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Greece

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SUMMARY – Due to its climatic conditions, Greece is a country often affected by droughts. Although Greek organizations have not developed concrete strategies concerning droughts, they have dealt with this phenomenon on a case to case basis, to a certain extent. However, from a review of the existing institutional structure, it can be concluded that the country needs a comprehensive effort to rationalize the entire drought analysis, monitoring and mitigation system. There is an obvious lack of scientific organizations, legal framework and operational capabilities to combat drought. It is also absolutely necessary to devise preparedness plans for achieving pro-active defence against drought. Needless to say that an operating mechanism should be instituted for an effective application of rational measures resulting from a scientific analysis. It should be noted that during drought, water restrictions are imposed mainly in domestic water consumption. However, 84% of the water used in the country is consumed in the agricultural sector. It is logical therefore to re-direct water restrictions, giving emphasis to agricultural use, which is the main consumer of water. Last but not least, it should be noted that there is a severe gap in the measures for combating drought, i.e. the lack of insurance of people and property in the event of a drought occurrence. However, it should be pointed out that following the recent approval in Parliament of the new Water Law and the subsequent presidential decrees, it is planned to institute scientific and technical commissions to analyse the occurrence and mitigation of droughts.

Key words: Drought, management, water.

RESUME – "Grèce". En raison de ses conditions climatiques, la Grèce est un pays souvent touché par la sécheresse. Bien que les organisations grecques n'aient pas développé de stratégies concrètes pour la sécheresse, elles abordent ce phénomène au cas par cas, jusqu'à un certain degré. Néanmoins, en examinant la structure institutionnelle existante, on peut conclure que le pays nécessite un effort d'ensemble pour rationaliser toute l'analyse de la sécheresse, le suivi et le système d'atténuation. Il y a une insuffisance évidente d'organisations scientifiques, de cadre légal et de moyens opérationnels pour lutter contre la sécheresse. Il est également absolument nécessaire de mettre au point des plans de prévention pour une défense proactive contre la sécheresse. Il va de soi qu'il faudrait instituer un mécanisme opérationnel pour une application efficace de mesures rationnelles résultant d'une analyse scientifique. Il faut noter que pendant la sécheresse, des restrictions sont imposées principalement pour la consommation d'eau domestique. Cependant, 84% de l'eau consommée dans le pays va au secteur agricole. Il est donc logique de réorienter les restrictions en eau, en particulier dans le domaine agricole, qui est le principal consommateur d'eau. Et finalement, le moindre n'est pas la fracture existante quant aux mesures de lutte contre la sécheresse, c'est-à-dire l'absence de programmes d'assurances pour les personnes et les propriétés en cas de sécheresse. Cependant, il faut souligner que suite à l'approbation récente par le Parlement d'une nouvelle Loi sur l'Eau et aux subséquents décrets présidentiels, il est prévu d'instituer des commissions scientifiques et techniques pour analyser la survenue et l'atténuation des sécheresses.

Mots-clés : Sécheresse, gestion, eau.

Preface

The current framework in Greece is characterized by changes. The new law was approved by the Greek Parliament in November 2003 to comply with the obligation of the member states to harmonize their legal system with the Water Directive 2000/60.

Data and information systems

The institutions that collect, record and process data that provide a representation of natural processes and socio-economic patterns directly or indirectly related to droughts are outlined in Table 1.

Table 1. Summary of institutions that collect and process data related to drought in Greece

Institution	Type of data
The Ministry of Environment	Water quality, water use, geographical data, land use
The National Meteorological Service	Meteorological data
The Public Power Corporation	Energy consumption
The Ministry of Agriculture	Meteorological data, water quality, water use, Agricultural Census
The Ministry of Interior	Municipal water consumption
The Ministry of Development	Land use, populations, groundwater
The National Observatory of Athens	Meteorological data
The Water Supply Companies	Water quality, water use
The Army	Geographical Agency maps, topography, land use, GIS
The Centre of Planning and Economic Research	Socio-economic indicators
The Institute of Geology & Mineral Exploration	Groundwater, land use, geology
The National Statistical Service	Statistics, macroeconomic indicators

The major institutions which play a role in combating drought are the three ministries: the Ministry of Agriculture, the Ministry of Interior and the Ministry of Environment. These Ministries are responsible for the use of water in agriculture, in municipalities and in the industry domain.

