, as in the countries of EU, it is very poor (0,09 ha per inhabitant).

Climate conditions in Montenegro are predominantly influenced by the Adriatic Sea and mountains' massifs. Starting from the sea and depending on the altitude, the climate changes from the Mediterranean to the Alpine. Thus, in this small area there is diversity of climates. Duration of sunlight increases with the proximity of the coast. Varying precipitation amounts are evident: the highest values are in parts of coastal mountain chains (in average around 4,500 mm/year), while they reduce towards the coast and in particular to the north and northeast. Alongside these main factors, there are also other influences which more or less contribute to the local climates. Such climate conditions are suitable for the development of ski tourism, sea tourism, growing of subtropical cultures, growing of olive and wine along the coastline, cattle breeding and growing of continental fruits (plum, apple, pear, raspberry, etc) in the continental and mountain regions.

According to the projection of population migration in Montenegro the increase of population number up to 687.366 is expected. Increase of population is noted in all regions, with different growth rates. Population number will decrease in the following municipalities: Andrijevica, Berane, Bijelo Polje, Žabljak, Kolašin, Mojkovac, Plav, Plužine, Pljevlja, Cetinje and Šavnik.

Serbia

Republic of Serbia is a continental country. It is located in South-East Europe Its territory covers the southern part of the Pannonian Plane and central part of the Balkans. Republic of Serbia consists of two Autonomous Provinces – Vojvodina and Kosovo and Metohia. Serbia's territory covers 88.361 sq km; Central Serbia covers 55.968 sq km, Autonomous Province of Vojvodina covers 21.506 sq km, and Autonomous Province of Kosovo and Metohia covers 10.887 sq km.

Approximately 70% of Serbia's territory is agricultural land, whereas 39% is woodland. Agricultural production avails about 4.025.000 ha arable land, orchards, and vineyards, then 665.000 ha of meadow grasses, and 1.002.000 ha of pastures. In average, it is approximately 0,43 ha of the arable lands per capita, and about 0,18 ha of the meadows and pastures per capita, in view of that 0,61 ha of the arable lands. (*Markovic, 1993*). Serbia is widely seen as the mostly rural region, and most of its revenue comes from food production. The impacts of drought and water shortages have large and devastating impacts on the income of the population and quality of life. In Serbia, however, there is no an official statistical definition of rural regions. During categorization, 1953, 1961 and 1971, the classification is carried out in relation to the proportion of representation of agricultural production in relation to the total population and we monitor the overall size of the settlement. According to a study ¨A Typology of Rural Areas in Serbia˝ (Bogdanov at all, 2008) managed in 2008 and 2009 in the OECD criteria (European Commission, "Rural Developments", CAP 2000 Working Documents, 1997) 129 municipals is characterized as rural, the municipalities covered 3904 villages.

The Serbian climate varies between a continental climate in the north, with cold winters, and hot, humid summers with well distributed rainfall patterns, and a more Adriatic climate in the south with hot, dry summers and autumns and relatively cold winters with heavy inland snowfall. The average annual air temperature for the period 1961–90 for the area with an altitude of up to 300 m is 10.9 ºC. The areas with an altitude of 300 m to 500 m have an average annual temperature of around 10.0 °C, and over 1000 m of altitude around 6.0 º C , 3.0 o C over 1500m. The lowest recorded temperature in Serbia was −39.5 °C (January 13, 1985, in Pester), and the highest was 44.9 °C (July 24, 2007, Smederevska Palanka).

Annual precipitation in the basin of the Danube in Serbia is around 74.0 billion m^3, of the amount of about 23.5 billion m^3 flows, and the remaining 50.5 billion m^3 of goes on the evapotranspiration. Also, the annual inflow is about 154.5 billion m^3, so the total runoff of the Danube at the exit from Serbia is about 178 billion m^3. Hydrological balance is very uneven in time and space. During the growing season, precipitation in some areas amount is only up to 28% of the annual average. Transboundary rivers, Sava (206 km in Serbia), Drina (220 km in Serbia) and Morava (308 km in Serbia), along with the Danube River, are the basic water resources in the country.

Water flow varies seasonally, requiring the formation of reservoirs over the Drina, Danube and Lim. There are 60 reservoirs (about 20 of more than 10 million m^3) and about 100 smaller reservoirs in the basin of the Danube River in Serbia. The total capacity of all reservoirs is about 6.5 billion m^3. Average annual rainfall in the country amounted to 734 mm, but there are wide variations.

According to the last official census data collected in 2002, overall population in Serbia is 7.498.001, of whom 52% live in cities; the census was not conducted in Serbia's southern province of Kosovo. Great migration from villages to cities is distinctive, as agricultural vs. nonagricultural activities. It changes and transforms economic structure of the inhabitants and affects agricultural development and overall economy. Labor force of the agriculture becomes a limited development factor, for many of 6000 villages are emptied, or only with aged population (*Markovic, 1993*). Family estates in the countryside are small and have distinctive natural consumption, and it is much less commercial than those in EU. Population trends that are of special importance for water resources is increasing demand for drinking water in urban areas, where urbanization is the trend of 52 - 69% in six big cities all of which face considerable problems of wastewater management and increasing pressure on already burdened water supply and sanitation.

Serbia has approximately 2.961.000 capable workers, but many of them are unemployed, unemployment (21,56%) is most prominent. About 30% of labor force works in agriculture, 46% in industry, and 24% in services (without Kosovo). There are 1.305.426 farmers in Serbia, which is 17,3% of the overall population.

Slovenia

Slovenia is located in central Europe with geographic coordinates of approximately 46° north latitude and 15° east longitude and it borders with Italy, Austria, Hungary and Croatia. In the southeast, its 46.6 km long coast enables access to the Adriatic Sea. Slovenia is with an area of 20,273 km^2 one of the smallest European countries.

Slovenia’s position between the Alps, the Dinaric Mountains, the Adriatic Sea and the Pannonian plain is the reason for the country’s diverse climate: the continental climate in central and eastern Slovenia, the Alpine climate in the northwest, and the sub-Mediterranean climate in the coastal area and its hinterlands. The highest peak is Triglav (2,864 m a.s.l.), located in NW of Slovenia. The largest national park – Triglav National Park with its surface area of 83,807 hectares – is situated in the same area. The intermittent Lake of Cerknica is a site of particular interest. It is also the largest Slovenian lake, but not always because in summer the lake ‘disappears’ and the local farmers then use its 26 km^2 area to produce feed for horses and bedding.

Precipitation is unevenly distributed. Lowest yearly amounts of precipitation are recorded in the northeastern part of Slovenia and in the small coastal region. In both areas amounts do not exceed 1000 mm and barely reach 800 mm in some stations. The highest values of precipitation are recorded in Julian Alps and Dinaric ridge, which separate the regions with Mediterranean influences on climate from the continental ones. Precipitation stations in mountainous regions frequently record yearly values above 3000 mm. Water resources are generally sufficient for the water supply for population and industry. Most of the agriculture is due to favourable climate under rain-fed conditions; Slovenia has one of lowest shares of water consumption in agriculture (less than half percent in 2003 according to Environmental indicators in Slovenia, issued by Ministry of Environment, 2005). The reason is mainly in poor infrastructure, which makes Slovenia's agriculture very vulnerable to the occurrence of even a very short precipitation deficit.

According to the Statistical office of Slovenia, the population of Slovenia is 2.032.362 (31 December 2008). Slovenia's capital and largest city is Ljubljana; it is situated in the central Slovenia at latitude of 46º03' and longitude of 14º30' and at an altitude of 298 m. In 2004, 266,845 people lived in Ljubljana. The average population density is 99,1 inhabitants per km^2.

The population of Slovenia is not expected to grow in the forthcoming decades. Slovenia experienced negative total population growth in the last years of 20th century, reaching -1.8 per 1000 inhabitants in 1998. Growth would remain negative in the first years of 21st century without migrations. Mainly migration influenced population growth to turn to positive numbers in year 2000, since 2006 there is also positive for natural population growth. According to Eurostat projections (EUROPOP 2008), Slovenia's population will moderately grow until 2020 and then start to decline; in 2030 approximately the same population is expected as of today. Therefore – at least from the water supply point of view – we cannot expect significant change of the overall situation.

Forests cover the majority of Slovenia's territory (63.3 %). Total agricultural land covers 30.5 % of the territory, developed areas 2.8 %, open spaces 1.6 %, transport infrastructure 1.1 % and water bodies 0.7 % of the territory. Terrain diversity, climate and pedological variety, large forests and the preservation of traditional ways of managing parts of the cultural landscape are the reasons for the high biodiversity, which is endangered due to potential climate change. 3000 ferns and flowers grow in Slovenia, along with 50,000 different animal species. Concern for preserving biodiversity is also evident in the increased number of protected areas. Protected areas comprise 11% of the entire territory, and include the Triglav National Park, 3 regional parks and 44 landscape parks. In addition, the Decree on Special Protection Areas (Natura 2000 Areas) in 2004 defined Natura 2000 areas which comprise 36 % of Slovenia's territory. Protected areas represent 25 % of Natura 2000 areas (Česen et al, 2006).

A.1. Information sources relevant to historical records of drought periods and impacts

There is an existing tendency among professionals, politicians, managers or even common citizens on viewing and considering drought as a natural hazard; a traditional disaster causing emergency mobilization. However, cumulative experience from scientific investigations of the recent decades is indicating that the recurrence of drought is unavoidable, as the phenomenon seems to be an inevitable and permanent part of the world's climate, especially with the recent indications of potentially increasing instability in the environment (greenhouse effect, ozone depletion etc.).

Albania

The main sources relevant to historical records of drought periods and impacts are:

a. Studies published in the annual scientific Journals of Hydro meteorological Institute, Tirana –Albania.

In the study of Prof. Siri Jaho and Prof. Asllan Mici "Some characteristics of atmospheric drought in Albania" (HIDMET 1981), the authors have evaluated the drought in Albania related with some quantitative characteristics point of view. To determine drought event.Also, the hydro technique coefficient is used to evaluate the geographic extension of drought event.

In the publication of Prof. Robert Naçi "The Hot and Dry Winds in Albania" (HIDMET 1986), the occurrence frequency of such winds is estimated. The definition of Hot and Dry Winds is a follow: wind speed ≥ 3 m/sec, air temperature ≥25°Cand relative humidity ≤ 30%. During the study period 1951-1980 the years 1961, 1962,1965,1968,1971 and 1977 are characterized by the high number of Hot and Dry Winds cases, while the years 1964,1967,1972,1976,1979 by the small number of such days.

In the publication "Precipitation and the drought in southeast of Albania" Assoc. Prof. Bojko Themelko (HIDMET 1989) Thornthwaite drought index is used to evaluate the drought level for the different zones of Albania.

In the paper "Extraordinary event over Albania" Assoc. Prof. Liri Muçaj (Gjoka) drought events are evidenced. Palma de Mallorca SPANJA 14-17 APRIL, 1997.

Evapotranspiration and its evaluation on the Albanian territory, Balwois 2010. PhD. Aferdita Laska Merkoçi&al.

An approach to mapping evapotranspiration by meteorological elements with application to the territory of Albania Skopje 2010. PhD. Aferdita Laska Merkoçi&al.

Meteorological Extreme events and their Evaluation Based on Climate Change Scenario. BALWOIS 2010. L. Muçaj[1] , V. Mustaqi[1] and E. Bruci[2].

b. Research projects funded by the European Commission, National funds, or Publications in books.

- MEDROPLAN, Mediterranean Drought Preparedness and Mitigation Planning. [2006]

In the frame of this project Albania has been involved giving the scientific report on the drought events in Albania and Mitigation measures.

- South Eastern Europe Disaster Risk Mitigation And Adaptation Program (Seedrmap) The World Bank, Sustainable Development Department Europe and Central Asia Region and UN/ISDR secretariat Europe March 2008Sov

c. Albanian Newspapers

The old Albanian newspaper Telegraf, Koha, Panorama, Shqip, jurnal of HMI etc. have displayed the drought and their impact especially in agriculture.

Bulgaria

The duration of rainless (or non measurable rain) period over 10 days is considered in this country as a drought beginning (Ganev, Krastanov, 1951; Sabeva et al., 1968). This is related to the stabilization of the synoptic conditions. There are different characteristics, which are used for estimation of the droughts intensity and frequency. Sabeva et al. (1968) used the rainless periods with duration above 10, 20, and 30 days during the vegetation period and coefficient of dryness K_{dry} as meteorological drought indicators.

The main rain indicators for the atmospheric drought used by Koleva (Koleva, 1991; Koleva, Alexandrov, 2008) are: Index of anomaly, Ped index, The de Martonne index, The Palfai aridity index. These indicators are applied for drought years' identification in the Bulgarian low regions during the 20th century (Koleva, Alexandrov, 2008) using monthly precipitation data from 36 stations and monthly averaged air temperature from 17 stations. Koleva and Alexandrov (2008) estimate the deviation of annual precipitation data from the averaged precipitation $\overline{P}$ for the period 1961-1990.

The standardized precipitation index - SPI (McKee et al., 1993) and Palmer Drought severity index - PDSI (Alley W.M. 1984) are recently used as indicators for dry (negative values) or wet (positive values) weather conditions in three representative stations in the country (Kercheva, 2004). These indices are especially useful for identification of the beginning and the intensity of drought. SPI could reflect shorter or longer drought periods depending on the base for calculation (1, 3, 6, or 12 months).

The impact of drought on crop yields is illustrated using data from controlled field experiments and from statistical yearbooks.

One of the most comprehensive study on the relationship between drought conditions and their impact on agriculture over 1931-1960 has been carried out in this country by Hershkovich and Dilkov (1968). Their approach was directed for estimation of: 1) periods of crop vegetation sensitive to drought; 2) Duration of droughts and their coincidence with the crop vegetation period; 3) Drought intensity and impact on crop yields; 4) Regions where the agricultural drought is spread.

In some cases the agricultural drought could be estimated by the absolute values of crop yields under rainfed conditions. The maize yield threshold of 3200 kg ha^{-1} is considered critical at the grain price of 180 leva/t in different studies (Varlev, 2002; Popova and Kercheva, 2002, 2004; Popova, 2008-a, 2008-b) since under that limit maize cultivation is unprofitable and related to economical losses. Considering the fact that the grain price is not stable over the years and usually vary within the range 180-300 leva/t, the critical yield threshold should have been variable as well.

The agricultural drought criteria in Bulgaria are based upon long-term studies on the "water-yield" and "evapotranspiration-yield" relationships and crop irrigation scheduling carried out by the research institutes of the Agricultural Academy. Series of data on crop yield, evapotranspiration, required number of irrigations, irrigation demands, water use efficiency etc., used to be obtained under controlled management practices at field scale in the experimental stations. The results were analyzed and published in numerous issues (Varlev, Kolev, Kirkova, 1989; 1990; 1994; Banov, 1988; Eneva, 1993a; 1993b; 1997; Furdjev et al, 1994; Varlev and Eneva, 2000; Jivkov, 1993) and books *Water-Evapotranspiration-Yield* (Varlev and Popova, 1999) and *Potential, efficiency and risk under maize cultivation in Bulgaria* (Varlev, 2008).

Croatia

The climate assessment in Croatia according to the aridity index shows the prevailing precipitation deficit in the warm part of the year in the whole country, except the mountainous region [2]. In the Panonian region there is no precipitation deficit on the annual scale but a deficit occurs in some months. The precipitation deficit decreases going from the east to the west. Moreover, the duration of deficit is shorter in the west and northwest region (from May to August) than in the east and central mainland (from April to September). The deficit is mostly pronounced in the Adriatic region. In the middle Adriatic region the precipitation deficit usually lasts from April to September while in the south region the deficit is present from February to October. The mean annual precipitation restores only 50% of evaporating water. According to the United Nations Convection to Combat Desertification (UNCCD) definition and criteria accepted by UNEP/GEMS (1992) after recommendation of FAO UNESCO (1977), the next scheme shows the threat to desertification due to climate conditions:(desertification) 0.05>P/PET>0.65 (no desertification)

Operational drought monitoring on different time scales started in Croatia in 2009 (Meteorological and Hydrological Service (DHMZ), http://meteo.hr/). The Standardised Precipitation Index (SPI) is used for this purpose which is useful for determining drought onset, duration and intensity. However, Mihajlović [9] analysed meteorological drought of 2003-2004 over the Panonian part of Croatia as well as the drought characteristics during the 20th century at Zagreb- Grič station. The results of SPI at timescales of 1, 3, 6 and 12 months

(SPI1, SPI3, SPI6 and SPI12) showed that the drought in Panonian region started in March 2003 and lasted till April 2004. However, it is shown that the meteorological drought is a regular feature over the Panonian part of Croatia. The meteorological drought of 2003–2004 had an exceptional magnitude at the 1-month timescale and did not have an exceptional magnitude and duration at the 3-, 6- and 12-month timescales. The most severe meteorological drought according to the Zagreb data lasted from July 1990 to August 1993. There are two other extreme drought periods with highest magnitude at a12-month timescale: May 1949 to November 1950 and November 1942 to September 1944.

Furthermore, the climatology of dry spells during the second half of 20th century in Croatia has been analysed [10]. Length of dry spell is expressed as number of consecutive dry days with daily precipitation amount less than 1 mm, less than 5 mm and less than 10 mm. The results affirmed the three main climatological regions in Croatia, with the highlands exhibiting shorter dry spells than the mainland, and the coastal region exhibiting longer dry spells. The prevailing positive trend of both mean and maximal durations is detected during winter and spring seasons, while negative trend dominate in autumn for all thresholds. Positive field significant trends of mean dry spell duration with 5 and 10 mm thresholds are found during spring and the same is valid for annual maximum dry spell duration with a 10 mm threshold.

The records of drought impacts in Croatia are systematically assesembled in the report of rare meteorological and hydrological events in the **Meterological and Hydrological Bulletin** of DHMZ (monthly reports). The source for these data are mainly from national newspapers.

F.Y.R.O.M.

Although the drought in F.Y.R.O.M. is a “climatic fact” (Filipovski, 1948), the information and data on drought and drought impact in the country are very limited. Some individual activities at a scientific or professional level do not offer sufficient information to assess all aspects of drought. On the other hand, numerous data could be gathered out of numerous national assessments in other areas, but the problem is the communication among different stakeholders that have those data. Most valuable data on drought periods that needs to be further processed are in possession of Hydrometeorological Service.

Earliest investigation of drought provides analysis of the available meteorological elements from observation in F.Y.R.O.M. in the period from 1927-1940, calculation of monthly and annual drought index according to De Mortone, analyze of 1945/46 drought impact on the agricultural production, conclusions about the drought in F.Y.R.O.M. and finally provides some measures for drought mitigation. De Mortone drought index for period 1927-40 shows values below 10 (5-10 =edge of desert and steppe) for summer months (July and August) for central (Veles) and eastern (Stip) part of the country.

Agricultural production in F.Y.R.O.M. is strongly influenced by the drought that is caused not by the small annual quantities of precipitation, but mostly by the unfavorable annual distribution, especially emphasized in the central and eastern part of the country. (Filipovski, 1948)

Records of drought periods defined as number of consecutive days (more than 10) with precipitation less than 1mm for the period 1951-1975, shows extreme long dry periods in 1953 (Feb-April), 1956 (July-Oct.), 1961 (July-Oct), 1965 (Sept.-Dec.), 1969 (Sept.-Dec.) , 1974 (July-Sept.).

The most extreme dry period was registered in 1956 from July-October, over entire territory of F.Y.R.O.M. with record 88 days without precipitation. (Lazarevski, 1982, 1993)

The latest archiving of drought data was done at the Hydrometeorological service, providing the extension of the mentioned period until 2000, shows prolonged dry periods in the period 1986-1989 (in the central part up to 54 days in Dec-Feb. 1988), in 1992 (Stip 54 days from Jan.-March), in 1997 (Prilep 40 days from June-July), in 2000 (Demir Kapija 47 days from July-Sept.) (HMS Archive, 2010). Unfortunately, there are insufficient data for impact of these droughts periods.

Greece

The climate in Greece is predominantly Mediterranean. However, due to the country's unique topography, Greece has a remarkable range of micro-climates and local variations. To the west of the Pindus mountain range (running from north to south and being the “spine” of the country), the climate is generally wet and has some maritime features. To the east of the Pindus range is generally dry and windy in the summer, particularly in the Aegean Sea islands. In this regard data from the Hellenic National Meteorological Service, the Ministry of Agriculture, the ministry of Environment and the Public Electricity Corporation have been extensivelly used.

In addition to that relevant scientific publications and reports have been incorporated. Therefore, the use of a drought index, such as SPI, lead to a more appropriate understanding of drought duration. The importance of the Index may be marked in its simplicity and its ability to identify the beginning and the end of a drought event. In this context, Greece, as it is very often facing the hazardous impacts of droughts, presents an almost ideal case for the SPI application. In 2010 a research effort examined the SPI drought index application for all of Greece and it is evaluated accordingly by historical precipitation data. Different time series of data from 46 precipitation stations, covering the period 1947- 2009 and for time scales of 1, 3, 6, 12 and 24 months were used. The results identified that the drought years were 1989, 1990, 1993, 2000, 2007 and 2008. Other results underline the potential that the SPI usage exhibits in a drought alert effort supporting drought forecasting in a drought contingency planning posture.