The National Data Bank of Hydrological and Meteorological Information (NDBHMI), which has been established using information provided by the first six institutions mentioned in Table 1, contains hydro-meteorological and hydro-geological data covering the entire country. Up to now only the institutions that have contributed in the creation of this data bank can access the data, but soon the data will be also accessible to other institutions and research organizations. The NDBHMI provides the required infrastructure for the implementation of the EU Water Framework Directive for the protection, rational management and exploitation of the water resources at the national level.

Various software applications are linked to the central database of the NDBHMI supporting the analysis and synthesis of the data and the elaboration of secondary information. The distributed form of the database allows a continuous online operation and exchange of data between the participating organisations.

A Geographical Information System (GIS) subsystem was developed to support the spatial analysis of hydrological data. The GIS applications were designed and implemented in such a way to allow both independent processing of data as well as interaction with the database and the different software packages.

Given the large number of organizations measuring rainfall in Greece, a rationalization plan was devised, creating a unified meteorological network.

Together with the National Network of Gauging Stations, the project team studied the development of network of 15 high resolution gauging stations in Attica, the greater area of Athens. These stations will automatically transfer data to the main database of NDBHMI at programmed intervals. The selection of the location of the stations was made, taking into account the geographical distribution as well as the security of each location. The main equipment in these stations consists of the following: auto-recording meteorological stations, data-transfer equipment and customized software for the automatic transferring of recordings to the database. This network will work in parallel with meteorological radars that the National Technical University of Athens (NTUA) is in the process of buying. This system will constitute an integrated storm prediction system in the wider area of Athens.

Legal framework

The key legal actions in Greece related to water and drought management are:

- (i) The Law 1739/87 for the "Management of Water Resources".

- (ii) The Law 1650/86 for the "Protection of the Environment", regarding the quality of water.
- (iii) The European Directive 2000/60/EC.
- (iv) The Law 3199/03 of "Protection and Management of Water".
- (v) The legal implications of the United Nations Convention to Combat Desertification (UNCCD) (1994).

The Law 1739/87 for the "Management of Water Resources" covered all issues related to water policy (research, organization, planning) by establishing procedures and structures that permitted water management on a national and a regional scale.

However the lack of presidential decrees covering specific aspects of the application of this law resulted in a fragmentary and incomplete application. Nevertheless, the Law 1739/87 served as a framework for the management of water resources in Greece for the last 15 years.

This statutory framework for Water Resources Management exists for 14 years. It includes Law 1739/87 on "Management of Water Resources and Related Provisions", regarding water use and management of water quantity, and Law 1650/86 for the "Protection of the Environment", regarding the quality of water.

The Law 1739/87 defines, *inter alia*, the River Basin Districts, the responsible authorities according to the type of water-use, the cardinal role of the Ministry of Development, an Intra-ministerial Water Committee, Regional Water Committees, Regional Water Resources Management Authorities, programs of water resources development, research on surface- and ground-water, works of water resources development, water use-permits, the preservation and protection of water resources, disposal of waste water, disposal of industrial waste and disposal of low-quality water to aquatic recipients according to Law 1650/86. According to Law 1739/87 the regional administrative authorities will be responsible for the system of water supply and the arrangement of conflicting uses.

This legal framework has moved forward the previous legal regime regarding water resources since it was the first time that were assigned the appropriate authorities to water uses and water management and was indicated the administrative body that was going to apply them.

The Law 1739/87 sets as primary goal the reservation of adequate water supply to satisfy the present and future demand for different water uses.

However, there are some points that led to the unsuccessful implementation of the Law 1739/87, such as: (i) the multiple distribution of authorities to different Ministries which has hampered integrated actions; (ii) the fact that water resources management was not incorporated in the environmental policy; and (iii) the allocation of water quality and quantity issues within the same area to different authorities.

The Law 1739/87 institutes the concept of planning for the development of water resources (preparation of water resources development programs). However, the planning focuses only on satisfaction of water demand, without dealing with the adaptation of the demand on the available water resources. The failure to practice integrated management has caused troubles in the past.

Integrated management of aquatic ecosystems was hampered by the distinction between management of water resources and environmental policy.

Several problems arose during the process of transfer of authorities from the Ministry to the Districts mainly because the overall infrastructure and specifically the operational infrastructure in the Districts is inadequate to respond to the present demands.

Water management is assigned to the Ministry of Development which is deprived of the adequate infrastructure, human resources, knowledge and material, and especially of the political will that is needed in order to apply water policy.

Incapability to perform the appropriate water authorities satisfactorily has been created from the complete assignment of the water authorities to the state sector and the lack of autonomy and self-reliance.

According to the Law 1739/87, as far as the water permits are concerned, every person has the right to use water. In order to use this right, the person should be supplied with a permit, issued by the responsible Ministry. Permits for multiple water use are issued only in special cases. The water permit defines the quantity and the conditions of water use. A water permit is not required for the satisfaction of personal or family needs; still this use should never be expanded in productive activities for product or service sharing and exploitation. The water supply is of first priority compared to any other water use. The permit of water supply for domestic use can neither be abolished nor limited.

The new European Directive 2000/60/EC "Establishing a Framework for Community Action in the Field of Water Policy" imposes the need for adopting a new framework for water, fully compatible with its content.

On November 12th, 2003 the new Law for the "Protection and Management of Waters" was adopted by the Parliament of Greece. The Law 3199/03 is based upon the principles of the European Directive. This law establishes a framework for the achievement of a sustainable water policy and, as a consequence, of a sustainable development of the country and aims at:

- (i) The creation of a contemporary and effective institutional/legislative framework.
- (ii) The development of long-term planning.
- (iii) The decentralization of responsibilities and the strengthening of regional structures.
- (iv) The creation of national laws with the Directive 2000/60/EC for the establishment of a framework for community action in the field of water policy.
- (v) The implementation of the objectives of the Directive taking into account local specificities of the country.

The new Water Law contains the following chapters:

- (i) Chapter A – Application field and definitions (Articles 1 and 2).
- (ii) Chapter B – Institutions and authorities (Articles 3, 4, 5 and 6).
- (iii) Chapter C – Management plans, programs of measures (Articles 7, 8 and 9).
- (iv) Chapter D – Use of water, financial regulations (Articles 10, 11 and 12).
- (v) Chapter E – Penalties (Articles 13 and 14).
- (vi) Chapter F – Repeals, transitional and final provisions (Articles 15, 16 and 17).

Provisions of the Water Directive 2000/60/EC and of its annexes, not included in the Law 3199/03, will be embodied in Presidential Decrees that are provided for in Articles 12 and 15.

According to the Law 3199/03, apart from the central authorities, decentralization is attempted by establishing Water Directions in all regions of the country. The law also establishes Regional Water Councils in which most of the stakeholders take part. The Water Councils are bodies of social discussion and of consultative type. The decisions on water resources of each basin are taken by the region in the territory of which they belong. In case that a river basin belong to more than one region, then the ensemble of the regions co-operate for water resources management of the river basin.

Regarding the water permits for water supply or the construction of a water project, they are issued, following a prescribed procedure by the general secretary of the corresponding region.

Finally several penalties in case of variation of the law are described in the last articles of the law. Most of the articles of the Law 1739/87 are replaced by the new law.

Although there are no specific articles regarding drought mitigation, it is implied that the bodies responsible for the water resources management will be also responsible for drought issues.

Although the major framework of bodies responsible for the water resources management according to the Law 3199/03 has been decided, further elaboration is needed in order to render this law functional. For this purpose a series of ministerial decrees should be issued, in order to customize the various directions provided in this framework law. At the same time, several actions have been taken for testing the proposed structure at a pilot scale. These activities have started and are expected to give results after one or two years. In this context, more detailed information will be provided including the establishment of river basin plans, national plans, organization aspects and other relevant issues related on the implementation of this law.

Specific measures of drought mitigation have not been legislated in the past in Greece. However in 1994 Greece signed the UNCCD, which was ratified by the Greek Parliament in 1997. Desertification may be considered related to drought.

Within the implementation of this Convention the National Committee to Combat Desertification (NCCD) has been established and finally in 2002 the Greek National Action Plan (NAP) for Combating Desertification has been developed. The Greek Government accepted officially the NAP in July 2001, through a Common Ministerial Decision (CMD) of six involved Ministers. The CMD was published in the Government's Gazette No. 974/27-7-2001.

Structure and linkages among the relevant institutions, organizations and stakeholders

As stated before, the Law 3199/03 establishes and defines the institutions and authorities responsible for the protection and management of waters. The NGOs can express opinion and from time to time are invited to make proposals to the responsible ministries. However, it is left totally to the Minister to decide whether the proposal will be accepted or not. The structure is depicted in Fig. 1.