Research projects funded by the E.C. which have been also used for data extraction and collection are as follows:

- Automated fire and flood hazard protection system (AUTOHAZARD – PRO),

- Developing Strategies for Regulating and Managing Water Resources and Demand in Water Deficient Regions (WATERSTRATEGYMAN),
- Desertification, Mitigation And Remediation Of Land (DESIRE),
- Sustainable Use Of Water Resources And Rural Development In Drought Affected Areas (IMAGE),
- Mediterranean Dialogue On Integrated Water Management (MELIA),
- Combating Desertification In Mediterranean Europe: Linking Science With Stakeholders (DESERTLINKS),
- Pan-European Soil Erosion Risk Assessment (PESERA),
- Mediterranean Desertification And Land Use (MEDALUS)

Hungary

In Hungary, the annual precipitation amount and the average soil moisture content has decreased since the beginning of 20th century. Especially the winter and spring precipitation amounts show a significant decreasing trend, with its endangering effect on the deep soil moisture content and on the groundwater table. There is a very dangerous decrease noted also in the ratio of annual precipitation to potential evapotranspiration (P/P_E). Additional problem is that the intensity of precipitation increases in average. The part of runoff became larger and greater part of the precipitation runs to the rivers, streamlets, and less part infiltrates into the soil. Therefore, the available water reduces for vegetation and other activities (drinking-water, irrigation, fishing etc.). Summarized, the drought tendency increases in Hungary.

As a result of frequent drought events in the country Hungarian specialists in water management, agriculture and agro-meteorology have been deeply involved in drought investigation. Intensive research work has been extended to the following main topics:

- Evaluation of the effects of drought events
- Determination of the reasons and circumstances in which severe drought occurs - finding out the effects of drought on plant production and animal husbandry
- Developing methods for reduction of harmful impacts of drought

Over time the results of researches have been explained and discussed, but after some serious drought events the experts evaluated the situation in home consultations and symposia. One of the most important evaluations of the experience of the drought of 1983 was made by the special group of the Hungarian Academy of Sciences during the next ten years (Baráth-Gyorffy-Harnos, 1993), in which the experts have made

- Mathematical evaluation of climate data time series and climate-yield correlation,
- Analysis of plant production on the basis of data gathered on several cultivated plots and plants,
- Correspondence analysis of different factors on yield,

- Historical evaluation of drought events and the role of the ever existing Hungarian governments in drought mitigation, and summary on the future tasks and possibilities.

Among the final conclusions there had arisen the strategy of drought mitigation in agriculture as a complex system of means and measures for the reduction of drought damages in agricultural production. Also the necessity of the establishment of monitoring systems and the use of computerized methods has been emphasized together with the well-organized complex research work on different impacts of drought. The Hungarian Academy of Sciences established a special commission for the coordination of these kinds of research activities. In 1992, there was again a serious drought in the region; the evaluation of its Hungarian impacts was made in a meeting held in the Ministry of Agriculture, organized by the Hungarian Association of Agricultural Sciences and the Hungarian Hydrological Society (Pálfai-Vermes, 1993). Parallel with home activities some important international events and conferences influenced the Hungarian activities in drought problems. In 1992 the 15th European Regional Conference of ICID (International Commission on Irrigation and Drainage) was held in Budapest, and one of its sections was devoted to the drought phenomena.

Hungary is taking part in more international cooperation programs, which involve scientific and technological topics related to the Convention (FAO, ICID, NATO-CCMS/SCOM, IDNDR)

According to the worldwide used aridity index, the ratio of annual precipitation to potential evapotranspiration (P/PET), Hungary can be identified as an "affected country" under the terms of the UNCCD. In fact, drought is a considerable and increasing risk factor, especially on the Great Hungarian Plain and other parts of the country and the Sand Ridge (in Danube-Tisza Interfluve) is threatened by desertification, this region has been classified as semi-arid zone by the Food and Agriculture Organization of the United Nations, the FAO. In the 20th century, the Danube-Tisza Interfluve was covered by nearly 600 smaller and larger lakes, but by most of them, now only their names remained.

Montenegro

Research project AEN-Extreme Atmospheric Conditions in Montenegro

Main objective of the project AEN is forecasts/warnings of dangerous meteorological situations in order to decrease damages generated by the extreme weather conditions.

In the project AEN was illustrated yearly realizations of precipitation for three periods: 1961-1990, 1991-2005 and 1950-2005 for 23 stations. Data was illustrated in table and by graphic for each station.

Beside that De Martonne aridity index for year, seasons and month was calculated.

Internal HI-M publications

- Monthly, seasonal and yearly climate analyses

In HI-M publications of monthly, seasonal and yearly climate analyses of precipitation, methodology of percentiles is in use for particular meteorological stations, as well as realization of precipitation (%). For preparation of climatological maps interpolation by Kriging is in use;

- Drought periods and their analyses by Silva Otorepec and Momirka Vukmirovic;

Frequency, duration, absolute maximum length, probability occurrence of drought periods on territory of Yugoslavia, as well as drought frequency in critical periods of growing wheat and corn. were calculated and presented in this publication. Period of analysis was 1951-1960. To determine drought periods, V.G. Rotmistrov methodology was used, i.e. drought period is every period with 20 and more consecutive days with daily precipitation amount under 5mm and average daily sum for that period not larger than 0.5mm;

- Droughts in Montenegro by Mirjana Ivanov , Podgorica jun 2005

The document was written for the purpose of media, thus it doesn’t contain detailed analysis. It provides briefly information about the AEN, as well as analyses of SPI12 index in December based on the available data from the meteorological station in Podgorica.

- Maximum drought periods

Maximum drought periods in Montenegro were calculated for 12 stations for the period 1949-1999 using the consecutive number of days with precipitation amounts below 0.1.

- Drought in Pljevlja

In this publication, drought periods and frequency of drought periods with condition of consecutive days with precipitation amounts below 0.1. were calculated Period of analysis was 1949-1999.

Internal documentation of Hydro Plant Piva

- monthly average inflow
- work report
- Newspaper Elektroprivreda

Report of chief economist of Central Bank of Montenegro

Data from statistical yearbooks

Media:

Newspaper Pobjeda

Newspaper Vijesti

Magazine Ekonomist

Serbia

The main reason why this aspect of drought deserves the most attention is the fact that precipitation is an element of the hydrological cycle that most affects water balance. In addition, this aspect of drought is usually first analyzed because:

- Meteorological drought preceded the emergence of other forms of drought;

- Meteorological drought conditions in our construction and use of irrigation is another factor that is most important for the development of agricultural drought;
- Meteorological drought is the closest to human perception (absence of rainfall, damaged land).

In order to evaluate the drought meteorology, data analysis included 26 meteorological stations from the national network of meteorological stations in the period since 1961 to 2005. The methods used are: trend analysis, intra distribution, analysis of climatological and SPI6 deficit. These are the only climatological analysis of the deficit, which is the difference between potential evapotranspiration ETP (according to the method of Thornthwaite) 7, and total rainfall.

In hydrology, the term drought includes long periods of low water with extremely low water levels in rivers and reservoirs that are much lower than average. Occurrence of long dry periods, it reduced the flow and water levels in rivers and cannels, causing decline in stock levels and groundwater in the basin. Periods of time with the emergence of extremely small flows are called periods of low flows.

Correlation area of meteorological parameters and state the quantity of water resources in Vojvodina and Serbia is difficult due to the presence of a large number of transit rivers, which have great influence meteorological and climatological impacts upstream of the observational profiles.

Many years of observations on the Danube were allowed as to classify through the statistical analysis their discharge characteristics. Using the Pearson III distribution, the analysis of flow profile on the Danube from 1840 - 1989, and characterization of water years made the following principle: that all the mean values are within the range of 25 to 75%, dry (low flows) from 75.1 to 95%, very dry from 95.1 to 99% and the disastrous drought of 1999, 1 to 99.9%.

The novelty in the analysis of drought periods is the use of two methods developed by prof. Jevdjevic, the University of Belgrade, whose work was changed in the analysis of drought on the river Morava in the National Project NPV 21A. The objective was to define the major droughts on Great Morava basin, during 1951 - 2003. He made the ranking of drought episodes by three criteria (duration, volume and intensity of the deficit) and for each of the methods, two methods introduced by prof. Jevdjevic: a method of steps (Eng. RUN method) and method of decomposition and synthesis of no stationary stochastic Series (TIPS method) is applied to the structural analysis of daily flows. On the basis of daily data from the reference period can be different (fixed or variable) thresholds derived. For defined time series of thresholds in hydrological and observed daily flows in the dry episodes occurring within a calendar year or be transferred from year to year.

The drought has been analyzed in a number of ways and by numerous aspects on scientific level. The most frequent approaches and methods are:

- Quantity and classification of precipitation, in other words, the precipitation deficit (*Dragovic, Labat, 1990*). The drought phenomenon intensity calculation was frequently conducted accordingly to the amount of precipitation in July and August respecting plant water needs in the perennial period. (*Dragovic, 1999, 2001*). As for agricultural production, the drought phenomenon analysis has the greatest importance, mainly for it is based on climate, hydrological and productive circumstance in order to define insufficient water supply for plants from precipitation or other sources in accordance with their needs, in other words – potential evaporated transpiration (ETP). The drought phenomenon is appearing as predial drought, arid, and physiological drought; all of them are mutually related and stipulated.

Ground drought has the greatest consequences on plant production, for it causes temporary or permanent water deficiency and so limits plant growth and intensification, consequently reducing their organic matter production and yield.

- Humidity procure index by Hargreaves's method.
- Drought index by Em de Marton's method (*Dragovic, Maksimmovic, 1994*)
- Drought intensity index by Palmer (PDSI) has been developed on the basis of balancing between influx and dissipation.
- Water balance of the ground.
- Above and beyond, the drought impact is detected trough yield loss and negative financial effect, both of which are methods for drought phenomenon analysis. Irrigation effect on yield and financial effect is quite opposite; optimal water supply gives high yield among the most represented herbs.
- Assessment of damage caused by drought can be approached to from different aspects. First, lowered yield of certain crops, evident in drought years, also causes loss of profit on the afflicted area. If it afflicts larger areas, it can inflict loss on the national income.
- *Beric et al., 1987, 1988, 1990, Beric and Neskovic-Zdravic, 1995 and Beric and Salvai, 1995* were carried out complete analysis of the stochastic process of extreme dry weather intervals during growing season at 22 meteorological stations in the Vojvodina. The analysis included all available data on extreme dry weather intervals, which are defined as the upper extremes of intervals of no rainfall longer than 15 days. The results of such analysis show that the part of the growing season with the highest probability of having the longest extreme rainless period refer to the period of the second half of August and September. Periods of no rainfalls have tendency of increasing from south-west to north-east.

Slovenia

Droughts is Slovenia differ to those in (for example) Mediterranean basin in many respects. Often it is expressed in absolute terms, for example inability for certain crop (most often maize) to grow in rain-fed condition during certain year, despite the fact that precipitation regime differs substantially among Slovene regions. Least precipitation during vegetation season falls in SW and NE Slovenia. Therefore, in the last forty years there are most frequently recorded observations of drought impacts in those regions – SW Slovenia (Slovenian Istria and the Littoral: thirty-one times) and NE Slovenia (Prekmurje region - twenty-seven times). In other regions (most notably in NW part of Slovenia) agricultural droughts generally do not cause damage to agricultural plants.

After examining all possible sources, it was found out that records of drought impacts in **Agrometeorological bulletin** (annual agrometeorological reports of national meteorological service) is the only source in Slovenia that was systematically assembling drought related information.

Alternative source of information are calculations of **surface water balance – difference between precipitation and reference evapotranspiration.** Cumulative deficit in water balance throughout the vegetation season can indicate drought condition; most often also shorter periods (from June to August) with distinct water balance deficit appear. In the period from 1961-2008 eight very severe droughts were recorded in this period in the territory of Slovenia (1967, 1971, 1983, 1992, 1993, 2000, 2001 and 2003). Longer periods of drought appear in Slovenia at the end of winter and in spring; however summer droughts are much more problematic due to faster evaporation. The worst summer droughts so far occurred in 2001 and 2003, which caused a great deal of damage to agriculture, and in places threatened sources of drinking water. Summer droughts in 1992, 1993 and 2000 were also of catastrophic proportions, and at the coast droughts usually occur every summer. In the summer of 2004, drought occurred only in the south-western part of the country, while precipitation in the summer of 2005 exceeded the average based on many years almost all over the country. (Česen et al., 2006)

Meteorological drought is often described in terms of drought indices, which are simple to use and simultaneously absorb great amount of precipitation data, temperature data, ground water content data, etc. Two of them were used in analysis of meteorological drought in Slovenia: standardised precipitation index (SPI) and Palmer drought severity index (PDSI). SPI can be calculated on different time scales, which is better for determining drought onset, duration and intensity. SPI with its multiple time scale can be useful tool to determine the effects of precipitation shortages to ground water level, river discharges and soil water content. The comparison of two indices for location Ljubljana showed good agreement between the PDSI and SPI on nine- and twelve-month time scale. Both indices indicated that after 1900 Ljubljana experienced worst drought conditions in 1947. SPI on three-month time scale showed significant (α=0.05) negative trend for summer precipitation (period 1961-2006) for stations Ljubljana, Murska Sobota and Bilje, located in three different climatic regions within Slovenia. SPI on 6-months time scale for September 2003 indicated extreme precipitation deficiency in greater part of Slovenia, except northwest; where above average precipitation was measured. In 2003 Slovenia recorded its most severe drought conditions after 1950 in all agricultural parts. (Ceglar et al, 2008).

A.2. Archive of local/regional/national drought periods and impacts based on historical records

Albania

The old Albanian newspaper Telegraf, Koha, Panorama, Shqip, jurnal of HMI, have been used for the archive of drought periods and impact especially in agriculture.

The major drought incidents in Albania are presented in the table A.1.

Bulgaria

The other source of information related to the impact of drought on crop yields are the data published in the Statistical Yearbooks (1901-2008) issued by the National statistical institute. Maize and wheat yields averaged for the whole country territory as well for the four major administrative production regions are presented and analysed in the report.

The consequences of drought during the period 1989-2009 was traced using the publications in newspapers, Internet and in two books devoted to this problem (Raev at al., 2004; Bachvarova et al., 2007).

The major drought incidents in Bulgaria are presented in the table A.2.

Croatia

At the Adriatic coast it is the dry period that is characteristic during summer months. However, small amounts during summer provide enough soil moisture for cultivating the most important Mediterranean culture, olives and vine. In summer 2008 Zadar archipelago was the most affected by drought at the Adriatic. Namely, because of the extremely small crop this event was proclaimed a natural disaster in the Zadar County. This was the motivation for analyzing the spatial distribution of SPI in the Zadar archipelago [11]. The SPI has the minimum value at 3 months scale (from July to September). The precipitation amount registered in summer 2008 had the second smallest value compared to the last 47-years period (1961-2007). These amounts have return period values of more than 90 years.

Records of drought impacts obtained from the Meteorological and Hydrological Bulletin during the period 2000-2010 are given in Table 3. Droughts in 2003 and 2007 lasted the whole year and all the Croatia was affected. Drought had impacts on agriculture, hydropower, water supply, river traffic was stopped; it increased forest fires danger and drying of rivers and wells. The natural disaster was proclaimed for many areas.

The major drought incidents in Croatia are presented in the table A.3.

F.Y.R.O.M.

The impact of prolonged dry conditions with intensive and uncontrolled antropogenic influence is evident on case of Dojran Lake, which is one of the three natural lakes in F.Y.R.O.M, notable by its specific biodiversity and climate conditions. It is situated on the south border line of F.Y.R.O.M and Greece, with a surface area of 41 km^2 (63% belongs to F.Y.R.O.M and 37% to Greece). The lake has elliptic form with total accumulated water amount of 262 mil m^3 and average depth of 10 m. It is very popular tourist resort and fishery region, unique by the method of fishing with birds' assistance. During the last period of prolonged dryness, the lake suffered enormous decrease of the water level. The Hydrological

Department at the Republic Hydrometeorological Institute, responsible for operational monitoring of the hydrological parameters had been recording the oscillation of the water level since 1951. The major drought incidents in F.Y.R.O.M are presented in the table A.4.

Greece

The Greater Athens metropolitan area in Greece, as well as the whole country, was severely struck in 1990, 1993, 2000 and 2007 by droughts. In 1990, a 43% decrease in average yearly precipitation in Greece was recorded. As a result of the decrease in precipitation, the inflows into lakes, rivers, reservoirs and aquifers were correspondingly decreased, all over Greece. Crops, livestock and wildlife were seriously affected during the drought. Industry and economic activities were faced by a recession. Losses to drought have escalated to about 1.5 billion USD in 1990 prices. The impacts of the drought in the water supply system of Athens were also profound. In 1990, the inflow in the supplying reservoirs had reached record lows and the Athens area in October had water reserves for only 56 days.

The 1993 drought has started to manifest its presence on December 1992, when the inflows in Mornos reservoir were about $30x10^6$ m^3 while the average is 80 x 10^6 m^3. Again on August 1993 it was announced that the Athens area had water reserves until the 3rd of October, of the same year. In this context the Athenian metropolis provides a unique opportunity to study drought and drought management responses in adverse physical and socio-economic conditions and across different cultural settings. The major problem in the Case of Athens has not been the lack of specific techniques for drought planning and management, but more the lack of holistic strategies through which drought decision-making and responses could be more effective and socially equitable.

The major drought incidents in Greece are presented in Table A.5

Hungary

One of the well-known results of our development is the Pálfai Aridity Index (PAI) designed by Pálfai in 1984, mainly for use in Hungary and in the Carpathian Basin, for the characterization of the severity of an arid situation by a single number derived from only few meteorological and hydrological parameters. In the base-formula to calculate the aridity index the mean value of air temperature of the period from April to August was divided by the precipitation depth summed up by the weighted monthly values of precipitation of the period October to August and multiplied by 100. The monthly weights for the precipitation values were based on the conditions of moisture storage and on the changing general water demand of the crops cultivated. For a more accurate expression of aridity the base-value of PAI_0 should be corrected by a) temperature (hot days) correction factor, b) precipitation correction factor, and c) groundwater correction factor. The index can be used for making comparison between the wet and/or dry situations of different periods as well as of different areas, and it is also good for some predicting purposes if calculation of PAI values is made continuously.

Réthly (1968, 1998) collected historical records of extreme meteorological events for the Carpathian Basin. The occurrence and characteristics of historic droughts in Hungary have been analysed by Szinell et al. (1998). They found that droughts have been recurring in the past century. Historic references (e.g. Gunst, 1993) suggest that although extremely dry periods occurred already before the beginning of regular meteorological observations, e.g. between 1779 and 1794, the series of severe droughts from 1983 to 1995 is rather exceptional.

According to the available official meteorological, hydrological data since 1900, the very dry years' rate has increased over the past twenty years. Such was the year 1990, 1992, 1993, 2000, 2003 and 2007, while the more than the last half century has only six such severe drought events.

The major drought incidents between 1990 and 2009 in Hungary are presented in Table A.6.

Montenegro

The major drought incidents in Montenegro are presented in the table A.7.

Serbia

Analyzing water flow over years showed following results. Disastrous drought years occurred in the 19th century in 1863 when the mean flow at Danube profile was less than 3500 m3/s. Very dry fall in 1866, 1894, 1921, 1943, 1949, when the average annual flow of the observed profile was between 3500 and 4000 m^3/s in the observed period, according to the considered classification, have been chosen 29 years of drought with average annual flow of the observed profile between 4001 and 4750 m^3/s. Minimum water on the Danube were under the influence of Djerdap, prior to its construction in 1972, looking at the minimum flow below 2000 m3/s, the frequency of their greatest in the period from 1855 until 1866, then in the late 19th century and early 20th century, as well as in the period from 1943 to 1945.

Nikola Mirkov, a creator of the Hs DTD project in Vojvodina, discovered and concluded that throughout 100 years of the precipitation in Vojvoidna, just 17 years had so called normal precipitation, whereas 37 years were with excessive precipitation, and even 51 years with a reduced amount of precipitation.

For the duration of 39 years (1965-2003) the amount and time rate sequence of the precipitation in Vojvodina (HMS Rimski Sancevi) varied significantly. The arid is predominant during the summers - one year was extremely aired, 20 years just regular, and 20 years moderately arid. Only 6 years were recorded without rainfall deficiency. Periodically, there was tremendous precipitation that led to water prevalent. In general 80% of the summer periods were with more or less water deficiency – 22% extremely arid, 32% arid – semi arid, 26% moderately arid – semi arid and just 20% had sufficient precipitation and suitable time rate sequence.

A period of 32 years was analyzed (1967 – 1995) and affirmed more arid years in eastern Serbia than in Vojvodina. In July, 84% of the years was arid (52% of them very arid), whereas in August 94% of the years was arid (74% of them very arid). The analysis through the aquatic assured index speaks about very dry July and August in eastern Serbia. The drought phenomenon in eastern Serbia is more intensive, mainly because of a smaller amount of the precipitation throughout vegetative period.

Analysis of weather conditions in 2003, indicates the amount of rainfall of 236 mm in Novi Sad (MS was performed), which is about 120 mm less than average years, were measured and very high air temperatures, according to which in 2003 was the warmest year in the period of observation of meteorological data, diagram no. 1 below. Agriculture in 2003 suffered severe damage due to lower yields per hectare, as measured by the amount of nearly U.S. $ 620 million, if the dry year of 2003, compared to a favorable 1991.

The major drought incidents in Serbia are presented in the table A.8.