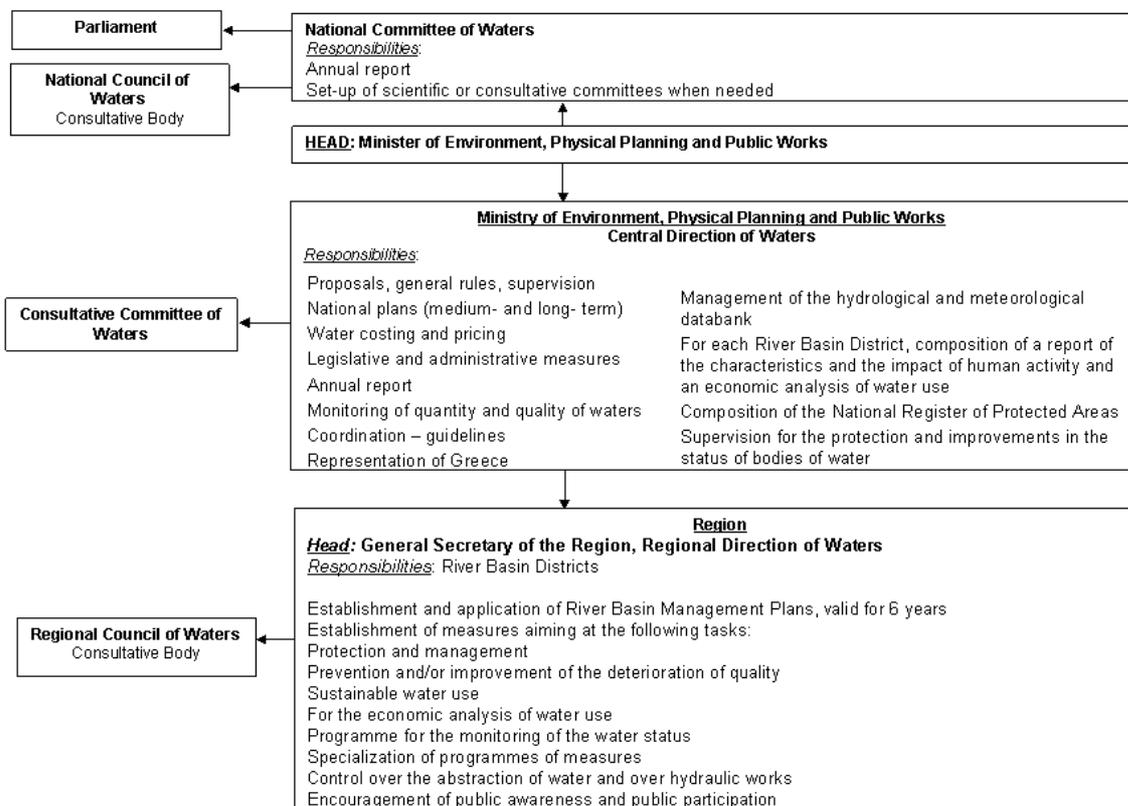


Fig. 1. Organization chart of services concerning water resources management in Greece.

The river basin district is the main unit for the management of river basins and was first introduced in Law 1739/87. Greece was divided into 14 river basin districts, including: West Peloponnese, East Peloponnese, North Peloponnese, West Sterea Hellas, Epirus, Attica, East Sterea Hellas and Evia, Thessaly, West Macedonia, Central Macedonia, Thrace, Crete and Aegean Islands.

It is estimated that the existing River Basin Districts will be changed and limited in number. Within this concept, it is suggested to divide Greece into 7 to 9 River Basin Districts.

National Committee of Waters and National Council of Waters

A National Committee of Waters is constituted, presided by the Minister of Environment, Physical Planning and Public Works. This committee is responsible for: (i) planning of the policy for the protection and management of waters; (ii) supervision and control of the implementation of the aforementioned policy; and (iii) approval of the national plans for the protection and management of the water potential of the country.

Members of the National Committee of Waters are the Ministers of Economy and Finance, of Interior Affairs, Public Administration and Decentralization, of Development, of Health and Welfare and of Agriculture. Other Ministers may participate when issues of their responsibilities are in the agenda. The Minister of Foreign Affairs participates when issues about international waters are discussed.

The National Committee of Waters may form consultative-scientific committees when needed. The National Committee of Waters submits an annual report to the Parliament and to the National Council of Waters.

A National Council of Waters is constituted, presided also by the Minister of Environment, Physical Planning and Public Works. Members of this Council are representatives of stakeholders, i.e. political parties represented in the Parliament, prefecture representatives, municipal unions and companies, unions of workers, scientific organizations and two non-governmental organizations. The National Council of Waters is a consultative body and reports to the National Committee of Waters.

Central Direction of Waters and Consultative Committee of Waters

A Central Direction of Waters is constituted as a unified administrative sector in the Ministry of Environment, Physical Planning and Public Works, having the following responsibilities:

(i) Working out of national medium- and long-term plans for the protection and management of waters.

(ii) Drawing up of the annual report mentioned above.

(iii) Coordination of the various state departments and public sectors and representation of Greece in the official bodies of the European Union.

(iv) Proposal of the general principles for water costing and pricing and supervision of their implementation.

(v) Proposal of legislative and administrative measures for the protection and management of water.

(vi) Management of the hydrological and meteorological database on a national level and care for updating.

The Central Direction of Waters is responsible for the economic analysis of the water use for each River Basin District, the composition of the National Register of Protected Areas, the surveillance for the protection, upgrade and restoration of surface, artificial or heavily modified water bodies, etc. In the Central Direction of Waters the Consultative Committee of Waters is constituted.

Regional Direction of Waters, Regional Council of Waters

Regions are responsible for the protection and management of each River Basin District. In each region is constituted the Regional Direction of Waters, has the following responsibilities:

(i) The specialization of the appropriate measures that have to be taken for the integrated protection and management of the River Basin Districts.

(ii) The specialization and application of medium- and long-term programs for the protection and management of the River Basin Districts.

(iii) The establishment of measures necessary for the economic analysis of water use.

(iv) The control over the abstraction of fresh surface water and groundwater and over hydraulic works developed for the exploitation of water.

(v) The establishment and application of River Basin Management Plans.

(vi) The encouragement of public participation.

In each region, the Regional Council of Waters is constituted, presided by the general secretary of the region. This is a consultative body and acts as a link for the promotion of public involvement and participation in the protection and management of waters.

Proactive and reactive plans and actions

The most recent regional drought episode in Greece was experienced during the period 1989-1993. According to the data of that period, this multiple-year drought had caused severe problems in most areas of Greece. The situation was so difficult that for the last six months of the drought period, several non-conventional scenario and solutions were proposed for securing water supply for domestic use in the major cities of the country. The most characteristic case was the case of the municipality of Athens, which derives its water from Mornos River as well as Yliki and Marathon Lakes, and a battery of boreholes from Viotikos Kifissos basin. (Recently Evinos River is also one of the contributors for fulfilling the water resources demands of Athens.)

Some of these scenarios referred to massive transport of water by vessels from various areas, the construction of a new aqueduct connecting Trichonis Lake with Mornos reservoir, construction of water supply networks from other areas of Sterea Hellas and Peloponnese.

The most amazing of all was that Athens, at the end of September 1993, had water only for one more month. The solution which was at that time decided was given by applying demand reduction measures, which were assisted by the change of climatic conditions soon after.

Gradually after October 1993, the reservoirs of the system started to be filled and after a lag of three years the situation was again normalized.

Within this plan, the institutional and legal measures related to water resources and more specifically the mitigation of drought, are covered by the Directive 2000/60/EC and the Law 3199/03. Particularly, measures taken or planned that are compatible with the NAP are:

(i) A programme for the management of water resources and the development of institutional structure for the period of 2001-2006 is being prepared.

(ii) The implementation of the plans for developing water resources at all levels, the establishment and operation of the regional water management services, the issue of regulation decisions by prefectures to protect water resources per water basin and the exertion of effective checking on infringement of the law and infliction of the respective penalties are ensured by the respective laws, and the support for more efficient operation of local land reclamation organizations.

(iii) The repairing and renovating the irrigation networks, the application of integrated irrigation systems, the water recycling and re-usage is implemented through the plans of the Land Reclamation Directorate for facing drought as well as the local land reclamation organizations.