Slovenia

A.) Agrometeorological bulletin

Records of drought impacts obtained from agrometeorological bulletin (annual agrometeorological reports national meteorological service) are the main source of information on historical drought impacts; they are the only systematic source of information on drought for longer time period.

The major drought incidents in Slovenia are presented in Table A.9.

B.) Alternative sources of information on drought impacts

1. **Application for Damage Assessment on Agricultural Products and Objects – AJDA** (Ministry of Defence, Administration of the Republic of Slovenia for Civil Protection and Disaster Relief); - new information system for drought impacts is working only since 2006. The system is designed for centralized electronic capture and processing of applications from the victims of natural disasters.
2. **Estimated damage caused by natural disaster (drought) from 1994 to 2008** (Statistical Office of the Republic of Slovenia). Data are territorially classified according to The Classification of Territorial Units for Statistics – NUTS, level NUTS 3.
   Note by Statistical office:
3. **Ministry of Agriculture, Forestry and Food (MAFF)**, available data about drought in agriculture for the years: 2003 and 2006
4. **Agricultural drought in Slovenia**
   a) Agricultural drought in Slovenia in 2007:
   Too dry and too warm weather with meagre precipitation and high air temperatures between May and August 2007 was the principal cause of agricultural drought. The

severity of the drought differed per various regions, as did the consequences visible on crops. The drought affected a total of 27,875 ha of agricultural area and the damage exceeded 16.5 million. Around 6500 farmers in 56 municipalities were affected. In its programme for the mitigation of the effects of drought the Government granted state aid in the amount of one quarter of the estimated damage. (Šušnik and Matajc, 2008)

b) **Causes and effects of agricultural droughts in 2006:**
Slovene agriculture was again struck by agricultural drought in 2006. It was specific from all points of view. Spatially it affected less than 25% of the area of Slovenia and lasted only slightly less than two months but was very intensive in the areas affected. According to the program for remedying the impact of damage to agriculture after natural disasters, around 21,000 agricultural claimants were affected in 139 municipalities, covering an area close to 170,000 hectares. (Sušnik, 2007)

c) **Crop Damage due to Catastrophic Drought in 2003:**
In 2003, Slovenia recorded its most severe water deficit in all agricultural areas of the country. In addition to summer drought, which is a typical phenomenon of northeastern Slovenia and the Littoral region, the whole country's agriculture suffered in 2003 due to the exceptionally early, severe spring drought, which extended into late summer. Only 40 to 70% of the normal precipitation fell in the major part of Slovenia in the period from March to August.(Sušnik and Kurnik, 2003/2004).

d) **Effects of Drought on Slovenian Rivers from 2000-2002:**
A drought was recorded from 2000-2002. It was associated with a period of lower precipitation and was reflected in low water flows and lower groundwater levels. The low water flows were recorded from June to August in 2000 and 2001. In 2002, the low water flows were recorded from the first half of the year up to July. The low water flows in 2000-2002 resulted from a precipitation deficit. Precipitation was below the average during the period 1961-1990. (Kobold, 2003/2004)

e) **The Turning Point in the Low Level of Groundwater in 2002:**
The low level of groundwater in 2002 mostly affected the alluvial aquifers in northeastern Slovenia. Drought in that region had been extremely severe and it had lasted the entire year, becoming a turning point in the management of groundwater in Slovenia. Groundwater levels dropped to the lowest point since 1952. (Mikulič et al, 2003/2004)

f) **Agricultural Drought in 2001:**
The 2001 vegetation period was the second season of extremely unfavourable weather conditions for crops. According to agrometeorologists this was the seventh most distinctive agricultural drought in the past 41 years. Severe damage on field crops, meadows and fruit orchards has been detected (Matajc, 2002). The hydrological drought was especially severe in the summer months of 2001, but it did not reach extreme limits during measurements. Due to the problems connected with the drinking water supply, more than 31,000 people were affected in the year 2001. The quality of

water (drinking water as well) worsened substantially in the period of hydrological drought. (Uhan, 2005)

g) Consequences of the 2000 Drought in Slovenia:

The third drought in the last ten years and one of the most severe in the last forty years affected more than three quarters of Slovenia's agricultural land in 2000. The yield of most field crops, vegetables and fruit trees was halved in some regions, and there was no yield at all in areas with light, sandy soils. (Matajc, 2000/2001).

Table A.1. Drought chronology from 1920 up to 2003 in Albania.

Country	*Location*	Source	Date	Abstract
Albania	***Tirana***	Koha newspaper	1920	Maize crop died from lasting drought
Albania	***Tirana***	Koha newspaper	June/1922	the sowing had to change in the food of livestock
Albania	***Tirana***	Telegraf newspaper	June/1990	During the summer months has damaged the sowing, maize, grape, vineyard
Albania	***Tirana***	Referred achieve of HMI	1930/1931	Seriously damages in the agriculture yield.
Albania	***Tirana***	Journal of HMI	1952	The spring drought lasted 2.5 months
Albania	***Tirana***	Journal of HMI	1953	The spring drought lasted 1.5 months
Albania	***Tirana***	Journal of HMI	1961	The summer drought lasted almost 4 months
Albania	***Tirana***	Journal of HMI	1965	Summer drought lasted almost 5 months
Albania	***Tirana***	Journal of HMI	1975	drought lasted about 94 days
Albania	***Tirana***	Journal of HMI	1978	about 100 successive days without precipitation
Albania	***Tirana***	Journal of HMI	1985	about 83 successive days without precipitation
Albania	***Tirana***	Journal of HMI	1986	about 80 successive days without precipitation
Albania	***Tirana***	Journal of HMI	1989-1991	Because of drought Albanian economy have loosed 24 million USD

Albania	***Tirana***	Gazeta Panorama	November/2003	Energy crises because of drought& lack of precipitation
Albania	***Tirana***	Gazeta shqiptare	2006-2007	352 fires burned the forest and the natural park in entire Albania
Albania	***Tirana***	Eco movement	19/01/2007	Drought. Electricity interruption, fauna of water get up to the shore.
Albania	***Tirana***	Eco movement in Albania	28 August 2007	Emergency. Evacuate 90 household because of the fire in entire Albania.
Albania	***Tirana***	Gazeta Panorama	30/10/2007	Drought. 33% of average production from Fierza HPP
Albania	***Tirana***	Gazeta shqip	September/2003	Droght, Lack of drinking water in the Tirana City.

Table A.2. Drought chronology from 1989 up to 2009 in Bulgaria

Country	***Location***	**Source**	**Date**	**Abstract**
Bulgaria	***NorthEast Bulgaria***	Raev et al., 2003	Winter 1987-1988	Losses of winter crops due to the increased mice population due to high temperatures
Bulgaria	***Whole country***	Koleva, Alexandrov (2008);	1989	Dry year
Bulgaria		Sendov (1990)	1990	Official statement of Bulgarian Academy of Science against projects “Rila” and “Mesta” for derivation water from Rila mountain
			26.01.1990	Parliament decree for stopping water derivation from Rila mountain
Bulgaria	***Whole country***	Koleva, Alexandrov (2008);	1992	Dry year upon climate records and different drought criteria
Bulgaria	***Whole country***	Raev et al., 2003	1993	Economical losses of wheat yield production 72.3 mln $ and of 102.2 mln of maize production
Bulgaria	***Whole country***	Koleva, Alexandrov (2008);	1994	Dry year upon climate records and different drought criteria

Bulgaria	***Sofia***	Raev et al., 2003	July-August 1994	Regime of water urban supply in Sofia
Bulgaria	***Sofia***	Raev et al., 2003		The main water source for Sofia - Iskar dam is almost empty
Bulgaria	***Sofia***	Staddon	21.11 1994 till June 1995	Regime of water urban supply for several regions in Sofia
Bulgaria	***Separeva banya***	Raev et al., 2003	8.02.1995	Troops were sent in the town Separeva banya (Rila mountain) to mitigate the protest of local people against a project for water relocation towards the capital
Bulgaria	***Sofia***	Raev et al., 2003	July-August 1995	Regime of drinkable water supply in Sofia
Bulgaria		http://unfccc.int/resource/docs/natc/bulnc1.pdf	Feb. 1996	First National Communication on Climate Change
Bulgaria			1998	Second National Communication on Climate Change
Bulgaria	***Whole country***	Koleva, Alexandrov (2008);	1999	Dry year upon climate records and different drought criteria
Bulgaria	***Whole country***	Koleva, Alexandrov (2008);	2000	Driest year in 20 century (as 1945 year)
Bulgaria	***Whole country***	http://infocenter.bnt.bg/content/view/full/2698	2000	Forest fires (37,430 da burn)
Bulgaria	***Whole country***		2000	National Climate Change Action Plan, Republic of Bulgaria, 2000, MEW, Sofia, 94
Bulgaria	***Whole country***	Bachvarova et al., 2008		Warmer than usual winter
Bulgaria	***North Bulgaria***	Bachvarova et al., 2008	25.03-17.05.2007	Unusually dry period
Bulgaria	***Plovdiv and Sofia***	Bachvarova et al., 2008	18.05-7.06 2007	Heavy rains and floods (7 June) in the region of Plovdiv and Sofia. 30% less wheat and barley yields due to the heavy rains at the 2007

Bulgaria	***Whole country***	Bachvarova et al., 2008	27.06 and 17-26July	Considerably higher than normal temperature – 40-43oC in some regions
Bulgaria	***Whole country***	Bachvarova et al., 2008	After 20 June &July	Low or no rains in some regions
Bulgaria	***Whole country***	Bachvarova et al., 2008	14 .07. 2007	Forecasts by the Internal Scientific Service of the EC –JRC for losses in maize and sunflower production - 40,4% and 20%, respectively
Bulgaria		Bachvarova et al., 2008	2.08.2007	Report of the National commission for independent monitoring of the influence of the unfavourable climate events on agriculture as part of the procedure for requesting governmental support
Bulgaria	***Dobrich region***	http://www.ndt1.com/article.php/20071016113304592	16.10.2007	5 times lower yield of maize (103 kg/da) in comparison to 2006 year; 11383 ha with sunflower failed
Bulgaria			18.10.2007	Decision of EC for governmental support
Bulgaria	***Whole country***	http://infocenter.bnt.bg/content/view/full/2698	2007	Peak of forest fire (230,000 da)
Bulgaria	***Whole country***	http://infocenter.bnt.bg/content/view/full/2698	Jan_Aug 2008	Forest fires (40,603 da burn)
Bulgaria	***Burgas, Varna, Dobrich, Pleven, Plovdiv, Stara Zagora, Shumen, Yambol.***	http://www.lev.bg/view_article.php?article_id=36165	2009	Compensation for failed yields of wheat, barley, maize for grain, sunflower
Bulgaria		http://www.capital.bg/politika_i_ikonomika/bulgaria/2009/03/06/	06.03.2009	EC stopped 1. 5 mlrd EU funds for reconstruction of water supply and sewerage

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Table A.3. Drought chronology from 2000 up to 2010 in Croatia.

Country	***Location***	**Source**	**Date/period**	**Abstract**
Croatia	***All Croatia***	Newspaper articles	Spring - Summer 2000.	Drought threatening agriculture, livestock, fresh water fisheries, hydropower, water supply, tourism, increasing forest fires danger, rivers and wells dried, natural disaster proclaimed for many areas
Croatia	***Korčula island***	Newspaper articles	Spring 2001	2 to 5 litre rain in 50 days
Croatia	***NW Croatia, Dalmatia,***	Newspaper articles	Summer 2001	Drought threatening agriculture, water supply
Croatia	***Imotski region***	Newspaper articles	Autumn 2001	Drought threatening agriculture, water supply, Blue lake dried
Croatia	***Adriatic coast region***	Newspaper articles	Winter 2001/2002	Drought threatening agriculture, hydropower, water supply
Croatia	***Northern Dalmatia***	Newspaper articles	Spring/summer 2002	Drought threatening agriculture, water supply, fresh water fisheries, tourism, natural disaster proclaimed for some areas
Croatia	***All Croatia***	Newspaper articles	Year 2003	Drought threatening agriculture, livestock, fresh water fisheries, hydropower, water supply, tourism, river traffic stopped, increasing forest fires danger, rivers and wells dried, natural disaster proclaimed for many areas
Croatia	***Istria***	Newspaper articles	Summer 2004	Drought threatening agriculture
Croatia	***Šibenik region***	Newspaper articles	Summer 2005	Drought threatening agriculture, livestock
Croatia	***All Croatia***	Newspaper articles	July 2006	Drought threatening agriculture, livestock
Croatia	***All Croatia***	Newspaper articles	Year 2007	Drought threatening agriculture, hydropower, water supply, river traffic stopped, increasing forest fires danger, rivers and wells dried, natural disaster proclaimed for many areas
Croatia	***All Croatia***	Newspaper articles	Winter 2007/2008	Drought threatening agriculture, livestock, fresh water fisheries, hydropower, water supply, tourism, river traffic difficult
Croatia	***Dalmatia, Lika***	Newspaper articles	Summer/autumn 2008	Drought threatening agriculture, water supply, tourism, increasing forest fires danger, state of natural disaster proclaimed for some areas
Croatia	***Slavonia,***	Newspaper articles	Winter to	Drought threatening agriculture,

	Dalmatia, Istria		autumn 2009	livestock, water supply, some wells dried, natural disaster proclaimed for some areas
Croatia	***Some Dalmatian islands (Korčula)***	Newspaper articles	Summer 2010	Drought threatening olives, Vela Luka 40 days without rain

Table A.4. Drought chronology from 2001 up to 2009 in F.Y.R.O.M.

Country	Location	Source	Date	Abstract
F.Y.R.O.M.	**Bitola**	www.idividi.com.mk	2001-02-19	Hydro system “Strezevo” alarms water shortage
F.Y.R.O.M.	**All teritorry**	Vest	2001-02-28	Water level in dams tree times lower
F.Y.R.O.M.	**Strumica, Gevgelija, Valandovo, Radovis**	www.idividi.com.mk	2001-03-23	Significantly lower areas planted due to unsolved irrigation problems
F.Y.R.O.M	**Veles**	www.idividi.com.mk	2001-03-28	Condition of 2.400 ha barley is critical
F.Y.R.O.M	**Negotino**	www.idividi.com.mk	2001-04-05	Reduced energy production of Hydro-power plant “Dosnica”
F.Y.R.O.M	**Strumica region**	www.idividi.com.mk	2001-06-08	Water management enterprises are warning farmers about the lack of water for irrigation
F.Y.R.O.M	**Negotino**	www.idividi.com.mk	2001-07-21	Unsatisfactory wheat crop
F.Y.R.O.M	**All territory**	Dnevnik	2001-08-07	Hydrologists appeal for use of water exclusively for necessities in order to prevent water crises
F.Y.R.O.M	**Probistip, Zletovo**	Vest	2001-09-15	Drying of wells near Lesnovo Monastery
F.Y.R.O.M	**Negotino**	www.idividi.com.mk	2001-10-01	30% lower grapes yield
F.Y.R.O.M	**Sveti Nikole**	www.idividi.com.mk	2001-10-10	Damages of the bee and honey production
F.Y.R.O.M	**Demir Kapija, Negotino**	www.idividi.com.mk	2001-10-18	Decrease in production of grapes and vine
F.Y.R.O.M	**Krusevo**	www.idividi.com.mk	2001-10-22	Delay of autumn planting
F.Y.R.O.M.	**Negotino**	www.idividi.com.mk	2001-10-24	Delay of autumn planting
F.Y.R.O.M	**All territory**	www.idividi.com.	2001-10-25	Damages in crops due to

		mk		drought and war in the amount of 1.2 mil.DM
F.Y.R.O.M	**Sveti Nikole**	www.idividi.com.mk	2001-11-12	Drought cause damages in the amount of 12.7 mil. eur
F.Y.R.O.M	**Kumanovo, Stip, Prilep, Krusevo, Makedonski Brod**	Dnevnik	2001-11-21	Difficulties in water supply of cities
F.Y.R.O.M	**Valandovo**	www.idividi.com.mk	2001-11-23	57 % of the field can be planted
F.Y.R.O.M	**Prespa Lake**	Dnevnik	2001-11-28	Decrease of water level
F.Y.R.O.M	**Prespa Lake**	Dnevnik	2001-12-03	Decrease of water level
F.Y.R.O.M	**Kicevo, Krusevo, Makedonski Brod, Prilep**	A1 TV	2001-12-09	Water shortage in the cities from the regional pipeline “Studencica”
F.Y.R.O.M	**Krusevo**	www.idividi.com.mk	2001-12-10	Restriction in city water supply
F.Y.R.O.M	**Strumica**	www.idividi.com.mk	2001-12-13	30 % decrease of tobacco production
F.Y.R.O.M	**Prilep**	A1 TV	2002-03-03	Citizens without water supply
F.Y.R.O.M	**Tikves Lake**	www.idividi.com.mk	2002-03-19	Sufficient water for irrigation only for the beginning of the season
F.Y.R.O.M	**Kumanovo**	Utrinski vesnik	2002-05-29	Drinking water problems
F.Y.R.O.M	**Ovce Pole**	A1 TV	2002-06-08	Unknown reason for drying of the wheat causes 7.5 mil eur. damages
F.Y.R.O.M	**Dojran Lake**	Utrinski vesnik	2003-05-16	Spring drought and human influence on Dojran Lake water level
F.Y.R.O.M	**Ovce Pole**	A1 TV	2003-05-18	Need for irrigation system
F.Y.R.O.M	**Kicevo**	Utrinski vesnik	2005-11-21	Possible restriction in water supply in the regional pipeline “Studencica”
F.Y.R.O.M	**All territory**	Forum	2007-01-12	Comments on meteorological conditions
F.Y.R.O.M	**Kumanovo**	Utrinski vesnik	2007-02-07	Difficulties in water supply of citizens
F.Y.R.O.M	**Negotino, Demir Kapija**	Nova Makedonia	2007-03-23	Autumn cereals, industrial and garden plants in danger of drought
F.Y.R.O.M	**Strumica region**	www.idividi.com	2007-04-25	Difficulties in planting spring plants
F.Y.R.O.M	**Pelagonija**	Dnevnik	2007-05-16	Farmers are warning that

				winter/spring drought will leave the country without wheat
F.Y.R.O.M	**Stip, Sveti Nikole, Prilep**	Vest	2007-05-16	There will be no harvest due to drought
F.Y.R.O.M	**Pelagonija**	A1 TV	2007-05-16	8500ha wheat, 4000ha barley and 1400ha ray are treat by drought
F.Y.R.O.M	**All teritory**	Utrinski vesnik	2007-05-18	Damages of the cereals
F.Y.R.O.M	**Pelagonija**	Spic	2007-05-19	Drought in Pelagonija
F.Y.R.O.M	**Stip**	Nova Makedonija	2007-06-19	Crops of the cherries reduced to half
F.Y.R.O.M	**Valandovo**	A1 TV	2007-07-10	Valandovo plantation endangered of drought
F.Y.R.O.M	**Kumanovo, Pcinja River**	Utrinski vesnik	2007-07-18	Drying of the Pcinja River
F.Y.R.O.M	**Skopje**	Utrinski vesnik	2007-07-19	Drying of the vegetation in the city parks
F.Y.R.O.M	**Kocani**	Nova Makedonija	2007-07-20	Damages of the vegetable
F.Y.R.O.M	**Kocani**	Nova Makedonija	2007-07-20	Crisis in the water supply of the citizens
F.Y.R.O.M	**Vardar Valley**	Vreme	2007-07-21	Decreased outflow of river Vardar
F.Y.R.O.M	**Bitola**	Dnevnik	2007-07-28	Ashes tobacco
F.Y.R.O.M	**Strumica**	Nova Makedonija	2007-08-03	Paprika “Kurtovska kapija”reduced to half
F.Y.R.O.M	**Dolneni, Krivogastani**	Vecer	2007-08-03	Catastrophe in tobacco, paprika, wheat crops
F.Y.R.O.M	**Skopje**	Dnevnik	2007-08-06	Public parks are drying
F.Y.R.O.M	**Kriva Palanka**	Dnevnik	2007-08-07	Drying of locust trees
F.Y.R.O.M	**Kumanovo, Kratovo**	Utrinski vesnik	2007-08-25	Lack of water for cattle
F.Y.R.O.M	**Ohrid Lake**	Vest	2007-09-19	Intensive decrease of water level
F.Y.R.O.M	**Prespa Lake**	Spic	2007-09-20	Dried Prespa Lake wells
F.Y.R.O.M	**Pelagonija**	Dnevnik	2007-09-28	Difficulties for land treatment for wheat, barley and ray planting
F.Y.R.O.M	**Stip, Gradsko, Bogoslovec**	Kapital	2007-10-25	Oasis without water
F.Y.R.O.M	**Debar**	Nova Makedonija	2008-01-08	14 % decreased production of energy
F.Y.R.O.M	**All territory**	Vreme	2008-01-28	Extreme drought caused difficulties in agro technical measures
F.Y.R.O.M	**All territory**	Vreme	2008-03-12	Water reservoirs at

				minimum level
F.Y.R.O.M	**Pelagonija**	Dnevnik	2008-06-05	Drought and diseases are reducing crops
F.Y.R.O.M	**Lakavica region**	A1 TV	2008-06-29	Drought in Lakavica region
F.Y.R.O.M	**All territory**	Vecer	2008-06-30	Advices heat wave and drought for human health
F.Y.R.O.M	**Pelagonija**	Vreme	2008-09-18	Less tobacco for 40%
F.Y.R.O.M	**Prilep**	Vreme	2008-09-26	30% of tobacco fields survived summer heat
F.Y.R.O.M	**All territory**	Utrinski vesnik	2009-03-19	Spending of water in Republic of FYROM according to “Water resources in Europe”
F.Y.R.O.M	**Strumica**	Dnevnik	2009-04-16	Destroyed 20 000 young seedlings
F.Y.R.O.M	**All territory**	A1 TV	2009-05-17	Problems in using the capacities of irrigation systems
F.Y.R.O.M	**Pretor**	Utrinski vesnik	2009-05-29	Water shortage problem influence tourism
F.Y.R.O.M	**All territory**	Vreme	2009-06-16	Problems in using the capacities of irrigation systems
F.Y.R.O.M	**Skopje municipalities**	Vest	2009-07-08	Dried wells for city’s green areas

Table A.5. Drought chronology from 1990 up to 2009 in Greece.