(iv) The actions for combating drought are being realised by the construction of dams and off-stream reservoirs in drought prone areas. So far, under this activity twenty dams and twenty-nine reservoirs have been constructed. Also technical studies for eleven dams and four water reservoirs have been prepared. Both Greek Government and EU fund the plans. Additionally, the Ministry of Agriculture has continued an activity initiated in 1994 for facing the drought problem, by funding works like drilling (where sufficient ground water resources exist), harvesting of spring waters, repairing the irrigation networks and other land reclamation projects. Recycled water has been used, at a relatively small scale, to satisfy irrigation needs. Other actions include:

- The refilling of artificially drained lakes and the planned diversion of the Acheloos River towards the one of Thessaly plain, which is threatened by desertification.
- The development and expansion of the National Data Bank of Hydrological and Meteorological Information.
- The support of research for increasing available water supply. Several reports are being prepared for the support and pilot application of the EU Directive.

Given that agriculture uses 84% of the water resources of Greece, most pro-active and reactive plans and actions concerning the effects of droughts were taken in the past by the Ministry of Agriculture.

Proactive actions

The most relevant proactive actions in Greece include: (i) small earth dams for collection of rainwater; (ii) canal rectification to reduce water losses; and (iii) modernization and improvements of irrigation networks.

In more detail, all proactive measures have the same aim to enhance the storage, the conveyance and distribution of water. In this context, it should be mentioned that important contribution to water saving is the gradual change from conventional surface irrigation systems to modern sprinkler and trickle irrigation systems. Therefore, application efficiency is enhanced if farmers follow this tendency.

Reactive actions

The most relevant reactive actions in Greece include: (i) constraints in water consumption; (ii) intensification of the use of groundwater resources; (iii) reallocation of water resources; (iv) use of saline and brackish waters; and (v) water transfer.

During drought, the reactive actions follow two categories of measures: the allocation of new sources of water, such as saline and brackish waters and also intensive pumping of existing ground waters. In some cases water also is transferred from users to the towns and cities for municipal consumption. If possible – in some cases – water transfers and reallocation of water resources is attempted. The reallocation of water resources of Viotikos Kifissos from the irrigation area of Viotia, in order to serve greater Athens complex during the drought 1989-1993 is the most profound example of this category of reactive actions. In the future, pro-active and reactive plans and actions for drought mitigation will be based on the new Law on Management of Water Resources, approved by the parliament in November 2003, Law 3199/03.

During this period several water resources management studies are prepared for most regions of the country under the supervision of the Ministry of Development. Although these studies have their roots on the previous legal system (Law 1739/87) by which the coordination of water resources management was responsibility of the Ministry of Development, they can produce important results for the implementation of the Law 3199/03.

In more detail the water resources management studies, which are under preparation, are: (i) Peloponnese (3 water districts); (ii) Attica, Sterea Hellas, Epirus, Thessaly (5 water districts);

(iii) Macedonia and Thrace (4 water districts); and (iv) Aegean Islands (1 district). The total budget for these studies is about 4.4 M € + VAT.

The study of the water district of Crete was completed in the framework of another study a year ago.

It is expected that these studies will organize the hydrological and other data in a systematic way and they will provide useful information about the drought-prone areas of the country. However it should not be anticipated that these studies will produce proactive or even reactive plans to combat drought. According to the Law 3199/03, proactive and reactive plans related to the mitigation of drought will be adopted by the Central Direction of Waters (proposals, general rules, medium-term and long-term national plans) and by the Regional Direction of Waters for each River Basin District.

Although reallocation strategies seem to be a very effective measure to combat drought in the agricultural sector, very little work has been done at the operational scale. It is expected that at least in some areas that are prone to drought experimental studies on changes of cropping patterns will be applied. For example, Thessaly plain has been proposed for these cropping pattern changes, where one of the major crops is cotton.

One of the major droughts experienced in most of the area of the country seems to be the 1989-1993 droughts. During this period, several measures were taken by the ministries involved and the prefectural and municipal services. Most of these measures, which have been presented elsewhere in this text, were taken with little co-operation and co-ordination. However, in most of the cases (and although there are some conflicts reported) the results were in the same direction, namely the reduction in water consumption and the use of some extra water resources wherever possible. Conclusively, it should be said that during the last drought there was no systematic approach and sufficient co-ordination.

Stakeholders

The Public Power Corporation SA (Hydroelectric Power Plants Operations Department)

Public Power Corporation (PPC) supplies Greece with electric energy. A percentage of 6% of the total energy is supplied by hydroelectric plants. The dams of PPC create artificial lakes that are used for power production irrigation and water supply purposes.

Perception of drought

The interviewee – director of the sector of exploitation of hydro-electrical stations – perceives drought as a comparison between the mean value of precipitations during a long time series and the mean value of precipitations of the current year. He also believes that mankind cannot easily control but only influence drought, because this is related to the quantity of precipitations. Agriculture is the most sensitive sector affected by drought (80% of the total water consumption is used in agriculture), while tourism seems to be the most insensitive sector.

Ordering the factors of uncertainty, which affect irrigation farmers, the climate may be considered as having the highest level of uncertainty, because in the interviewee's opinion it is not influenced by man. In a second rang the economic value of agricultural products should also be considered, because they are related to the climatic conditions. On the other hand, in the interviewee's opinion, agricultural policies are rather insensitive to uncertainty.

Legal arrangements

The interviewee believes that only a small part of users are holding a water permit in Greece. The whole issue is complicated and has many aspects: financial, social, developmental and legal. According to the Law 3199/03, many sectors are represented and participate in organizations/committees, responsible for the definition of water allowance during drought periods. The problem focuses in the fact that such numerous bodies do not easily make decisions.

The number of users related to a certain water allowance influences decisions, due to the political power of the vote. There is also greater ability to make decisions concerning the definition of water allowance for representatives of the public sector (ministries, etc.).

There is no formal procedure to declare a "drought situation". As far as the management of inflows in reservoirs of hydroelectric plants is concerned, the "drought situation" is considered by taking into account the current meteorological and hydrological information, in comparison with previous conditions, the volume of the reservoirs, the snows existing in the basin district, etc.

Priorities and measures

According to the interviewee, in the case of drought, highest priority for the water supply should be given obviously to the domestic use of water and lowest priority to tourism, with the exception of the Aegean Islands. These priorities correspond also to the priorities that the administration should defend.

The PPC does not have a specific policy that is followed in the case of drought. Nevertheless, during past periods of water scarcity, pressure has been applied on farmers for the reduction of the quantity of water used for irrigation (informal measure) and a report has been sent to the Prime Minister. In drought periods a pro-active measure adopted by the PPC is the construction of reservoirs managed by the Corporation itself and which are multi-purpose projects.

A reactive measure taken by the PPC, related with the drought management, is the appropriate management of water outflows from the reservoirs for domestic use and irrigation purposes, in addition to the energy production. According to the interviewee, creation of reservoirs may be considered as the most important measure to be carried out for the management of drought, because rainfalls are few in Greece and unevenly distributed during the year. Desalinisation of water is considered by the interviewee as an expensive way for water supply. Measures should be adopted separately for the various districts of the country because they have different weighting conditions of water use.

The interviewee considers as measures not accepted by public: (i) the substitution of high water-demanding crops with low water-demanding crops; (ii) the reallocation of water; (iii) the inter-basins transfers; and (iv) the conversion of some irrigation surfaces to dry farming.

Economic analysis

The interviewee expresses the opinion that water cannot be treated in a way similar to other natural resources (oil, gas, etc.) because the property of water cannot be easily controlled, i.e. who the owner of water is and how the water will be sold. The water management should be carried out by public organizations and the users should pay the cost according to social criteria.

There are two distinct parts in Greece: (i) the eastern part and the Aegean Islands, characterized by scarcity of water and consequently a considerable number of users that would probably buy water; and (ii) the western part, with adequate quantities of water and, therefore, less inclined to buy water.

Water is a good of first priority, essential for the human life. Buying and selling water would result in the interest of some people or companies dealing with the water marketing and a high cost for the water itself. The establishment of institutions which would deal with water buying and selling seems to be unfeasible for the time being.

The Greek National Committee for Combating Desertification

Perception of drought

The interviewee – president of the Committee – perceives drought as a naturally occurring phenomenon that takes place when precipitations have been significantly below normal recorded levels, causing serious hydrological imbalances that adversely affect land resource production systems. He also believes that agriculture is the most sensitive sector affected by drought (80% of the total water consumption is used in agriculture), while tourism seems to be rather insensitive.

According to the interviewee the agriculture sector is the major consumer in Greece and therefore this is the one whose responsibility is to cope with the effects of drought.