Country	***Location***	**Source**	**Date**	**Abstract**
Greece	***Athens***	To Vema	11/1/1990	Drought is imminent
Greece	***Athens***	To Vema	11/2/1990	Athens faces water shortage
Greece	***All Greece***	Ta Nea	8/3/1990	Drought threatening agriculture, hydropower and urban water supply.
Greece	***All Greece***	To Vema	11/3/1990	Climate experts question if drought presages a "Greenhouse Planet
Greece	***All Greece***	E. Tachydromos	22/3/1990	Long range drought responses suggested
Greece	***Olympia***	El. Typos	28/3/1990	Urban water supply in central Greek cities approaches critical
Greece	***Athens***	Ethnos	29/3/1990	The agricultural production will be seriously damaged, only 10% expected to survive

Greece	***All Greece***	Eleutheros	30/3/1990	Drought was predicted since 1987, however, no responses were implemented
Greece	***Thessalonike***	Macedonia	31/3/1990	Mandatory water rationing by the city of Thessalonike, emergency declared
Greece	***All Greece***	Kerdos	1/4/1990	Damages in agriculture expected to be over 1 billion USD
Greece	***Crete***	New York Times	5/4/1990	Crete faces drought
Greece	***All Greece***	Eleutheros	3/4/1990	Precipitation falls to 40% of the average
Greece	***Athens***	E. Tachydromos	5/4/1990	Despite knowledge of the limits of the existing water supply scheme for Athens since late '70's, no new project was initiated even with E.E.C. funds
Greece	***Athens***	Eleutherotypia	4/5/1990	Detailed maintenance program for the greater Athens water distribution system announced
Greece	***Macedonia***	Express	5/5/1990	The Geotechnical Chamber of Greece suggests responses for the drought in Macedonia
Greece	***Thessalia***	Apogeumatine	11/5/1990	Serious industrial and domestic waste pollution in the rivers of Thessalia
Greece	***All Greece***	E. Tachydromos	17/5/1990	Lack of long range planning management and maintenance in the previous years accentuates drought
Greece	***All Greece***	Eleutherotypia	17/5/1990	Ten percent decrease in water consumption in comparison with 1989
Greece	***Athens***	Kathemerine	13/6/1990	Water hauling by ship tankers from Acheloos to Mornos suggested to ease Athenian drought
Greece	***All Greece***	E. Tachydromos	14/6/1990	Water resources management policies are absent in Greece
Greece	***Athens***	Ta Nea	15/6/1990	Severe penalties will be initiated for excessive water use
Greece	***Thessalonike***	Macedonia	23/6/1990	Water supply projects should have been initiated 10 years ago for the Thessalonike area
Greece	***Athens***	Prote	4/7/1990	Heat wave and drought compound to the problems in Athens

Greece	***All Greece***	Kathemerine	5/7/1990	Water hauling by ship tankers proposed again by the National Technical University
Greece	***All Greece***	Eleutherotypia	10/7/1990	Prime Minister declares drought emergency and announces drought responses
Greece	***All Greece***	Nautemporike	10/7/1990	Measures focus on potential water rationing and penalties for excessive water use, conservation initiatives, well drilling, water hauling by ships, and announcement of another conference with the participation of local government and public interests representatives
Greece	***Athens***	Eleutherotypia	11/7/1990	To reinforce the Athens water supply through ship water hauling and well drilling an estimated 270 million USD cost is projected
Greece	***Athens***	Kerdos	14/7/1990	Long range ones include the construction of a new reservoir in Euenos river
Greece	***All Greece***	Ethnos	15/7/1990	The SGE states that Greece has more than adequate water resources, but water resources projects have not been implemented
Greece	***All Greece***	Eleutherotypia	16/7/1990	The water distribution system is old and maintenance almost non-existent
Greece	***All Greece***	Emeresia	18/7/1990	Twenty-seven million USD allocated for water supply projects
Greece	***All Greece***	Peloponnesus Patron	18/7/1990	Drought impacts more intense, due to lack of water resources planning and management than lack of water
Greece	***Athens***	Nike	21/7/1990	Political parties dispute in parliament over water price
Greece	***Athens***	Demosiographos	22/7/1990	Structural deficiencies, lack of maintenance and of water resources planning and management in the Mornos/Ylike water supply scheme compound with the

				water shortage problem in Athens
Greece	***All Greece***	Nautemporike	26/7/1990	Six hundred million USD for water supply and wastewater projects announced
Greece	***Thessalonike***	Macedonia	7/8/1990	The Minister of Interior announces wastewater system improvement, new sanitary landfills and drought relief measures for the city of Thessalonike
Greece	***All Greece***	Ethnos	8/8/1990	Conflict and fights among farmers over irrigation water
Greece	***Athens***	Apogeumatine	14/8/1990	Major water pipe leak causes accident in Athens
Greece	***Athens***	Mesemvrine	17/8/1990	if drought persists, Athens will face severe water shortage in Spring 1991
Greece	***All Greece***	Kathemerine	17/8/1990	CWWP proposes conservation measures with high penalties for violators
Greece	***Athens***	Epikairoteta	20/8/1990	Athens has water for only 85 days
Greece	***Athens***	Prote	27/8/1990	Groundwater for the Athens water supply has a higher cost than Mornos scheme
Greece	***All Greece***	Apogeumatine	23/9/1990	Illegal connections to stormwater system
Greece	***Athens & Thessalonike***	El. Typos	1/10/1990	Drought continues as well as lowering of water levels in major rivers. Industrial water should be recycled in both Athens and Thessalonike
Greece	***Athens***	El. Typos	7/10/1990	Twenty-five to 30 percent reduction in water consumption due mainly to the water price increase
Greece	***Athens***	To Vema	7/10/1990	Two to three years for the recovery of the Athens water supply
Greece	***Athens***	Apogeumatine	19/10/1990	CWWP cancels cloud seeding agreement and invites new participants

Greece	***Athens***	Kerdos	1/11/1990	Projects include: sealing of lake Ylike's floor, maintenance of Mornos scheme, well drilling, and expansion of water treatment plants
Greece	***Athens***	Eleutheros	7/11/1990	Water leak and delayed maintenance upset consumers
Greece	***All Greece***	Kathemerine	4/12/1990	Construction of the Euenos dam announced. Study suggests continuing decline in precipitation for Greece the last 30 years
Greece	***All Greece***	Ethnos	9/12/1990	Water shortage still a hazard
Greece	***All Greece***	Ta Nea	18/12/1990	Prime Minister announces plans for water resources policy
Greece	***All Greece***	E. Tachydromos	24/1/1991	Lack of water resources policy the major hazard
Greece	***All Greece***	E. Tachydromos	4/7/1991	Reports state that supply augmentation not a solution for future drought
Greece	***All Greece***	www.in.gr	13/3/2007	Measures against drought, fires, blackouts and the government announced
Greece	***Thessaly-Cyclades***	Kathimerini	18/3/2007	Drought hits Cyclades - Thessaly
Greece	***Chios***	I Alithia	12/4/2007	Subsidies for Drought
Greece	***Chios***	I Alithia	24/4/2007	Drought and the planned model of development for our county
Greece	***Ikaria***	www.nikaria.gr	14/5/2007	Drought in Ikaria
Greece	***Cyclades***	www.kykladesnews.gr	25/5/2007	ACTIONS BY THE DROUGHT IN THE CYCLADES: Full abstraction works on all islands
Greece	***Thessaly***	Ethnos	17/7/2007	Thessaly on brink of civil war for Drought
Greece	***Thessaly***	Eleftherotypia	23/7/2007	Drought "burn" the plain of Thessaly
Greece	***Cyclades***	Kathimerini	1/8/2007	Here and now works against Drought. In an emergency, Cyclades
Greece	***Cyclades***	Kathimerini	1/8/2007	Was intensified the Drought in Cyclades
Greece	***All Greece***	Eleftherotypia	9/8/2007	Whatwe make fot the Drought* Limit adequacy in the whole country
Greece	***Samos***	www.samos.gr	29/8/2007	Measures for Drought

Greece	***Greece***	Imerisia	5/3/2008	National issue of the new decade, the Drought
Greece	***Samos***	www.samos.gr	23/5/2008	Ways of saving water in the aspect of Drought
Greece	***Karditsa***	Macedonia	7/7/2008	Drought threat to half of Greece
Greece	***All Greece***	Ta Nea	17/4/2009	100.000 pools in Drought Period in Greece
Greece	***Trikala***	www.trikalanews.gr	10/7/2009	Signed contracts in the prefecture of Trikala for projects dealing with drought
Greece	***Karditsa***	www.karditsa.gr	19/11/2009	Calculation of state financial aid to offset the loss of production losses from Drought of 2007
Greece	***Trikala***	www.trikalacity.gr	12/12/2009	Drought threatens regions of prefecture

Table A.6. Drought chronology from 1990 up to 2009 in Hungary.

Country	Location	Source	Date	Abstract
Hungary	***Lake Velence***	MTI	01.07.1990	Because of the drought water level of Lake Velence is lower than ideal
Hungary	***Lake Velence***	MTI	19.07.1990	Low water level, the blue-green algae appeared in Lake Velence
Hungary	***Hungary***	MTI	30.07.1990	Less wheat has been taken over
Hungary	***Budapest***	MTI	31.07.1990	Record of water consumption in the capital - Call for water saving
Hungary	***Budapest***	MTI	01.08.1990	Trees on the streets are crying for water
Hungary	***Hungary***	MTI	02.08.1990	Desolate overview of the border - Due to lack of precipitation vegetables in the fields are dying, the trees in the orchards have already shed leaves and fruits
Hungary	***Danube Bend, Gödöllő region***	MTI	06.08.1990	Water restrictions in Danube Bend
Hungary	***Hungary***	MTI	06.08.1990	There will be serious drought damage (Drought continues, farms should be counted significant losses in revenue)
Hungary	***Hungary***	MTI	08.08.1990	Significant drought - According to first estimates, the drought damage may exceed the 4-5 billion HUF)

Hungary	***Hungary***	MTI	13.08.1990	Land and forest fires, twice as much as usual in this weekend
Hungary	***Danube***	MTI	14.08.1990	Fords of the Danube - Proposal for a restriction of water
Hungary	***Hungary***	MTI	14.08.1990	Drought damage is more than 20 billion HUF - In the middle of the last week losses have been around 5 billion, but now exceed 20 billion
Hungary	***Hungary***	MTI	14.08.1990	Farms continue the irrigation
Hungary	***Hungary***	MTI	14.08.1990	Announcement of the Agricultural Co-operatives and Producers Association: If the drought lasts longer, without any help of the state producers have no realistic chance to repeat even the same level of production
Hungary	***Budapest***	MTI	15.08.1990	Record low water level in August in Budapest
Hungary	***Harkány***	MTI	15.08.1990	The thermal water of Harkány is in danger
Hungary	***Budapest***	MTI	16.08.1990	Another record low water level on the Danube in Budapest
Hungary	***Hungary***	MTI	17.08.1990	Fire ban
Hungary	***Hungary***	MTI	17.08.1990	The Hungarian Credit Bank provides various benefits to the injured farmers in drought
Hungary	***Lake Balaton***	MTI	17.08.1990	Lake Balaton tolerates drought well
Hungary	***Lake Velence***	MTI	22.08.1990	The water level of Lake Velence is one meter, which is 40 centimetres below the level of regulatory minimum
Hungary	***Baranya County***	MTI	29.08.1990	The autumn sowing in Baranya County is in danger because of the unprecedented drought
Hungary	***Hungary***	MTI	30.08.1990	Catastrophic drought damage - Loss rate of the country is now close to 50 billion HUF
Hungary	***Fejér County***	MTI	31.08.1990	More than two billion HUF drought damage in Fejér County
Hungary	***Fejér County***	MTI	05.09.1990	Discount loans to buy seeds
Hungary	***Hungary***	MTI	10.09.1990	Few oxygen - Fish mortality in the rivers
Hungary	***Hungary***	MTI	15.09.1990	Cheaper plow tractors - Discount for the drought-stricken farms

Hungary	***Csongrád County***	MTI	19.09.1990	There is no money for seeds - 40-50 percent less order of seeds in Csongrád County
Hungary	***Ráckeve Danube branch***	MTI	25.09.1990	Ráckeve Danube branch is in danger, poor water quality
Hungary	***Hungary***	MTI	25.09.1990	Imports of grain is on the board - The grain has already been purchased, and corn will come from the United States
Hungary	***Agárd***	MTI	25.09.1990	Decrease in cattle herd
Hungary	***Danube-Tisza Interfluve***	MTI	26.09.1990	The half of the collective farms on Kiskunság will suffer losses
Hungary	***Hungary***	MTI	05.10.1990	The first consignment of feed grains for drought relief has arrived to the country
Hungary	***Hungary***	MTI	06.10.1990	Preferential bank loans for drought victims
Hungary	***Hungary***	MTI	19.10.1990	President Bush announced that the United States provides new loan (47,5 million U.S. dollar) for Hungary
Hungary	***Jász-Nagykun-Szolnok County***	MTI	07.11.1990	Unprofitable collective farms in Jász-Nagykun-Szolnok County
Hungary	***Jász-Nagykun-Szolnok County***	MTI	21.01.1991	The dry winter may leads to summer drought?
Hungary	***Nógrád County***	MTI	24.01.1991	Bad year for the farms in Nógrád County
Hungary	***Hungary***	MTI	06.02.1991	The government set up one billion HUF credit line to help small farmers hit by drought last year
Hungary	***Fejér County***	MTI	08.02.1991	45 loss-making cooperative in Fejér County
Hungary	***Danube, Tolna County***	MTI	23.04.1991	Fish mortality in the backwater of the Danube in Tolna
Hungary	***Lake Velence***	MTI	15.05.1991	Ten million cubic meters of water missing from the Lake Velence
Hungary	***Lake Velence***	MTI	30.05.1991	Restrictions on water use by the Lake Velence
Hungary	***Hungary***	MTI	04.03.1992	Forest fires - an extraordinary situation - there is a big drought in the country, so land- and forest fires occur everyday
Hungary	***Southern Great Hungarian Plain***	MTI	12.05.1992	Drought alert in the Southern Great Hungarian Plain - The Southern Great Plain suffers from one of the worst drought in the century

Hungary	***Jász-Nagykun-Szolnok County***	MTI	18.05.1992	Thirsty plants, billionaire drought losses expected in Szolnok County
Hungary	***Hungary***	MTI	20.05.1992	In order to alleviate drought, irrigation is important
Hungary	***Hungary***	MTI	20.05.1992	Drought in this year likely to be more serious than in 1990, because it occurs with manure and fertilizer shortages, low-quality seeds, privatisation and bankruptcy
Hungary	***Hajdú-Bihar County***	MTI	21.05.1992	Disastrous situation of agriculture in Hajdú-Bihar County
Hungary	***Hungary***	MTI	21.05.1992	The government grants 400 million HUF for agriculture to alleviate the drought
Hungary	***Kiskunság***	MTI	21.05.1992	Cooperatives in Kiskunság are endangered
Hungary	***Hungary***	MTI	01.06.1992	Drought damage - About 330 thousand hectares of arable land remained without sowing
Hungary	***Hungary***	MTI	17.06.1992	Agricultural support for drought damage relief - Refund of part of water service charge
Hungary	***Budapest***	MTI	22.06.1992	Regional conference on water management
Hungary	***Hungary***	MTI	05.08.1992	Due to the very hot and dry weather there is an increasingly alarming situation in the autumn harvested crops
Hungary	***Central Tisza region***	MTI	10.08.1992	Water restrictions in the Central Tisza region
Hungary	***Lake Tisza***	MTI	11.08.1992	Water level in the Lake Tisza is decreasing
Hungary	***Hungary***	MTI	11.08.1992	Every day that passes without rain worsens the chances of maize crop
Hungary	***Budapest***	MTI	13.08.1992	Plant mortality is expected in the capital because of the long-term heat
Hungary	***Danube***	MTI	25.08.1992	A critical situation on the Danube - The Danube water level is low
Hungary	***Danube***	MTI	26.08.1992	The Danube keeps ebbing - 35 fords in the Hungarian section
Hungary	***Danube***	MTI	31.08.1992	The water level of Danube further decreased

Hungary	***Hungary***	MTI	31.08.1992	Drought damage in agriculture - Drought in this year decreased yields by 20 percent in the country
Hungary	***Szabolcs-Szatmár-Bereg County***	MTI	31.08.1992	Severe drought damage in Szabolcs-Szatmár-Bereg County, where the experts estimated the amount of damage at more than 100 million HUF
Hungary	***Somogy County***	MTI	31.08.1992	One billion HUF losses expected in yields in Somogy County because of the drought
Hungary	***Hungary***	MTI	01.09.1992	Two drought in a year - In this year drought affecting agriculture for second time, in the Great Hungarian Plain it was the driest spring of the century
Hungary	***Fejér County***	MTI	02.09.1992	The estimated drought losses in Fejér County are 2.5 to 3 billion HUF
Hungary	***Hungary***	MTI	09.09.1992	The drought damaged also the horticultural crops
Hungary	***Hungary***	MTI	11.09.1992	The government has taken measures to mitigate the effects of severe drought in agriculture (providing loan discounts)
Hungary	***Szabolcs-Szatmár-Bereg County***	MTI	21.09.1992	Algae in the rivers of Szabolcs
Hungary	***Hungary***	MTI	24.09.1992	Further measures have been taken by the government
Hungary	***Hungary***	MTI	18.11.1992	Billionaire drought damage - About 30 billion HUF losses in agriculture
Hungary	***Hungary***	MTI	12.04.1993	Animal nutrition problems in livestock breeding due to the drought last year
Hungary	***Hungary***	MTI	03.05.1993	Deficit in the agricultural exports due to the drought last year
Hungary	***Danube***	MTI	21.05.1993	Ebb of the Danube
Hungary	***Jász-Nagykun-Szolnok County***	MTI	02.06.1993	Drought in Nagykunság and in Jászság
Hungary	***Hungary***	MTI	11.06.1993	Measures have been taken by the government to prevent and mitigate the drought damage
Hungary	***Hungary***	MTI	11.06.1993	Drought damage and greyhound crisis

Hungary	***Szabolcs-Szatmár-Bereg County***	MTI	14.06.1993	The drought damage of the century threatens Szabolcs-Szatmár-Bereg County
Hungary	***Bereg Plain***	MTI	24.06.1993	The Bereg Plain is in danger
Hungary	***Jász-Nagykun-Szolnok County***	MTI	26.06.1993	Due to the significant water table decline the Bereg Plain is sinking
Hungary	***Szabolcs-Szatmár-Bereg County***	MTI	15.07.1993	Quarter of a billion HUF drought damage in cereals in Szabolcs-Szatmár-Bereg County
Hungary	***Jász-Nagykun-Szolnok County***	MTI	22.07.1993	Cooperatives in Jász-Nagykun Szolnok County have about two billion HUF crop losses caused by drought
Hungary	***Tisza***	MTI	29.07.1993	Water-saving program has been developed for the Tisza region, in case of serious drought will take longer
Hungary	***Hungary***	MTI	29.07.1993	Further measures have been taken by the government to alleviate the situation of the drought-affected farmers
Hungary	***Tata***	MTI	18.08.1993	Decreased water level of the Tata Old Lake
Hungary	***Sand Ridge***	MTI	17.09.1993	The long years of rainfall deficit affected seriously the inner region between Danube and Tisza, the Sand Ridge
Hungary	***Budapest region***	MTI	24.09.1993	Due to the years of severe drought and forest fires in the summer 140 thousand trees have died out around the capital in park forests
Hungary	***Budapest***	MTI	08.10.1993	The drought mitigation opportunities - Scientific conference
Hungary	***Heves County***	MTI	22.10.1993	Catastrophic drought damage in Heves - 2 billion HUF losses in the county
Hungary	***Heves County***	MTI	03.12.1993	Livestock is in danger because of the feed shortage
Hungary	***Transdanubia***	MTI	18.01.1994	Due to severe drought affecting the quarter of the Transdanubia, reduction in yield strength is expected
Hungary	***Medgyesbodzás***	MTI	12.04.1994	Disaster relief in Medgyesbodzás - Three hundred houses were damaged in the drought

Hungary	***Bács-Kiskun County***	MTI	01.07.1994	Thirsty lands, increasing irrigation in Bács-Kiskun County, also this year drought damage is expected
Hungary	***Great Hungarian Plain***	MTI	09.07.1994	Drought forecast - If in July and August dry and warm weather continues, then in the central and southeast Great Hungarian Plain severe drought can occur
Hungary	***Fejér County***	MTI	21.07.1994	Because of the drought the wheat harvest is weaker in Fejér County
Hungary	***Hungary***	MTI	24.07.1994	Drought damage in Hungary - Because of the years with extremely dry and hot summers, desert conditions evolved in some areas of the country. Similar drought as in 1990, in 1992 and 1993, was recorded in the last 60 years only once, in 1952
Hungary	***Budapest***	MTI	02.08.1994	Sprinkling in the capital because of a heat wave
Hungary	***Hungary***	MTI	03.08.1994	If the high temperatures and rainfall deficit in August will continue, by the autumn harvested plants a significant loss of yields can be expected
Hungary	***Hungary***	MTI	07.08.1994	Karst water resources in Hungary are in danger
Hungary	***Somogy County***	MTI	10.08.1994	A half-billion HUF drought damage in Somogy County
Hungary	***Hungary***	MTI	10.08.1994	Severe drought in the Great Hungarian Plain is possible because of the hot and dry weather for the middle of June
Hungary	***Danube***	MTI	11.08.1994	Ebb of the Danube
Hungary	***Fejér County***	MTI	25.08.1994	40 percent less maize grew in Fejér County
Hungary	***Hungary***	MTI	16.11.1994	Payment may be deferred for drought victims in this year
Hungary	***Lake Rétköz***	MTI	03.01.1995	Lake Rétköz will be upload with water from the Tisza
Hungary	***Keszthely***	MTI	26.01.1995	Drought and pest control - A national forum
Hungary	***Hungary***	MTI	28.09.1995	The drought has already caused damage - Losses by the harvested crops exceed 10 billion HUF and higher than the 37 billion HUF is expected yet

Hungary	***Fejér County***	MTI	13.10.1995	The drought had destroyed 20-25 percent of maize in Fejér County
Hungary	***Szabolcs-Szatmár-Bereg County***	MTI	24.07.1996	Drought destroys in Szabolcs-Szatmár-Bereg County, where only the cereal fields have more than a billion HUF losses caused by the rainfall deficit
Hungary	***Hungary***	MTI	25.04.1997	A moderate drought is expected in the central part of the country, but in other areas of the country drought is not expected
Hungary	***Hungary***	MTI	11.11.1997	Drought across the country - After the unusually wet summer in the middle of August is still a long drought
Hungary	***Hungary***	MTI	10.04.1998	Drought forecast in April - Despite the dry winter, a serious drought is not expected, if the weather in the period April-August will be the average
Hungary	***Hungary***	MTI	13.08.1998	Fire ban
Hungary	***Somogy County***	MTI	15.05.2000	Drought in Somogy County - Less crop
Hungary	***Hungary***	MTI	13.06.2008	Fire ban in forests
Hungary	***Hungary***	MTI	15.06.2000	Irrigation support for farmers in order to prevent and mitigate drought
Hungary	***Pest County***	MTI	16.06.2000	Drought in Pest County - Vegetables and fruits will be expensive in the capital
Hungary	***Szabolcs-Szatmár-Bereg County***	MTI	19.06.2000	Drought damage in Szabolcs - 30-35 percent yield loss
Hungary	***Nógrád County***	MTI	21.06.2000	Poor raspberries harvest in Nógrád
Hungary	***Lake Balaton***	MTI	04.07.2000	Low water level of the Lake Balaton due to the extreme weather
Hungary	***Hungary***	MTI	07.08.2000	Drought will continue in most of the country's territory, but especially in Szeged region, the Danube-Tisza region and around Berettyóújfalu
Hungary	***Hungary***	MTI	08.09.2000	Century's record: For 100 years did not occur such an extreme drought and flooding in the same year

Hungary	***Körösök***	MTI	21.02.2001	Because of the drought two months before the irrigation season began the damming of the Körösök
Hungary	***Lake Balaton***	MTI	16.07.2001	The water level of the Lake Balaton is continuously decreasing
Hungary	***Pest County***	MTI	16.07.2001	Land fires in Pest County
Hungary	***Zala County***	MTI	26.09.2001	Zala: 17 billion HUF losses of maize
Hungary	***Győr-Moson-Sopron County***	MTI	27.11.2001	Drought, farmers demonstration in Győr-Moson-Sopron County
Hungary	***Hungary***	MTI	19.04.2002	Drought is possible - This was the driest winter in Hungary since the last seventy years, if dry weather will continue until the end of the summer severe drought can occur in some areas
Hungary	***Jász-Nagykun-Szolnok County***	MTI	25.04.2002	Drought in Jász-Nagykun-Szolnok County
Hungary	***Szabolcs-Szatmár-Bereg County***	MTI	14.05.2002	Drought affects the agriculture of Szabolcs-Szatmár-Bereg County
Hungary	***Jász-Nagykun-Szolnok County***	MTI	25.06.2002	3.5 to 4 billion HUF revenue loss is likely in Jász-Nagykun-Szolnok County because of the drought in spring
Hungary	***Hungary***	MTI	06.07.2002	Major drought is expected, if the dry weather continues
Hungary	***Jász-Nagykun-Szolnok County***	MTI	31.07.2002	7.3 billion HUF revenue losses in Jász-Nagykun-Szolnok County, and 3.6 billion HUF more are expected in autumn
Hungary	***Rába***	MTI	05.08.2002	Water restrictions at Rába
Hungary	***Jász-Nagykun-Szolnok County***	MTI	13.11.2002	7500 claim for mitigation of drought damage in Jász-Nagykun-Szolnok County
Hungary	***Szabolcs-Szatmár-Bereg County***	MTI	22.04.2003	Drought threatens in Szabolcs-Szatmár-Bereg County
Hungary	***Hungary***	MTI	12.05.2003	Water balance and forecast information - Spring drought is already formed, and if until the end of August rainfall will less than the average, then an exceptional drought similar to those experienced in 1992. may

				will occur
Hungary	***Csongrád County***	MTI	27.05.2003	Drought in Csongrád County
Hungary	***Sand Ridge***	MTI	29.05.2003	Water deficit in Sand Ridge - The well-known problem for fifteen years is still remains
Hungary	***Hungary***	MTI	10.06.2003	Frost and drought caused significant damage both in the autumn and spring sowings
Hungary	***Hungary***	MTI	11.06.2003	100 billion HUF drought damage nationwide
Hungary	***Jász-Nagykun-Szolnok County***	MTI	17.06.2003	5 billion HUF loss in crop is expected
Hungary	***Tisza***	MTI	25.06.2003	Central Tisza - Low water level, disruptions in traffic
Hungary	***Hungary***	MTI	25.06.2003	In the region of the Great Hungarian Plain, higher than average level loss of grape and fruit production is expected, the government declared the country to drought-stricken area
Hungary	***Hungary***	MTI	27.06.2003	Fire ban in forests
Hungary	***Hungary***	MTI	27.06.2003	Drought - Potatoes - A significant loss in yield is expected
Hungary	***Transdanubia***	MTI	01.07.2003	Transdanubian fish farms - A crisis caused by drought
Hungary	***Hungary***	MTI	01.07.2003	The government declared the country to drought-stricken area
Hungary	***Hungary***	MTI	02.07.2003	The expected yield loss of cereal grains due to drought will be more than one million tonnes in this year
Hungary	***Hungary***	MTI	09.07.2003	For the damage caused by the drought, the government sets aside for farmers 60 billion HUF
Hungary	***Debrecen***	MTI	10.07.2003	Lack of water at the reservoirs in Debrecen
Hungary	***Budapest***	MTI	15.07.2003	Dying trees in the capital - Drought, winter salting
Hungary	***Rába***	MTI	17.07.2003	Water restrictions on the Rába in Vas County and in Gyöngyös

Hungary	***Danube***	MTI	17.07.2003	Low water level on the Danube - Warning for the water transport
Hungary	***Villány***	MTI	24.07.2003	Drought affects the Villány wine region
Hungary	***Mohács***	MTI	24.07.2003	Because of the low water level on the Danube the ferry in Mohács is hardly able to go
Hungary	***Hungary***	MTI	24.07.2003	Frost and drought damage mitigation - The Regulation was published
Hungary	***Szabolcs-Szatmár-Bereg County***	MTI	25.07.2003	10 thousand farmers in Szabolcs request for aid to alleviate the damage
Hungary	***Debrecen***	MTI	07.08.2003	National drought strategy - Discussion forum in Debrecen - From crisis treatment we have to switch to risk management, so we must avoid the aid-centred drought damage treatment
Hungary	***Hungary***	MTI	10.08.2003	Consultations of the drought strategy - United Nations Convention on the fight against desertification and drought, the UNCCD defines the whole area of Hungary a drought-stricken area
Hungary	***Szolnok***	MTI	13.08.2003	Drought management strategy - Forum in Szolnok - Everyone should be aware that the problems caused by the drought affect the whole society, and treatment must be resolved at that level)
Hungary	***Danube***	MTI	14.08.2003	Mahart: Ships forced to stop - low water level
Hungary	***Tisza***	MTI	25.08.2003	Low water level of the Tisza - Negative records
Hungary	***Hungary***	MTI	06.10.2003	Water balance information - Dry weather is continuing since February
Hungary	***Hungary***	MTI	07.10.2003	From the first of January 2004, the agriculture ministry is planning to create 100 billion HUF, 50% interest-supported credit line
Hungary	***Rétimajor***	MTI	14.10.2003	Aranyponty Fishing Co. - 70-80 million HUF losses due to the drought

Hungary	***Hungary***	MTI	10.11.2003	Water balance information - the drought ended
Hungary	***Szabolcs-Szatmár-Bereg County***	MTI	03.12.2003	17,000 agricultural producers requested compensation in Szabolcs County
Hungary	***Bács-Kiskun County***	MTI	10.12.2003	3.6 billion HUF damage because of the draught and frost in Bács-Kiskun County
Hungary	***Hungary***	MTI	22.07.2004	Fire ban
Hungary	***Lake Balaton***	nol.hu	17.07.2004	The water level of Lake Balaton is still low due to the smaller amount of precipitation than the average since 2000
Hungary	***Hungary***	nol.hu	24.04.2007	There is a lack of rain, and irrigation is expensive
Hungary	***Hungary***	nol.hu	05.06.2007	About 100 billion HUF drought and frost damage so far
Hungary	***Hungary***	nol.hu	14.07.2007	Poor harvests of the fruit due to frost and drought damage
Hungary	***Hungary***	nol.hu	27.07.2007	The drought affected the entire country, but in Jász-Nagykun-Szolnok, Pest, Hajdú-Bihar and Békés County are the most of the damage
Hungary	***Hungary***	nol.hu	29.07.2007	MDF (Hungarian Democratic Forum) calls for drought (damage) strategy
Hungary	***Hungary***	nol.hu	29.07.2007	Food price increase is expected
Hungary	***Hungary***	nol.hu	02.08.2007	Deplorable situation in the forests: autumn view and forest fires
Hungary	***Hungary***	nol.hu	06.09.2007	The government will continue to purchase maize for drought mitigation, and will reduce the official fees of livestock breeding
Hungary	***Hungary***	nol.hu	21.09.2007	Less cereal yields in this year
Hungary	***Hungary***	nol.hu	24.09.2007	The beekeepers complain that the drought weakens the industrious insects
Hungary	***Hungary***	nol.hu	28.09.2007	The minister for Agriculture and Rural Development declared this year's drought in the whole territory of Hungary force majeure
Hungary	***Hungary***	index.hu	11.01.2008	Less maize and wheat grew than a year earlier, so the bread is expensive

Hungary	***Hungary***	nol.hu	14.02.2008	Because of the last year's frost in the spring and drought in the summer, animal products can be expensive too
Hungary	***Hungary***	Szabad Föld Online	08.05.2009	In some areas of the country, there was no rain for 6-7 weeks, significant crop losses are expected
Hungary	***Hungary***	nol.hu	11.05.2009	Drought caused agricultural damage can measured in 10 billions
Hungary	***Hungary***	nol.hu	14.05.2009	Increase in the price of bread is expected because of the drought
Hungary	***Hungary***	nol.hu	20.05.2009	Rising prices of vegetables and fruits can be expected because of the drought
Hungary	***Hungary***	nol.hu	21.05.2009	Few and expensive fruit will be in the markets
Hungary	***Hungary***	nol.hu	21.05.2009	Drought damage in the agriculture could be up to hundred billion HUF or more
Hungary	***Hungary***	nol.hu	02.06.2009	30 percent less wheat in this year
Hungary	***Hungary***	nol.hu	05.06.2009	The minister of Agriculture has declared force majeure this year's drought throughout the country
Hungary	***Hungary***	MTI	04.07.2009	The water levels of the rivers in Hungary are reducing
Hungary	***Csongrád County***	nol.hu	20.07.2009	Because of the drought in the spring, wheat crop is very poor in Csongrád County
Hungary	***Hungary***	MTI	08.10.2009	Drought strategy call - Domestic scholars argue that the National Assembly should take a decision as soon as possible to develop a program of preventing and defending against drought

Table A.7. Drought chronology from 2000 up to 2009 in Montenegro

Country	Location	Source	Date	Impact
Montenegro	***Montenegro***	Media	1/7/2000	Agriculture, Water/Energy, Fire, Social, Environment, Economical
Montenegro	***Montenegro***	Media	27/7/2000	Agriculture
Montenegro	***Podgorica***	Media	24/7/2003	Agriculture, Social, Economical

Montenegro	***Kolasin,Bijelo Polje, Plav, Berane, Pljevlja, Cetinje***	Media	25/7/2003	Water,Environment,Economical
Montenegro	***Pljevlja***	Media	26/8/2003	Agriculture
Montenegro	***Bar, Budva, Kotor, Herceg Novi, Cetinje, Niksic, Plav, Pljevlja***	Media	1/9/2003	Water, Social
Montenegro	***Kolasin,Bijelo Polje, Plav, Berane, Pljevlja, Cetinje***	Media	10/9/2003	Fire, Environment, Economical
Montenegro	***Pljevlja***	Media	1/7/2003	Fire, Environment, Economical
Montenegro	***Zabljak***	Media	1/8/2003	Fire, Environment, Economical
Montenegro	***Podgorica***	Media	20/6/2005	Fire, Environment, Economical
Montenegro	***Kotor***	Media	29/6/2005	Fire, Environment, Economical
Montenegro	***Herceg Novi***	Media	9/9/2005	Fire, Environment, Economical
Montenegro	***Podgorica, Kotor, and Niksic***	Media	1/7/2006	Fire, Environment, Economical
Montenegro	***Niksic***	Media	1/11/2006	Water, Social
Montenegro	***Kolasin***	Media	28/11/2006	Water, Environment
Montenegro	***Podgorica, Niksic, Cetinje, Kolasin, Zabljak, Pljevlja, B.Polje***	Media	24/7/2007	Agriculture
Montenegro	***Bar, Budva, Tivat, Kotor, Herceg Novi***	Media	1/7/2007	Water, Social, Economical
Montenegro	***Kolasin***	Media	12/9/2007	Water, Environment
Montenegro	***Montenegro***	Media	1/6/2007	Fire, Environment, Economical
Montenegro	***Montenegro***	Media	9/8/2007	Water/Energy
Montenegro	***Podgorica, Niksic, Kolasin, Mojkovac, Pljevlja***	Media	1/8/2006	Water, Social, and Economical
Montenegro	***Pljevlja***	Media	20/8/2008	Agriculture
Montenegro	***Montenegro***	Media	1/7/2008	Fire, Environment, Economical
Montenegro	***Montenegro***	Media	17/8/2009	Fire
Montenegro	***Podgorica***	Media	20/8/2009	Fire, Environment
Montenegro	***Kotor, Herceg Novi***	Media	21/8/2009	Fire, Agriculture, Environment

Table A.8. Drought chronology from 2000 up to 2008 in Serbia.

Country	***Location***	**Source**	**Date**	**Abstract**
Serbia	***Banat region***	Nin - newspaper (http://www.nin.co.rs/)	30/09/2000	Catastrophic drought made huge losses in agriculture and on

				human health
Serbia	***Serbia***	www.vreme.com	30/11/2000	Extreme worm year
Serbia	***Serbia***	Agroekonomika (Agrieconimica - scientific paper)	17/06/2003	Government rules for declaration of drought
Serbia	***Vojvodina region***	Agroekonomika (Agrieconimica - scientific paper)	25/12/2003	Drought had catastrophic impact on crops
Serbia	***Serbia***	www.vojvodina.com	30/03/2007	Discussion about global influence on weather and drought periods in Serbia
Serbia	***Serbia***	[redacted] (Agricultural Company)	28/04/2007	Winter crops cannot grow, and even spring to germinate. The land drained 40 cm in depth.
Serbia	***Bačka Topola - town***	www.v-land.rs	03/09/2007	Agricultural drought made financial loss of 2 billion dinars, and loss in agricultural production more than 50%
Serbia	***Serbia***	Ministry of agriculture, forestry and water resources	25/09/2007	Resume of drought in 2007, and proposal of measures for reduction of damage
Serbia	***Serbia***	Agrosvet - newspaper (http://www.agromarketdoo.com/)	October 2007	Forest fires due to high summer temperatures in National Parks Đerdap, Tara, Borjak, 33229 ha of woods had been caught by fire
Serbia	***Vojvodina region***	Suncokret - newspaper (www.poljoberza.net/suncokret.aspx)	04/11/2007	Huge losses in agriculture due to drought
Serbia	***Bačka region***	www.poljopartner.rs	06/11/2007	Huge losses but Government stays silent, are the laws in Serbia adequate?
Serbia	***Serbia***	Agropress - newspaper (http://www.agropress.org.rs)	25/12/2007	Social - economic drought and politics
Serbia	***Serbia***	[redacted] (Agricultural Company)	10/06/2008	Drought impact on bees
Serbia	***Serbia***	Glas javnosti - newspaper (www.glas-javnosti.rs/)	08/07/2008	If rain does not fall drought is inevitable
Serbia	***North Serbia***	Glas javnosti - newspaper (www.glas-javnosti.rs/)	22/07/2008	Drought is imminent

Serbia	***Serbia***	Pečat - newspaper (http://www.pecat.co.rs)	08/08/2008	Land need water - due to low rate of irrigated land Serbia is located last on the European list
Serbia	***Serbia***	Pravda - newspaper (www.pravda.rs)	09/08/2008	Losses in corn production due to drought
Serbia	***Odžaci - town***	Blic - newspaper (www.blic.rs)	12/08/2008	Israel offers solution for underground irrigation systems
Serbia	***Bačka Palanka - town***	Nedeljne Novine - newspaper (www.backapalanka.org/nedeljne_novine/naslovna.htm)	17/08/2008	Need for new irrigation system
Serbia	***Srbija***	Večernje novosti - newspaper (www.novosti.rs/)	19/08/2008	Only 3% of irrigated land, drought hits Serbia
Serbia	***Kanjiža - town***	Građanski list - newspaper (www.gradjanskinovine.com)	19/09/2008	Building of new channel for irrigation

Table A.9. Drought chronology from 1962 up to 2007 in Slovenia.

Country	***Location***	**Source**	**Date**	**Abstract**
Slovenia	**Primorska region**	Agrometeorological bulletin	1/9/1962	40% of maize crops destroyed
Slovenia	**Primorska region**	Agrometeorological bulletin	11/9/1962	yield reduced by 50%
Slovenia	**Littoral**	Agrometeorological bulletin	1/8/1967	Yield reduced by 50%
Slovenia	**East Slovenia**	Agrometeorological bulletin	21/3/1968	Yield reduced by 50%
Slovenia	**Littoral**	Agrometeorological bulletin	21/7/1970	south-western part heavily affected; soil completely parched and cracked.
Slovenia	**Štajerska region**	Agrometeorological bulletin	11/8/1971	yield reduced by 50%
Slovenia	**Štajerska & Dolenjska region**	Agrometeorological bulletin	11/8/1973	Štajerska and Dolenjska region heavily affected
Slovenia	**East Slovenia**	Agrometeorological bulletin	11/9/1976	maize yield reduced by 50%
Slovenia	**All Slovenia**	Agrometeorological bulletin	21/8/1981	maize yield reduced by 50%
Slovenia	**All Slovenia**	Agrometeorological bulletin	21/8/1983	summer drought - 50-year record

Slovenia	**Pomurje region**	Agrometeorological bulletin	21/8/1985	parts on both sides of Mura river heavily affected
Slovenia	**Pomurje region**	Agrometeorological bulletin	1/8/1988	maize seriously affected ; from 30 to 40% affected areas
Slovenia	**Savinjska region**	Agrometeorological bulletin	1/10/1988	yield reduced by 60-70%
Slovenia	**Primorska region**	Agrometeorological bulletin	1/10/1988	yield reduced by 70% (even by 100%)
Slovenia	**All Slovenia**	Agrometeorological bulletin	1/5/1990	herbicide application hindered due to first drought signals
Slovenia	**NE Slovenia**	Agrometeorological bulletin	10/8/1992	drought lasted more than two months
Slovenia	**Littoral**	Agrometeorological bulletin	10/8/1994	yield reduced by 20-30% (early vegetable), yield reduced by 60-80% (late vegetable).
Slovenia	**Pomurje region**	Agrometeorological bulletin	May 1997	yield reduced by 30-90%
Slovenia	**All Slovenia**	Agrometeorological bulletin	June 2000	maize seriously affected; yield decrised by 30-50%
Slovenia	**NE, SW, SE Slovenia**	Agrometeorological bulletin	August 2001	NE, Littoral, Istra region, Vipava valey, Dolenjska, Posavje, Bela Krajina region, part of central Slovenia heavily affected
Slovenia	**All Slovenia**	Agrometeorological bulletin	March 2002	spring droughts signals; fire danger
Slovenia	**All Slovenia**	Agrometeorological bulletin	July 2003	Damage due to drought estimate 125000000 €; recorede on 60% of agricultural areas
Slovenia	**Prekmurje, Štajerska region**	Agrometeorological bulletin	May 2007	yield reduced by 50%
Slovenia	**Pomurje, Štajerska, Dolenjska, Posavje, Bela Krajina region**	Agrometeorological bulletin	July 2007	yield reduced by 50%

A.3 Conclusions and remarks:

Albania

Albania reflects numerous cases of drought phenomenon and their impact are considerable, especially in the agriculture field.

Remarks: the drought indexes used in the studies mentioned above do not give general view of drought in the territory. So, the new drought indexes as Palmer drought severity index (PDSI), SPI, etc. will be applied.

Based on SPI3 the years with extreme dry result: 1952, 1953, 1955, 1956, 1958, 1969, 1975, 1982, 2985, 1986, 1989, 1990, 1992, 2000, 2003, 2007.

As it can be seen in the table I.4 the main impact of drought belongs to the agriculture field. It's expressed in the Maize crop died from lasting drought, shortage water, reduction of yield production, fauna of water get up to the shore, the increase of forest fire frequency (352 fires burned the forest and the natural park in entire Albania).

Another important field vulnerable by the drought is the energy production. Energy crises because of drought & lack of precipitation, Electricity interruption has been some times in the extreme forms. For example the main hydropower of energy production in Albania Fierza HPP has experiences the highest dry in the year 2003. In this period the water level on the reservoir achieved 256 to 250 meter above sea level, meanwhile the maximum water level of this reservoir is 295 meter so average daily production from Fierza HPP was 33% of its capacity. In this case the old Kuksi city (which has been flooded during the constructed HPP) was uncovered

Drought impact is reflected even in the shortage of drinking water in some quarters of Tirana city as well as in the other cities of Albania. Those cities have suffered the lack of drinking water for prologue time, especially during the summer.

Bulgaria

The atmospheric droughts do not always impact the agricultural crop growth. From the point of view of national agriculture and economy, it is important to estimate the damages which a drought could cause to the main crops development and yields. Long - term scientific studies have evaluated such huge damages in Bulgaria. Farmers used to suffer significant economical losses caused by the droughts in 2000 and 2007. Moreover drought produced higher prices of food. The analyses of yields and evapotranspiration under irrigation and rainfed conditions, different irrigation schedules and net irrigation requirements can be found in numerous publications by the researchers from the institutes and the experimental stations of the Agricultural Academy.

The National Institute of meteorology and hydrology (NIMH) at the Bulgarian Academy of Science has maintained the national net of meteorological stations covering the territory of the whole country for more than hundred years. The data used to be published till 1984 in the official Meteorological Yearbooks and Monthly References. There are also significant numbers of comprehensive analyses of atmospheric drought published in monographs, papers and reports, some of them available via Internet. However the basic meteorological data after 1984 are not available and the information published in some Internet sites is not confirmed as official or reliable. This makes more difficult to relate the soil water regime, irrigation requirements and other information relevant to crop growth (agricultural risk) to the meteorological information. The current DMCSEE project gives the opportunity to overcome these obstacles.

The Statistical Yearbooks issued by the National statistical institute contain data for the main crops yields on the average for the whole country and for the administrative regions relative to the period from 1901 to 2008. These data could be used for drought risk assessment analyses taking into account the fact that irrigated areas decreased dramatically from 6-8 to 0.35 mill.da after 1990. The variability (Cv, %) of maize yields, which is an indicator for summer drought, is more pronounced than the one related to the meteorological elements over the last 19 years. Such analyses could be made for a longer period in the case of winter wheat, e.g. after 1965 when the new varieties were introduced.

The existing information on drought occurrence in Bulgaria is almost complete and complex. It is usually summarized for long-term periods and regions and presented in graphs. One of the main obstacles to use this information is the fact that significant number of papers published in international ISI journals, proceedings of symposiums and conferences on drought problems do not reach the national libraries. At last but not at least it is concluded that there is not enough publicity given to the materials concerning drought impacts and management and the mitigation practices in this country.

Croatia

In a globally changing climate, the region of Croatia belongs to the transitional area between northern Europe with an increase in average precipitation and a drying Mediterranean. During the 20th century, there has been a decreasing trend in precipitation and an increasing trend in temperature for most places in Croatia, during most seasons. In the future, Croatia is expected to be hotter and drier – especially in the summer [12]. Precipitation affects economic development in many ways. Water is an essential factor in many sectors of economy like agriculture, hydro-power, tourism and fisheries; and reductions in the availability of water can lead to serious damages in those sectors.

Hence, it is necessary to develop good system of drought monitoring in Croatia. In the Meteorological and Hydrological Service of Croatia monitoring of meteorological drought has been set up in 2009 and it is still in progress. There is still necessity for systematic meteorological drought research in Croatia. Furthermore, requirements for the monitoring of agricultural and hydrological drought in Croatia are obvious. There are not available data of drought impacts in quantitative way.

F.Y.R.O.M.

Drought is a common phenomenon in F.Y.R.O.M, which causes many problems in agriculture, forestry and water management. Significant decrease in crop production in non-irrigated areas, as a result of drought, is very common especially in eastern parts of the country. Forest drying and decrease of forest growth are current phenomena observed in the forestry sector. Drought has a directly harmful effect on water management. Long-term water shortages directly influence water resources of catchments areas, disturbing the water balance conditions. The drought periods are characterized with discharges under the annual averages at almost every river in F.Y.R.O.M.. In addition, drought causes lowering of the water level of natural lakes and artificial reservoirs. Besides the impact on the quantity, drought has an impact on the quality of water resources.

The monitoring and data management regarding drought issue can be considered as partly satisfactory. There is a need of improvement in two areas: (1) improvement of monitoring and observation systems; (2) improvement of data management systems. Although the monitoring systems are not in a bad condition, still they need a lot of improvement requiring increased financing both for development and maintenance.

Improvement of data management systems can be achieved through increasing the efficiency of responsible institutions, education and specialization on data management methodologies, extension and automatization of the monitoring networks. In this regard efficient use of the CLIDATA meteorological database could significantly contribute, as well as participation in MEDARE Project (Mediterranean Data Rescue Project). Calculation of drought index for various purposes in the previous research was carried out mostly using De Mortone, Lang or Gracanin and mostly for annual values. There is need of application of different indexes as Palmer Drought Severity Index, Palmer Drought Index, Palfai Aridity Index, Standard Precipitation Index, etc. based on monthly, seasonal and annual values.

Reliable and comprehensive evaluation of drought impact in various sectors should be undertaken in future period in cooperation among relevant ministries, governmental and research institutions, stakeholders, etc.

Greece

Apart from the incidents mentioned in Table I.2 there was no indication of any other droughts in Greece for the last 20 years. Accordingly, drought contingency plans are not considered of announced. There is only recently that a Greek Drought Master plan was announced (Technical support to the central water agency for the development of a drought master for Greece and an immediate drought mitigation plan, 2008). In this regard, it may be to be safe to predict that if another drought is set over metropolitan Athens or Greece, crisis management efforts will be again applied. In addition various floods in Attica have started to change the perspective. To the public water shortage and on the same time torrential flooding consisted of a typical oxymoron. However, the situation in Greater Athens and by expansion to all of Greece is showing the lack of understanding the need for holistic water resources management strategies under adverse conditions, facing physical, economical, political and social impediments. The absence of serious planning, the haphazard city development and the inefficient water infrastructure will always present problems unless they are confronted with long-range time horizon commitments of an effective water resources planning and management scheme. The last 15 years (1995 – 2010) are classified as the hottest years from 1850 to today.

In Northern Europe precipitation has been increased from 10% to 40 %, though in South Eastern Europe has been decreased about 20%. The last 20 years there is an increase in flash floods because there is also an increase in the number of days with precipitation bigger than 20 mm. At the same time urban water use in Greece is increased at about 45% compared to 1980. In Attica it was reported to be increased about 27% in relation to 1990 and 62% in relation to 1993. Further more in 1993 urban water use was decreased 26.5% as a result of the increased sensitivity of the public under the threat of a new drought.

According to measurements in the last 100 years in Attica region, taken by the National Observatory of Athens, precipitation remains in the same levels, 400 mm per year in average, except year 2002 when precipitation measured at 900mm. At the same time the days of precipitation are decreased, which means that there is an increase of the intensity of the rainfalls, causing flash floods.

Greece, compared to other European countries is in a good condition regarding water supplies. Problems concern water resources management and not water availability. Agriculture in Greece consumes 82-84% of the available water; however a big proportion (around 50%) evaporates because of lack of water resources management.

Waste water problems are faced also in domestic water use, namely leakage losses arrive to 20%. Domestic water use is increased about 45% in regard to 1980, without the corresponding population increase. Most of domestic water is used in Attica in households for toilet flushing, bathing and showering, for washing machines and dishwashers.

To safeguard Greece and other countries from the impacts of extreme drought events, they should be fortified with an action plan able to set goals and objectives with strategic insight on management of water resources. However mostly in Greece, politicians and decisions makers do not work with insight and in the basis of the existing plan so the phenomenon can be mitigated.

Hungary

The drought has an important influence not only in the agriculture and production of plants but also animals (domestic and wild), plants and human beings. It means that the damages influence uncultivated lands, nature reservations beside the agriculture, and also the human society (all parts of it). Consequently the harmful impacts of drought must be known globally.

In order to be able to fight effectively against drought, we have to make a suitable examination. Maybe the most important task is the systematical collection, processing, and analysis of data. It is important that the society be aware of the importance of understanding the behaviour of drought. Intervention is needed not only when the event is going on. Setting up drought plans to country lands may contribute to the reduction of the impact of drought.

As far as future tendencies are concerned, based on the analyses of climatic data on long term observations and taking into account the recent investigations on the effects of climatic changes in Hungary, it can be stated that an increase in temperature and a significant decrease in precipitation as well as in average soil moisture content is anticipated, and therefore the interest in the fight against drought and desertification is a priority in the country. Severe or moderate droughts occur in Hungary nearly every year. Drought frequency has unfortunately increased, primarily in the last decades.

Montenegro

Based on collected information about drought impact it can be said that:

- 2000 was a year of drought on regional level, what confirms the monitoring data from the countries in surroundings of Montenegro. The biggest impact of drought was on the agricultural production. Yields were significantly lower than expected, what was evident in July. Also, the forest fires were frequent and burned areas were huge (7500ha).
- 2001 and 2002 in Montenegro were not recorded like year of drought.
- 2003 was year of drought with impact on whole territory. Agricultural drought was mostly present in middle and northern parts of Montenegro, where the yield quantity of agriculture (mostly fields and vegetables) were considerably lower than expected. Till the end of August about 100 larger forest fires have been noted (estimated damage is around 3milion of euros), from which major was in surroundings of municipalities Tivat, Kotor, Cetinje and Podgorice. Drought had an impact on lack of drinking water, what was the reason of frequent and long restrictions in water supply, especially in the coastal areas of Montenegro.

Even there were significant economical losses in 2003, they were much smaller than in 2000.

- In 2006 longer periods of drought or bigger negative impacts on country economy were not detected. A local drought in November was detected, which has an impact on the amount of drinking water and problems in water supplying in affected areas.

- 2007 was the year of regional drought, and Montenegro was also affected. Drought has affected whole country and caused huge economical losses (10 to 15 millions of euros). Agricultural prouduction was decreased, and forest fires where numerous in all areas. Also the problem was lack of drinking water and supplying. Rivers and lakes where dried up, what influenced the production of electric energy.
- In 2008 long periods of droughty and severe drought impacts were not detected. During August were present certain problems related to the lack of water and water supply as well as several larger fires.
- 2009. year was not characterized like year of drought.

In previous period, drought in Montenegro were not permanently analyzed and monitored. Efforts invested in collecting the information regarding drought appearance and impacts are in an inverse proportion with quantity and quality of information shown in HO of Drought impacts. This review shows all gaps in monitoring and drought assessment in previous periods:

1) lack or sparsely data of drought indicators, impacts or damages. Evidences, if exists, are parcial and imprecise.
2) insufficient data availability (small number of electronic archives..)
3) the importance of integrated approach in studying the drought and its impacts was not recognized.

For the last ten years it is noted the progress in regards to information availability, due to slightly bigger number of electronic archives.

Data of primary drought indicators, based on which the analysis of historical drought appearance can be done, exists and are complete for the part of meteorological indicators: precipitation, temperatures, global radiation, wind (for period 1949-2009). Agrometeorological data on the moisture in the soil or plants do not exist. Measured data of the underground water level exist only for a limited areas and for a short time period. Hydrological data are complete and available for the period 1948-2009.

It would be necessary to do the comparative analysis of more data on historical data series, for collecting the information on frequency and intensity of drought in Montenegro. Also, it is necessary to do the analysis for more localities in each geographical region of Montenegro. Application of statistical methods on any component is necessary, but insufficient to complete analysis. Because the optimal approach for using indices is to calibrate them with observed impacts, risk level, and vulnerability, it is necessary to continue the search and recording of historical information of drought impacts for the past decades. Combination of the analysis results and historical, information about drought impact would allow understanding of a complex phenomena such as drought. Thus drought phenomenon could be on time recognized and could be defined the roles, responsibilities and activities in the process of drought management.

Serbia

On the basis of the statistics of 80 analyzed years in Vojvodina (1924-2003) prolonged period with less than average precipitation is extremely in July (84%) and August (86%). More than 50% of the analyzed years were with less than 50 mm precipitation, which causes reduced yield between 30% and 50% in relation to suitable years, and 80% to 100% in exceptionally waterless years. Arid intervals are more frequent for during summer in Eastern Serbia. Historical data notify that the situation is serious and needs our urgent response.

The negative impact of drought in our country may include all of the following:

- Agriculture (only in 2007 the damage from drought were 600 million €)
- Decreasing of energy productions (in 2007 hydro power plant produced 1,77 milliard kWh less than in 2006 year);
- Transportation;
- Commerce and industry (recreation/tourist industry down);
- Urban areas (lawn irrigation, sanitation, drinking);
- Water resources and
- Environmental/ecological

The most investigated areas were agricultural, but least studied areas was economic aspects of drought, and valuation of damage in counted branches.

Slovenia

One of the extreme phenomena that causes a great deal of damage, above all to arable farming, is drought. Although Slovenia gets enough annual precipitation, has experienced a severe summer drought four times during the last 15 years. Reason is poor infrastructure and inability to adjust to drought conditions during the vegetation season. Especially the northeast of Slovenia is a drought-prone region due to intense production of maize. . In addition, in the Karst and coast regions a summer drought is quite common, although it is geologically driven. Damage caused to agricultural production has been significant. The most serious drought was in summer 2003.

The collected data are mainly for the impacts caused by agricultural drought. It is not sufficient to study drought impacts in quantitative way, however quantitative data on drought impacts (damages or crop loss) exist only for last few droughts (since 2003). To have complete information about impacts caused by drought, we would also need information of the impacts caused by hydrological drought and for other economy sectors.

B.1 Information sources relevant to Mitigation practices and drought management Methodology used, for drought mitigation

Albania

Taking into account the presence of drought in Albania, irrigation works have existed for a long time, but the largest irrigation projects were completed after the Second World War.

In Albania, irrigation relies mostly on surface water. About 60 per cent of the arable land is under irrigation, more than half in the coastal plains, accounting for some 80 per cent of the agricultural production.

Surface irrigation methods dominate, with 95 per cent either furrow-type or stripe-type systems. The development of irrigation was accompanied by building reservoirs or dams, pumping stations, and flood protection works.

Farmers have begun to pursue private groundwater development. Pumping the groundwater used to be marginal (1,000 ha), but it seems to be a rapidly increasing in the last years.

Previous research projects funded by the European Commission or National funds, Publications in books or scientific Journals):

Environmental Performance Review (UNITED NATIONS New York and Geneva, 2002)

World Bank. 1999. *Albania Irrigation Development Project, Project Appraisal Document. Annex 2.* Washington, DC, USA.

World Bank. 2004. *Water Resource Management Project*. April 22,2004

National Water Strategy For Albania Agim Selenica, Polytechnic University of Tirana

Bulgaria

Agro-climatic conditions of Bulgaria have historically determined the requirements of crop irrigation in the period June-September. Climate change towards warming and drying requires the undertaking of mitigation measures in agriculture and adaptation of irrigation practices (Petkov, 2003; Varlev, 2004, 2010; Popova, 2008-c, 2009-a, 2009-c). The basic adaptation measures for future irrigation development consist of elaboration of management, financial and economical standards and irrigation strategies. They should aimed at: management improvement, better use and protection of water resources under irrigated agriculture; improvement of irrigation uniformity and efficiency and use of the existing irrigation systems; improvement of technologies and equipment for irrigation; application of economically justified irrigation scheduling alternatives adapted to the irrigation method and soil characteristics and development of technologies of crop cultivation under the conditions of drought and water deficit.

Nowadays different national institutions are involved in studding, teaching and implementation in the field of irrigation, as Research institute of land reclamation and agricultural machinery, Institute of soil science "N. Poushkarov" (ISSNP), Institute of water problems, University of architecture, civil engineering and geodesy (UACEG), University of agriculture – Plovdiv, National institute of meteorology and hydrology (NIMH) and others.

An underground automated system for furrow irrigation with movable risers (USFI) used to be developed and implemented in the irrigation practice on 1500 ha in the Danube plain and Sofia field (Varlev et al., 1974; Varlev, Vichev, Penev, Popova, Krustanov 1986; Varlev and Popova, 1985; 1987; 1988; 1990).

Crop growth, drainage and nitrogen leaching were then simulated in 30 representative points of the non-homogeneous furrow set by formerly validated CERES-NC-maize model (Popova et al.,1999; 2001-a; 2005-c; Popova, 2008-a).

Well calibrated simulation crop models are mighty, precise and efficient tools to study the impact of climate variability and change, soil characteristics and management operations on yields and environment. Irrigation scheduling simulation models produce in addition frequency curves of irrigation requirements, support upgraded irrigation management practices, recognize yield impacts of water stress and search for optimised water saving and environmentally oriented practices for irrigation water management.

Validated models can be used as well to assess the impact of climate uncertainties on irrigation scheduling and crop yields, evapotranspiration (ET_a), nonused precipitation, deep percolation and nitrogen leaching under different soil and climate conditions. They can be used for risk assessment analyses of drought under maize and wheat (Popova et al., 1999; 2000-a; 2001-b; 2002-b; 2002-c; 2004; 2005-b; Popova, 2007; 2008-a; 2008-b; 2008-d; 2009a and 2009b)

The computer system DSSAT is used in NIMH-Sofia for model simulation and estimation of optimal irrigation timing and application depth under maize and diverse climate conditions (Alexandrov, 1998, 1999).

Different soil tillage practices aiming at reduced evaporation of soil water have been studied in ISSNP, Bulgaria. Obtained results proved that such management could contribute to drought mitigation for field crops under certain soil and climate conditions in this country (Dobrudja region).

Croatia

The Republic of Croatia signed the UN Convention to combat desertification in countries experiencing serious drought and/or desertification. The Croatian Government established the National Committee to Combat Desertification. The basic task of the Committee is the monitoring and participation in the preparation and implementation of a

National Action Programme (NAP) [2]. In 2003 the Committee started to work on the preparation of a project under the title "National Action Programme to Mitigate the Effects of Drought and Combat Land Degradation" which was adopted in 2007.

In 2004 National Project of Irrigation and Land and Water Management in the Republic of Croatia (NAPNAV) is launched. Its aim was to organize irrigation and concentration of agricultural land and introduce income crops, in order to ensure the conditions for the application of new technologies. This should result in better utilization of natural resources for more efficient agricultural production, and finally bring about the development of rural areas. Under this project, within four years from the project implementation period, irrigated areas should have been expanded from the current 7200 hectares of irrigated land to a minimum of 30000 hectares.

Irrigation as a solution to agricultural drought impact mitigation**.**

Irrigation is a melioration measure for a compensation of water deficit in agricultural production. Generally speaking, irrigation systems in Croatia are quite disorganized. Farmers usually finance the irrigation infrastructure on their own.

The highest development in irrigation was reached before the War of Independence. In 1989 13,290 ha of agriculture land was irrigated. In 1990s only 5,790 ha of land was irrigated (0.28% of cultivated land and 0.44% of sown land). Today, the official data about methods and infrastructure used in practice in Croatia are scarce and with poor precision. The irrigated area of agricultural land in Croatia is one of the smallest in Europe. According to the agricultural census from 2003 it is estimated that from total of 1,077.403 ha agricultural area only 0.86% was irrigated .

The most affected water regions are Dalmatia, especially the River Neretva valley, and Zadar – Biograd region. In the rest of country irrigated areas are dispersed and depend on the cultivation of specific cultures.

F.Y.R.O.M.

There are not many activities directed primarily to combating drought and desertification, but numbers of projects (mostly regarding water resources management) partly contribute to overall goal. The following projects in the area of agriculture and environment sector also contribute to drought mitigation:

- Water Resource Strategies and Drought Alleviation in Western Balkan Agriculture – EU
- EU approximation and Regional Cooperation in the Agro and Food sector - 1.) Approximation of the legislation of F.Y.R.O.M with the EU. In close cooperation with MAFWE the project works on the law on agriculture and rural development and its by-laws; and 2.) Support to the regional cooperation in South Eastern Europe. The project has also one subcomponent which is related to the introduction of standards of quality of the products as GAP, SEUROP, HACCP etc. (Germany-GTZ)

- Agriculture Advisory Support Programme of F.Y.R.O.M (MAASP)
- Support to Farmers Associations in F.Y.R.O.M Phase II (Sweden-SIDA)
- Project for Improved Agriculture Statistics in F.Y.R.O.M (Sweden-SIDA) Building capacity for formulation of policy and economic analyses in the agriculture sector in F.Y.R.O.M (Sweden-SIDA)
- Second National Environmental Action Plan (NEAP 2) (EU CARDS)
- National Strategy for Sustainable development (NSSD) (SIDA)
- Strengthening of the Environmental Management (CARDS 2004)
- Improvement of the Management of Transboundary Water Resources (CARDS2003)
- Strengthening of the Environmental Management (CARDS 2006)

Greece

A review of the drought literature may indicate that most water agencies or authorities are not implementing drought contingency measures, responses or plans until a drought is imminent (Yevjevich, V. et al., 1983; and U.S.A.C. E., 1991). Even then, the applied management actions are usually focusing on voluntary or mandatory water conservation, water rationing, and usage of emergency water supply.

Throughout the literature it was reported that water authorities and decision-makers responded to drought using mainly crisis management techniques. At the same time, drought research has clearly indicated in many publications the potential advantages of anticipatory and proactive drought management efforts (Dziegielewski, B., 1988; Karavitis, C.A., 1992). Such anticipatory measures may include (Dept. of Water Resources, 1988; and Grigg, N.S. and Vlachos, E.C., 1990): predrought preparation and planning drought description and forecasting; mitigation, relief and recovery adjustments; and post drought measures such as additional recommendations, revisions in planning, etc.. In this regard, the U.S. Army Corps of Engineers (1991) report presents the following categories of drought adjustments: strategic adjustments; these are primarily long-range adjustments to drought (i.e., construction of reservoirs and/or irrigation systems, long term water conservation measures, etc.) tactical or short term drought adjustments (emergency conservation measures, drought relief activities, supply reallocation, etc).

Europe and particularly the Mediterranean region has experienced a series of drought incidents (Hammer, M., 1990). In this region water is used mostly in an unsustainable manner. In addition, the Mediterranean environment as a whole is ecologically fragile and seriously endangered by existing social and economic trends. Therefore, vulnerability raises the question of ecosystem resilience, especially because of periodic droughts, floods and increasing anthropogenic disturbances. Nevertheless, the prevailing attitude is also to confront drought using mainly a crisis management approach (Karavitis, C.A., 1992). Even specific approaches, such as the one by ECWRMGS (1990), seem to have been concentrated on mainly water supply problems and hydrological aspects of drought, rather than an integrated drought management methodology.

Concern about drought events and water scarcity situations arose among member States due to an increasing frequency of drought events in recent years. This led in 2003 to the emergence of a working group set up by the Water Directors, in charge of preparing a technical document on drought events and long-term imbalance issues. Water directors approved its main conclusions and recommendations in a policy summary in June 2006.

At the occasion of the Environment Council taking place in March 2006, some Member States claimed a European action on drought events and water scarcity situations. The Commission undertook to present a first analysis on the scope of these issues in June 2006.

The Environment Council held in June 2006 took note of the analysis but asked for further discussion on specific measures at EU level. The Commission proposed to strengthen the diagnosis, based on an in-depth assessment to consider what further action would be required at EU level.

Member States and the Commission stated that the in-depth assessment had to be fed by national contributions and additional inputs drawn up at EU level. Considering the importance and urgency of the issue, they also pointed out the need to get an interim assessment report before end 2006.

The Commission, with the help of the working group leaders (France, Italy, Spain), and with the assistance of appointed Experts, consequently built up a questionnaire, aimed at getting national information on water scarcity situations as well as drought events. It asked for data on the delineation of the problem and affected populations, the key players and causes, the economic, social and environmental impacts. It also invited member States to describe their use of EU funds for addressing the identified problems as well as their water pricing policies. It finally went into Member State expectations related to the Water Framework Directive.

In continuation of the previous actions, the Hellenic Government and specifically the Hellenic Water Directorship, assigned the generation of the Drought Master Plan (Technical Support to the Central Water Agency of Greece for the Development of a Drought Master Plan for Greece and an Immediate Drought Mitigation Plan) for Greece to a team of experts lead by department of NRD & Agricultural Engineering, Agricultural University of Athens.

Hungary

Against crop damage occurring in the agriculture the farmers can effectively defend with melioration and irrigation. In the 1990's developed drought forecast will significantly help to prepare irrigation. In order to avoid the harmful water shortages, both the possibility of water transfer between regions, as well as the reasonable water retention must be ensured. This can be achieved in different facilities, e.g. with construction and operation of ducting channels, reservoirs, dams, water retention structures. From water stocks stored in these streams, canals, reservoirs irrigation water can be sent with various methods to the vegetation.

The biggest problem is on the Danube-Tisza Interfluves, where in the past 100 years annual precipitation was 80 mm lower than in the past fall, the ground water ran down with meters. According to experts, for the agriculture of the area the solution would be the construction of the channel connecting the Danube and the Tisza. To treat the problem, a government decision has been taken, the plans include the evolving of 50 reservoirs, which will create in the natural depressions and the rain and inland waters will catch in them.

The melioration (land improvement) is one of the most effective tools of drought parry. It is a complex activity, which can ensure the preservation and improvement of soil fertility. It contains on the one hand agronomic and agricultural technology, on the other hand technical activity. The key of soil fertility lies in water management of soils. This required appropriate agricultural technology – deep plowing, deep relaxation – to ensure the soil water absorption capacity. With this simple agricultural technology element the keeping of the fallen precipitation in the area, and in optimal time used water are ensured. Furthermore, it reduces inland hazard, because the excess water does not stop at the soil surface, but infiltrates, and in dry time it reduces the damages caused by water scarcity. Irrigation is also the most efficient, when it is achieved as part of the complex melioration.

Montenegro

In Montenegro does not exist a national policy or strategy directly involved to drought? Only a few strategic documents exist related to drought. The most significant of these is Montenegro Spatial Plan until 2020 (http://www.gov.me/files/117498935.pdf), which has a significance of the law. By this Plan is recognized the need for carrying out melioration measures, which will significantly contribute to the successful combating the droughts and formation of a new usable land surfaces. By the developing plan for agriculture until 2021. year is predicted the increase of irrigated surfaces from present 3% up to 80% of total available land surfaces suitable for irrigation. In that way, instead of present 18000 ha would be irrigated 59425 ha from the total surface of 74090 ha land suitable for irrigation. The largest surfaces (2000ha) under the irrigation system in Montenegro are in Cemovskom filed (Podgorica), property of Stock Company ”Plantaze”.

Also, experimental field of Biotechnic Faculty (Podgorica) is irrigated (around 25 ha), 400ha of citruses on Montenegrin coast, and young plantation of olives (only 3-5% of total number of seedlings). Irrigation is present and in the middle and south parts of Montenegro, where exist agricultural production of vegetables on open fields, forage plants and field crops, but there are no precise evidence about that. In north part of Montenegro irrigation is applied like additional measure, but we also don't have precise information in regards.

Serbia

Drought Monitoring System for Serbia - Serbian National Water Program "Hydrological Bases of Water Resources, Development and International Cooperation" (NPV-21A), supported by Ministry for Science and Environment Protection Republic of Serbia.

Multidisciplinary approach to resolving drought crisis comprises a lot of special measures and scientific discipline that can give their contribution to diminish drought consequences on larger farming surfaces. Allocated production creates environment for naturalizing species and hybrids resistant to droughts.

There are approximately 180.000 hectares with installed irrigational systems, but only 30.000 - 40.000 hectares are irrigated, which is less than 1% of total amount of the farming land in Serbia, which further poses Serbia at the last place on the list of all states in Europe. Vojvodina has better results than Serbia, although significant farming land surfaces with vegetable crops are irrigated in Macva, Leskovac, Negotin and Pomoravlje. It is important to emphasize that almost all mentioned irrigational systems are older than 25 years. Outdated and not well maintained, at many places even abandoned, available irrigational systems are not serviceable for larger exploitation of new species and hybrids, hence it is of great significance to make a sophisticated step toward developing plants genetic and create numerous hybrids with upgraded uniqueness and immunity against diseases and droughts. New genotypes should be able to self regulate water transportation and nourishments even in air and ground drought phases, high air temperature and relatively low air humidity.

At the Institute for Field and Vegetable Crops, Novi Sad, which is the leading institute in Serbia, work many experts and scholars who have created more than 1000 new species and hybrids, half of which have been registered and grown abroad. Adequate agro-technical measures facilitate a lot within intensive crop farming like factors that contribute to preserving and resourceful using of ground water, which also mitigate droughts consequences. Crop rotation is furthermore very important for the reason that crops water consumption is not equal in every growing phase of crops, in so doing they leave different ground water quantities behind (*Videnovic et al. 1997*). Regular destruction of weeds also improves conditions of crops water consumption. In view of the fact that autumn periods in our state are on secondary precipitation minimum a reduced tillage is desirable because of higher yield and profit (*Konstantinovic, Malesevic, 1996*). Optimal crop density and nitrogenous fertilizer should be defined on the basis of the winter precipitation that makes ground water reserves and nitrogen penetrating in soil; despite the fact that there is no guaranteed successful crop production that equally depends on precipitation amount and its regularity during the crop vegetative stage.

In investigation of *Potkonjak* (*1993*), the author considers the management possibilities of agricultural production especially in dry years. According to the general theory, three types of models accommodated to irrigation conditions have been developed.

Slovenia

Information sources relevant to Mitigation practices and drought management Methodology used in Slovenia are the following:

i) Revision report on Drought mitigation Measures

(Revizijsko poročilo o smotrnosti ravnanja RS pri preprečevanju in odpravi posledic suše v kmetijstvu, 2007. Računsko sodišče RS, št. 1207-3/2006-22, Ljubljana). The importance of this revision lies mainly in expected changed conditions in the future.

The revision found out, that the total estimated damage caused by drought in agriculture in the revised years (2000, 2001, 2003 and 2006) amount to 247 M€. About 86 M€ were allocated in national budget and spent for recovery measures and only 3 M€ were allocated for preparedness measures. 26.2-fold increase spending to offset the effects of drought on agriculture than the implementation of preventive measures is not an effective solution from public finances' point of view.

The conclusions were:

- Irrigation systems are underdeveloped (economical justification of investments should be reconsidered)
- Other infrastructure (i.e. river reservoirs) should be put in function for drought mitigation where possible
- Drought monitoring and possibly early warning should be improved
- Public risk fund or subsidies for drought insurance should be considered

ii) Technological recommendations to reduce the vulnerability of agricultural production to drought:

This document was created with financial assistance from the European Agricultural Fund for Rural Development.

A range of adaptations are recommended, for example: changing sowing dates; changing varieties used (exchanging later crops with earlier); more intense fertilisation to compensate for the reduced growing time and water shortage; changes in sowing structure, farm production policy and production technology; changes to crop rotation; improving soil state during droughts by increasing humus/topsoil; guided irrigation using irrigation models and taking into account meteorological conditions and weather forecasts to optimise water use, and ensuring permanent and natural balancing of agricultural crop production on irrigated surfaces.

iii) IRRFIB crop water balance modelling:

The IRRFIB model is a decision support tool in the frame of agrometeorological information system and enables quick and accurate transfer of information on crop water balance to farmers. IRRFIB model on the basis of hydrometeorological data calculates the need for additional input of water into soil.

Agrometeorological model IRRFIB was developed at AgMet Departement of Meteorological sector of Hydrometeorological Institute of Slovenia in 1984. It is in fact the computer model that gives the soil water balance and calculates the content of available wateraround rooting system. Together with the weather forecast parameters it estimates the soil water consumption for next three days.

B.2 Mitigation practices and drought management that were implemented

Albania

In 1986 nearly 400,000 hectares of land, or 56 per cent of the total cultivated area, were under irrigation. A drought between 1983 and 1988 set back agriculture and hydroelectric power production.

In Albania, irrigation relies mostly on surface water. About 60 per cent of the arable land is under irrigation, more than half in the coastal plains, accounting for some 80 per cent of the agricultural production.

The development of irrigation was accompanied by building of 653 reservoirs or dams, 639 pumping stations, and flood protection works (865 km of dams on the coast and 300 km of channels in the hills directing waters to the sea).

Land distribution and social upheavals in 1991 resulted in substantial damage to the irrigation and drainage systems, and to the protection works. The lack of maintenance and of water supply to a multitude of farmers due to non-payment of user charges worsened the situation. In 1994, 114,000 hectares were inoperative and 153,000 hectares severely damaged, only 80,000 were operating normally.

A number of projects are under way to repair the irrigation system. The Ministry of Agriculture and Food estimates the overall rehabilitation potential at 315,000 hectares.

It is not likely that the irrigable land will be extended significantly in the near future. The projects aim exclusively at the rehabilitation of existing systems, not expansion to new areas. Their impact on the environment will not increase.

Bulgaria

Two Hydromelioration acts were prepared in 2008, but neither has come into practice yet. The future Hydromelioration law should regulate the irrigation and drainage activities aiming at increased agricultural and land productivity (Petrov, 2008)

Alexandrov (2005) paid attention to the fact that sometimes flooded areas near by the dams were returned to the owners as a result of land restitution. Therefore a lower water level than the designed one must be maintained in the dams. Thus accumulation of smaller water volumes and inefficient use of the dam water is a frequent practice.

Questions concerning drought are discussed both at scientific and political level. The question about necessity of a program related to treads and mitigation measures in conditions of drought was raised. The ex Minister of MOEW of Bulgaria answered that Bulgaria had obligations to United Nations Framework Convention on Climate Change (UNFCCC) and United Nations Convention to Combat Desertification (UNCCD). The UNCCD was adopted in Paris 1994 and was ratified in 2001 by Bulgarian government. The final aim of the Convention is to undertake effective measures to combat desertification and to mitigate drought consequences at all levels in the frames of integrated approach and in accordance to the international partnership agreements for sustainable management. A strategy and a plan 2005-2011 have been worked out in order to provide required capacity for fulfilling the obligations of Bulgaria in the mentioned conventions. The strategy and the plan are inseparable part of the project concerning the National strategy for the environment and the Action plan for 2005-2014.

National Action Program (NAP) 2007 - 2013 for sustainable land management and combat desertification (SLMCD) is developed in the context of philosophy and principles in Operational program 15 of Global environment facility (GEF) on sustainable land management (SLM) and under the UNCCD formerly ratified by Bulgaria in 2001. The Program has been developed and applied in Republic of Bulgaria (2007-2013) to implement commitments in the context of UNCCD. This is the tool by means of which Bulgaria will fulfil the arrangements to the Convention.

Bulgaria (ISSNP and NIMH) takes part in a Subregional project 2008-2011 on Drought Management Centre for South East Europe (DMCSEE) in the context of UNCCD. DMCSEE should focus its work on monitoring and analysis of drought and also on the risk assessment and vulnerability to droughts.

Problems related to land degradation and combat to desertification are covered indirectly in number strategic documents

- *National Strategic Development Plan for Rural Areas 2007 - 2013*
- *National Strategy „Sustainable Forestry Development in Bulgaria" 2006 – 2015*
- *National Regional Development Strategy 2005-2015*
- *Operative Programme „Environment" 2007 – 2013*
- *National Agro-Environmental Programme of Bulgaria, 2007 – 2013*
- *Programme for Limitation and Liquidation of Pollution in Vulnerable Areas (in processof elaboration)*
- *National Operative Programme „Regional Development", 2007-2013.*

Croatia

From the agricultural point of view drought can start when a plant does not have enough water during the vegetation season which can affect the crop yield. Drought in Croatia occurs every three to five years and it reduces the yield of some crops from 20% to 40% depending on the intensity and duration of drought.

Although there are many possibilities for irrigation in Croatia they are rarely used. The water source used for irrigation is usually surface water (rivers, lakes) and sometimes underground water. There are many water reservoirs made but the water for irrigation purposes is almost not used. The quality of water is satisfying in the continental part of

Croatia, in watersheds of rivers Dunav, Drava and Sava and in Istrian peninsula. However, at the coast and in Dalmatia the water for irrigation is often salinized and alkaline.

The potential irrigation development in water regions in Croatia is given in table B.1.

Table B.1. Short and long term estimation of irrigation development and annual water demands in river basins in Croatia according to NAP [2].

River basins	Planned area **2009**., ha	Annual water demands , 10^6 m^3	Planned area **2015**., ha	Annual water demads, 10^6 m^3
Drava - Dunav	14 650	19,85	36 800	50,57
Sava	5 070	6,37	13 200	16,78
Littoral - Istria	3 250	7,92	5 950	14,45
Dalmatia	6 150	17,69	11 750	33,94
Total	29 120	51,83	67 700	114,84

F.Y.R.O.M.

During the drought in 2007 which affected many sectors and mostly the agricultural, the Government undertook several immediate actions like establishment of Drought Crisis Committee. The Committee announced drought alarm in May 2007 and the Ministry for agriculture reviewed possibilities for provision of artificial rain.

In the course of July 2007, the Crisis Management Center of F.Y.R.O.M. executed simulation exercise “Drought-2007”, which enabled practicing of actions in case of forest fires due to drought conditions. It should be mentioned that, not only during the exercise, but also after one week of its ending, the country was affected by real devastating fires on many locations.

In 2008, under the obligation of the UNFCCC the country finalized the Second National communication on Climate Change (SNC, 2008) which provided valuable information about future projections of temperature and precipitation amounts having in mind possible effects of global climate change. Due to significant decrease of precipitation, the most vulnerable sector – agriculture could face 17% yield decrease of winter wheat by 2050 in Stip. Yield decrease in alfalfa in Bitola could reach 62% in 2050, as with yield decrease in apples in Resen and grape in Kavadarci (50%).The most dramatic projections are for yield decrease in tomato in Gevgelija region (78% in 2050). These projections are prepared with assumption that crops will be planted without irrigation.

Greece

Overall, it would seem that the 1990 drought has taught no lesson in management efforts. This was ruefully proved in the case of the 1993 drought, where crisis management efforts have again been applied. Indeed, on March 20, 1992, the total water reserves of the Greater Athens area were only 295 x $10^6 m^3$. This volume was far less than the one of 1989. Another drought was imminent, while drought contingency plans were not reported. The last measures were announced in February, 1991. Plans for a water resources policy, although announced, seem to still be pending. The incorporation to the water supply aquifers adjacent to the Mornos and Ylike scheme, as well as the construction of the new reservoir in the Euenos river, seem to be so far the only long-range measures. Additionally in 1995, although a hydrologically normal year, the consumption was 280.2 x 10^6 m^3, hence 25% less than that in 1989. The reasons for such a reduction may be primarily attributed to the increase of the water prices, as the prices were quadrupled in relation with the 1989's ones with severe monitory penalties for overconsumption, and there are still in use (1998).

In addition no serious economic crisis has been reported so as to reduced the non domestic water users, and the leaks reduction plans, although announced since 1990, have only started to be applied in late 1997 (the losses continue to be in the range of 30%). In this regard, it may be to be safe to predict that if another drought is set over metropolitan Athens, crisis management efforts will be again applied. Furthermore, the recent floods in Attica, have started to change the perspective. However, the situation in Greece is showing the lack of understanding the need for holistic water resources management strategies under adverse conditions, facing physical, economical, political and social impediments. The absence of serious planning, the haphazard development and the inefficient water infrastructure will always present problems unless they are confronted with long-range time horizon commitments of an effective water resources planning and management scheme.

In the case of the Greater Athens drought, one of the major constraints in drought management efforts was the lack of understanding the complicated nature of water resources management among political leaders, administrators and managers. The lack of realizing the long-term commitment necessary to confront drought presents an additional consideration. In this context, decision-makers are sometimes reluctant to commit time and resources to such long-range actions, particularly if they are faced with political/electoral constraints. Water resources management under adverse conditions has to face not only physical, but economic, political and social impediments. In other words, an interdisciplinary approach, aided with the state-of-the-art in computer information technology and with a long-range time horizon commitment may offer the potential "optimum" results.

By examining the relevant data, it can be derived that the 1990 drought should have been expected since late 1989. Again, drought responses were not initiated, except for after the establishment of the drought. Briefly, the 1990 drought responses may be categorized as follows (for further analysis see Karavitis, C.A., 1992).

January - March, 1990 CWWC suggested water conservation measures, however, responses had to wait to be implemented after the election in April, 1990. April - June, 1990. The CWWC initiated a public information campaign on water conservation measures. The Church responded to drought as the Archbishop of Greece called priests and congregations to pray for rain. Governmental short range responses included water price increases, use of the aquifers for emergency supply and water conservation measures. Conservation measures focused on initiatives, public information and rigorous maintenance procedures. Long range responses were focused on the construction of the river Euenos project. July - October, 1990. Responses announced by the highest decision making level, the Prime Minister. The measures may be categorized as short and long range. Short range measures focused on the improvement of the existing maintenance procedures, conservation, groundwater use, and emergency water hauling by ships. The announced long range responses included the Euenos river project. CWWC proposed cloud seeding programs. From October to February, 1991 . Drought has dissipated. The MEPPW announced the last series of responses. The first cluster comprised of system maintenance improvement series, and consumption and losses control measures. The second concentrated on emergency supply augmentation measures such as groundwater usage and water hauling by ships. The third one included the construction of Euenos project as the long range response to future drought. Finally, plans for a water resources policy in Greece were also announced.

In 1991, as soon as the drought hazard dissipated for the Athens area, it seemed that drought management efforts have also dwindled. In 1992, all the indications suggested the arrival of an another drought, and it was so predicted (C.A. Karavitis, 1992). However, drought contingency plans were not reported. Crisis management efforts were again applied. The 1993 drought responses may be summarised in the following:

On June 1992, CWWC initiated campaign for water conservation measures, while the high pricing policy was still in effect, since 1990, as a drought countermeasure. On December 1992, the Minister of EPPW suggested rationing from January 15, 1993 of 2.5 m^3/p/month. Nevertheless on January 1993 it was announced that due to technical and administrative constraints, rationing cannot be imposed. Water hauling by ships was again being discussed on March 1993. But it may be proven dangerous for the public health as oil tankers will be used. New pricing incentives and penalties for excessive water use were announced. However, pricing and penalties pitfalls were reported regarding consumer groups and lifestyles.

On May 1993, it was registered that conservation measures reduced revenues for CWWC. A 31% decrease in consumption between 1992 and 1993 was recorded on August 1993. On October 1993, MEPPW announced measures aiming at recycling, maintenance and repair of the Athenian water distribution system and reducing non - essential uses. On December 1993, water resources management plans are considered by MEPPW for Athens as well as for the whole Greece.

On March 2007, water transport by ship was started in Cyclades for the summer period. In Thessaly thousands of hectares were in danger because of the lack of irrigation water. On April 2007, In Chios the measures focused on the improvement of the existing system and construction of new desalination plant. On May 2007, in Samos island were announced 34 measures for drought management. On June 2007, in Ikaria island was announced the construction of new pipe systems for water transport from reservoirs and boreholes. On July 2007, in Trikala (Thessaly) minor irrigation systems and small dams were constructed. On August 2007, the minister of environment announced measures for drought management in Aegean islands and improvement of the existing infrastructure.

Hungary

In Hungary, the irrigable area was in the 1970s already close to 400 thousand hectares. But it has changed due to the negative processes in the agriculture, which begun in the eighties and intensified after the political change in 1990. Most of the melioration and irrigation development investments implemented in the '80s have amortized and become orphaned. As a result, the rate of the water rights permit holder areas is now reduced. But there is another problem that the water application is decreasing in the irrigable areas. While in drought years 2002-2003 there were over 120,000 hectares of irrigated areas, in 2008 (similar dry like 2002-2003) there were only less than 80 thousand hectares of irrigated farms.

In 2009, the water rights permitted irrigable area was 178,607 hectares. The total irrigated area was 92,000 hectares. Nationally, the 51% of the total water rights permitted irrigable areas were irrigated. The farmer organizations, farmers, growers significantly irrigated with surface water (approx. 83%).

In 2006, a strategy about irrigation management and melioration development was issued by the Irrigation Management and Melioration Development Committee of the Ministry of Agriculture and Rural Development. In 2008, a government regulation was born to support the development of irrigation's, melioration's and water management's facilities. By the end of 2009, 15 and a half billion HUF aid requests received.

In order to tackle the increasing risk stemming from global climate change, and to support the improvement of the domestic climate policy the Ministry of Environment and the Hungarian Academy of Sciences launched a common research programme titled VAHAVA - "VAltozas-HAtas-VAlaszadas" (change-impact-response).

The most important recommendation of VAHAVA project is that the Hungarian Parliament should enact a decree on long-term greenhouse gas emission reduction and adaptation in the frame of a National Climate Change Strategy, including the National Drought Strategy. This strategy is to be harmonised with international commitments, integrates into existing development plans and concepts, and forms priorities, defines the role and responsibility of the Government in execution, evaluation and monitoring of progress.The Hungarian Meteorological Service prepared studies on drought impacts including "climatological water deficit" and makes the methodology and calculation software available for the public.

The National Drought Strategy was elaborated in 2006. It deals with the strategic planning framework for the protection and sustainable management of ecosystems in drought-prone areas. The aim is to systematize the concepts, methods, steps and all of the resources for the responsible and decision-making members of the society that can be used in the prevention of drought, as well as in reduction and tolerance of the occurrence of the damage.

Combating desertification and drought is of high importance in Hungary. The National Drought Strategy aimed at prevention and control of droughts. The key elements of the strategy are promotion of water-saving farming methods (for example, tillage systems, application of organic manure, use of certain types of agricultural machines); plant protection and weed control; amelioration and irrigation; afforestation and plant breeding; and improvement of observation systems.

Montenegro

In 2007 Montenegro Government has adopted the measurement package of 10 million € for damage mitigation which was estimated by the competent Ministry, in range of 10 to 15 million €. Government has among other decided to give 400.000€ for purchasing of irrigation system with additional credit participation of bank sector (Bureau for public relations of Montenegro Government, 16.11.2007).

Montenegro Water Law of year 2007 represents also an important document in drought combating and mitigation of drought impacts (http://www.gov.me/files/1246958897.pdf). This Law, among other, regulates the water management, what is of great importance during longer droughty periods.

In aim of combating the drought, Ministry of Agriculture, Forestry and Water Management (http://www/gov.me/minpolj/) through some agricultural development projects indirectly influence on mitigation of drought impacts. Through the project “Agricultural development on individual farms” (http://www.nasme.me/publikacije) the Ministry has approved the credit line for purchasing of mechanization and equipment for irrigation.

Also, some municipality helps in similar way in drought combating. Municipality Podgorica (http://www.podgorica.me) through the Secretariat for entrepreneur development gives the restricted loans for irrigation systems to independent agricultural producers. In years, when the drought has caused the large damages to the country economy, Montenegrin Government has brought the special measurements for drought mitigation.

Serbia

As a result of different climatological and hydrological regimes, drought monitoring system for Serbia must take in account different drought indices describing meteorological, hydrological (surface water and groundwater) droughts, and their cumulative effects on agricultural and socio-economic droughts. Consequences of drought periods that affect Serbian population are restrictions in water supply and losses in agriculture products. For example, serious drought in 2003 caused reduction of even 46% in agriculture production (in respect to the average) in some regions of Serbia. At the territory of Vojvodina (Dedić M., 2003), the following characteristics of meteorological and hydrological drought were described in the season from March to August 2003: (i) duration of meteorological drought period where between 48 and 82 days, and rainfall amount were 51% of average; (ii) hydrological droughts at the main trans boundary rivers had duration between 71 days (the Danube river) and 113 days (at the Sava and the Tisa river), with significant surface flow reduction from averages at the entrance profiles in Serbia (49% for the Sava river, 58% for the Tisa river and 72% for the Danube river). As a combination of two drought types, at the area of Vojvodina available water where reduced in a range 32–74% from averages. There are the similar problems in neighboring countries at the Balkan area.

In 1994, the Balkan countries proposed establishing and development regional drought monitoring project to the WMO, but that suggestion was not accepted. Balkan countries were not included in the ARIDE project (Demuth S. and Stahl K., 2001) supported by EU (1998-2000). Because of that, in Serbia was decided to develop National Drought Monitoring System, hoping that would stimulate the other Balkan countries to cooperate at the regional level. Drought Monitoring System for Serbia was imagined as a pilot program which would cover representative meteorological and hydrological stations at all major catchments. Project development consists of several phases: (i) literature review and experiences study, (ii) methodology acceptance, (iii) pilot studies and database development and (iv) pilot monitoring system development. Multidisciplinary project team consists of meteorologists, hydrologists, hydro-geologists, forest engineers and IT experts. We hope that all aspects of drought will be included, and a final product will be Internet oriented. Obtained results will be transferred to Republic Hydro meteorological Service of Serbia. Hope was that this methodology would be usable to all sub-catchments in Serbia.

Slovenia

Making an overview of the current irrigation practices in Slovenia someone could result that the lack or inappropriate distribution of precipitation causes shortage of water during the important phenological stages of plants in the areas where irrigation is not obligatory technological measure and damage due to the agricultural drought can appear.

In Slovenia irrigation seems to be the principal solution for preventing disasters caused by drought in agriculture. Since most of crops in “normal” years don’t require irrigation, it can be regarded as irrigation measure. 8343 ha of agriculture land is now irrigated (which is – since total cultivated land in Slovenia is estimated to cca. 470.000 ha – less than 2% of total cultivated area). Also as future recommendation to avoid future droughts especially on shallow sandy and gravely soils is evidently monitored and supervised irrigation of economically effective crops. Because of that, it is necessary to give more attention to water resources for rural development and food production and implement the programs on irrigation, drainage and physical planning of rural areas.

Other recommended practices are: tillage, with stress on deep ploughing to preserve soil moisture, to reduce evaporation losses; retention of snow to store of winter moisture in soil, as well as an establishment of the windbreak, by planting of trees and shrubs with aim to reduce effect of the dry winds. Plant breeding approaches are another possibility for improving the drought tolerance of crops, etc.

There is no drought master plan or similar strategic document prepared for management of drought. Also insurance of crops against drought is not possible (whereas against for example hail and frost it is possible to get insurance).

In Slovenia since 1978, around 8,343 hectares of land were equipped with irrigation infrastructure. The following crops are found under irrigation: hops and field crops (69 %), orchards (13 %), vegetable (6 %), other (12 %).

The area equipped for irrigation was 6500 ha in 1995, most of it located in the Savinja valley, Podravje region and Vipava valley. After a severe drought (1992-1993) a National Irrigation Program was prepared and based on a feasibility study undertaken by the World Bank (1997-1999) the development of an additional irrigation area of 10 000 ha was suggested. The total area equipped for irrigation is now 15 643 ha in Slovenia.

To ensure stable and quality agricultural production MAFF plans on the base of National Irrigation Program of Slovenia to give financial support for the implementation the following water management actions for rural development (Juvan et al, 2002):

• to ensure sufficient water resources for irrigation needs (water reservoirs, pumping stations,
pipe distribution net),

• irrigation systems are supposed to be implemented on 3000 ha every year,

• drainage systems that were implemented in past 30 years (1969 – 1999) on approximately 72000 ha and are poorly maintained are supposed to be reconstructed where required and/or maintained properly. Financial support is being given to farmers for these actions.

B.3 Conclusions and remarks:

Albania

Based on the chronology of drought in Albania, it can be said that the drought is common phenomenon. Their impacts have been considerable, especially in the reduction of agriculture yield production, energy production, water supply.

Different measures are taken since before 1950 years in order to mitigate drought impact. These measures are concentrating in the construction of irrigation system (reservoirs or dams, channels) pumping stations, and flood protection works.

About 60 per cent of the arable land is under irrigation, more than half in the coastal plains, accounting for some 80 per cent of the agricultural production. Land distribution and social upheavals in 1991 resulted in substantial damage to the irrigation and drainage systems, and to the protection works. In the recent years the reconstruction and reorganized the irrigation and drainage systems is going to be improved.

Bulgaria

Long-term scientific studies have developed efficient drought mitigation practices that are well adapted to local climate, soil, terrain, crop and economic conditions. Field observations proved that deep percolation of irrigation water is under control by maintaining soil moisture over the cracking level by sprinkler, drip and surge furrow irrigation technologies. The effect of surge furrow irrigation on uniformity and efficiency of irrigation is evaluated to be 24-30% in the cracking soils.

Derived results could be used for: a) assessment of mitigation practices and adaptation to climate change; b) assessment of drought consequences and elaboration of recommendations for drought preparedness; c) validated model use in different practical situation for decision making in irrigation management, agro-climatology, risk assessment of crop productivity and ground water pollution.

Variable activity plans, programmes and strategies used to be developed for droughts mitigation and management in Bulgaria. However in spite of availability of such documents, there is no significant realisation of recommended mitigation/ management of drought into real practice. Strong evidence for that is the fact that average yields of summer crops have remained low for the last 20 years in this country. They have not surpassed the threshold of 30-40% of the yields relative to irrigated agriculture.

Except from the soil and water resources, this country disposes of qualified scientists and specialists in the field of land reclamation, dam construction, agrometeorology, agroecology and so on. Thus most of the required prerequisites are available to start implementing mitigation practices and rehabilitating the irrigation systems.

The following remarks and proposed practical measures could help to improve drought preparedness:

- The prices of water delivered by the "irrigation systems" association are so high that the farmers have no interest to irrigate main summer crops. Ministry of Agriculture and Food should introduce limited and differentiated prices for the different crops under irrigation (such practice is already established for rice crop).
- An independent audit of the main National irrigation systems should be organized. As a result the Minister of Agriculture and Food will take the appropriate measures aiming at irrigated areas increase.
- Short - term training courses for irrigation men and medium - term courses for agronomists and hydro engineers should be organized with the assistance of the Research Institutes of Academy of Agriculture and National extension service. Such courses would provide the specialists with updated knowledge on the real agronomical and economical benefits of good irrigation practices.
- A national council of independent experts on drought mitigation and management should be appointed by the Ministry of Agriculture and Food. The council should discuss and propose the necessary measures and polices related to enlargement of the irrigated areas in this country.
- The management of irrigation during each coming season should be organized by the Ministry of Agriculture and Food. For that purpose forecasts and maps should be provided by a National Drought Management Center with participation of NIMH, ISSNP, Institute of melioration and mechanization and other institutions.

Croatia

For the successful combat to drought impacts a great water reserves are needed for irrigation of vulnerable area. As it is mentioned above Croatia is reach in water and there exist basic preconditions for advanced irrigation systems then it is today. However, more detailed hydrological analysis showed that in the natural conditions there is not enough water storage for irrigation during low water period and especially when drought occurs. The preventive possibility to mitigate drought impacts can include the water transport from the region with excess water to region with temporary water deficit as well as collecting and storing the water for irrigation purposes. This includes building canals, water supply systems and surface water reservoirs as storages during dry periods.

F.Y.R.O.M.

Although the territory of F.Y.R.O.M is very vulnerable to drought due to its natural and climatic conditions, at present does not have coherent and comprehensive policy regarding drought. Some sectors and medium specific policies connected with the issues of drought do exist and are formulated in various policy documents and strategies. The reason for this is that land drought issues are not on top of the government/ministries agendas, due to number of more urgent and complicated socio-economic problems and issues.

However, mitigation of the effects of drought should be one of the priorities at the country level. Development of strategic document (National Strategy for Drought Mitigation, as well as National Action Plan for Combating and Agricultural Development Strategy) is one of the urgent priorities of the country, which should include activities, mechanisms, measures and targets at national level as well at the sub-regional and regional level. International cooperation including technology transfer is a very important part of these activities.

Greece

It would seem that the 1990 drought has taught no lesson in management efforts in Greece. As soon as the 1993 drought was established, crisis management actions were again applied. The prevailing attitude was still towards supply augmentation measures, with the potential introduction of the Acheloos river-Trichonis lake diversion scheme. Computer support systems have only lately and marginally started to be incorporated in the management scheme. Demand-reduction, recycling and reuse measures have also been announced (1997). There is only recently that A Greek Drought Master plan was announced (Technical support to the central water agency for the development of a drought master for Greece and an immediate drought mitigation plan, 2008).

Hungary

In spite of the relatively active evaluative and research work conducted for solving drought problems in the country, practical actions and governmental interventions remained in most of the cases ineffective, unfounded and not quite well consolidated. Most of the measures against drought damages have been improvised, the steps have been mainly succeeding and not preventing ones; and the actions have been mostly stop-gap type actions with only partial effects. Based on these perceptions and joining to relevant international movements in this topic (mentioned above) we came to the conclusion that more complex and preparative type of work is necessary for an effective drought mitigation in Hungary.

The ratio of irrigated agricultural land is critically low in Hungary compared to the potential opportunities and needs. In order to prevent drought damages, the main task of the state is the establishment and operation of the water transfer systems between large areas, furthermore, the establishment of the water retention and water conservation. As a result of this activity, the urban water management, the recreation, the industrial and agricultural production and the ecological water supply opportunities can be achieved in times of drought.

Montenegro

Montenegro has in 2007 ratified the EU Convention to Combat Desertification (UNCCD) (http://www.ncsa-montenegro.com/index.php?jezik=0&opcija=0&id=5). By approaching to UNCCD and adopting its obligations, from Montenegro is expected to produce own national strategies directly involved in combating droughts. Ratifying and approaching the Convention Montenegro has the obligation of Development and implementation of programs for sustainable irrigation, like necessary condition for agricultural development in rural and arid areas. Realization of this plan will have numerous positive effects on agricultural production, as on combating the drought and mitigation of drought impacts.

Serbia

Analysis of basic climatic data revealed that the dry years were more common for the period after 1981. All criteria that have been used for determination of dry years proved that. Also, after that period climatic changes are caused with reduced precipitation, relative air humidity, higher air temperature and sum of sunshine hours, which all, consequently, caused increased reference evapotranspiration. The period after 1994 had the significant occurrence of moderate, and wet years. In order to determine the frequency of occurrence of dry and wet periods, longer observations are needed. The values of climatic elements are more extreme in period 1990-2004 and they more or less are different from multiyear average values.

Besides drought issues, irrigation issues should be solving by multidisciplinary approach in order to mitigate arid consequences on wider area.

Applied irrigation systems are increasing and stabilizing crop yields, and its quality, than mitigating drought consequences, and in line with mentioned the profit is higher. Producing structure should include livestock too. Low profitable crops such as wheat and corn should be replaced on irrigated surfaces with profitable sorts, such as vegetables, seeds and fruit. Additional effects can be obtained by subsequent seeding on approximately 25-30% of the irrigated surfaces.

Investing in irrigation is vital for higher results crop yield and profitable crop production. Finally, instead of the conclusion, one question: Has our policy and strategy in agricultural production been right or wrong when we had loss of hundred million USD biennially, because of ignoring importance of irrigation systems?

The presented investigation showed an approach to determination of losses caused by drought as well as the impact of drought on crops. Five years of following the effects in maize production have not confirmed the interaction between precipitation deficiency and yield, due to the impact of certain other factors (precipitation spread, temperature sum, etc.). Introducing irrigation decrease drought damage by increasing, and stabilizing yield. In case of limited system capacity and available water quantity, it is necessary to balance, i.e. distribute water on those crops that will produce maximum economic effects. This particular case elaborates a mathematical model taking in account several different limiting factors. The model was tested on a 3000 ha area where parameters of individual crops proportion in drought years were given. The model needs to be elaborated further in terms of objective function as well as balancing water requirements for individual crops in case of varied production structure.

Slovenia

Based on the chronology of drought impacts in Slovenia, it can be stated that drought is part of our climate and therefore recurrent phenomenon. Drought impacts have been considerable, especially in the reduction of agriculture yield production. Although climatic conditions are favourable and enable agricultural production under rain-fed conditions during vegetation period of most of the years, risks of suffering crop yield losses are relatively high.

Because irrigation in Slovenia is one of the most important mitigation practices to fight drought, we should in future improve existing irrigation system. Main problem is water infrastructure; most systems for water supply haven't counted on irrigation needs when they were established. Farmers now usually count on drinking water supply systems or nearby rivers as source of irrigation water – which is unacceptable, both due to economical and ecological reasons. Main challenge for the future remains water supply for irrigation which should be accessible for every farmer with reasonable investment requirements.

Table C.1: Synoptic table on mitigation practices applied in drought periods

SEE countries	Mitigation Practices in agricultural sector	Mitigation Practices in hydrological sector	Drought management	Drought Master plan
Slovenia	Irrigation Tillage Retention of snow Establishment of the windbreak	Drainage systems Resevoirs, dams etc	No	No
Greece	No irrigation possible in drought periods	Resevoirs, dams etc Improvement of the existing maintenance procedures, conservation, groundwater use, and emergency water hauling by ships Public information campaign on water conservation, rationing water	Crisis management	Announcement of master plan 2008
FYROM	No irrigation causes losses	No irrigation causes losses	Establishment of Drought Crisis Committee. Simulation exercise "Drought-2007 Second National communication on Climate Change (SNC, 2008)	-
Albania	Irrigation Projects are under way to repair the irrigation system	Reservoirs or dams Pumping stations Flood protection works	-	-
Hungary	Irrigation Tillage systems Application of organic manure Plant protection and weed control	Reservoirs or dams Water retention structures	National Climate Change Strategy, including the National Drought Strategy	-
Serbia	Irrigation Crop rotation Use of different hybrids and species Maintenance of irrigation systems	Maintenance of the water supply systems	Development of National Drought Monitoring System	-
Bulagaria	Irrigation Reconstruction of irrigation systems Regulation of prices of water for irrigation Use of different hybrids	Water management on river basin principles Water discharge regulation Prevention overexploitation of groundwater Reconstruction of the water supply systems	National capacity for global environmental management. 2003-2004 Development and application of systems for estimation and early warning for irrigation needs and determination optimal irrigation scheduling Management plans for river basins 2009-2015	National Environment Strategy for 2005-2014 and Action Plan for 2005-2009. 2007: National Action Programme for Sustainable Land Management and Combat to Desertification April 2012 – National action plan for climate change (2013 – 2020)

Croatia	Irrigation Use of groundwater	Resevoirs, dams etc Construction of water supply systems Water transportation from region to region	National Project of Irrigation and Land and Water Management National Action Programme to Mitigate the Effects of Drought and Combat Land Degradation	-
Montenegro	Irrigation Loans for irrigation systems to independent agricultural producers	Construction of water supply systems	Montenegro Water Law of 2007	Montenegro Spatial Plan until 2020

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