Ordering the factors of uncertainty that affect irrigation farmers, climate may be considered as having the highest level of uncertainty, as it is often related with severe consequences. On the other hand, in the interviewee's opinion the work market is rather insensitive to uncertainty.

Priorities and measures

According to the interviewee, in the case of drought, the highest priority for water supply should be given obviously to the domestic use of water and second to agriculture. The lowest priority should be given to the recreational use of water. These priorities correspond also to the priorities that the administration should defend.

The Committee's proposal with regard to proactive measures generally adopted in drought periods includes the construction of reservoirs, the enforcement of the artificial groundwater recharge and the improvement and repair of the water supply systems. Concerning the reactive measures generally adopted in drought periods, it is suggested to discourage wasteful use of irrigation water and to use agricultural methods limiting evapotranspiration.

According to the interviewee, increase in the regulation capacity for irrigation purposes and creation of reservoirs may be considered as the most important measures to be carried out for the management of drought (management of supply). Inter-basin transfers of water and use of brackish water are considered by the interviewee as being of lowest priority measures for water supply (least important).

Economic analysis

The interviewee expresses the opinion that it is possible to treat water in a way similar to other natural resources (oil, gas, etc.) but at the same time, there should exist an intervening state policy to preserve public interest. The option to buy and sell water would possibly involve users from the whole country.

The interviewee considers as possible negative effects of buying and selling water, the increase of the price of water, the profits without control to companies selling water and the various environmental consequences of such a policy. Simultaneously with the creation of water banks, controls for the protection of the public interest should exist.

Ministry of Interior, Public Administration and Decentralization (Department of Technical Services and Environmental Protection)

The Ministry of Interior, Public Administration and Decentralization according to the old Water Law 1739/87 was responsible for supplying water for domestic use. With the Law 3199/03 no responsibility related to the water domain is attributed to this Ministry. However, according to the Municipal Code that is still valid, municipalities are still responsible for supplying water for domestic use (municipalities are supervised by the Ministry of Interior, Public Administration and Decentralization).

Perception of drought

The interviewee – supervisor of the sector of environment protection – perceives drought as a series of hydrological dry years and believes that drought can be controlled by adopting appropriate management plans and by carrying out appropriate hydraulic works.

According to the interviewee the environment and the agriculture domain are the most sensitive sectors to be affected by drought, while domestic users (because of their social importance) seem to be the most insensitive one. Furthermore, it is Government/Administration responsibility to apply the appropriate water policy in order to cope with the effects of drought.

Legal arrangements

The interviewee believes that the Law 3199/03 adopts basic rules for the rights of water permit. Presidential Decrees, which are provided in Articles 12 and 15 of the Law, are necessary for a more detailed approach of the water policy. According to the interviewee, no compensations are predicted by the Law 3199/03 in case of drought. The interviewee also believes that there is sufficient participation by all sectors affected by drought in the National Council of Waters and the Consultative Committee of Waters. However it should be stated that these bodies are only consultative. The interviewee admits that there is no formal procedure in Greece to declare a "drought situation".

Priorities and measures

According to the interviewee, in the case of drought, highest priority for the water supply should be given obviously to the environment which requires preservation of its biodiversity and secondly to domestic use. Lowest priority should be given to the recreational use of water which is of secondary importance. During periods of water scarcity, the following measures were adopted especially for dry islands: construction of additional desalination plants and water transfer. In the framework of proactive measures, the Ministry finances municipalities for the construction or improvement of water supply systems.

As already mentioned, in drought periods the Ministry also finances the construction of additional desalination plants and water transfer. Local water supply companies are making suggestions to the public for the control of wasteful use of water. According to the interviewee, the most important measures to be carried out for the management of drought are those acceptable by the public, i.e. measures aiming towards the improvement of the efficiency of the water supply systems for all uses. All the other measures (reallocation, reuse, desalination, transfer, etc.) should be carefully studied as alternative scenarios within the framework of the integrated management of water resources.

Economic analysis

The interviewee expressed the opinion that it is theoretically possible to treat water in a way similar to other natural resources (oil, gas, etc.) but water is primarily a social good and secondary an economic one.

Ministry of Agriculture – Hellenic Agricultural Insurances

The Hellenic Agricultural Insurances Department of the Ministry of Agriculture is the domain responsible for all compensations concerning the irrigation farmers. The policies followed are promoting the development of agriculture, the competitiveness of products and the restructuring of the countryside.

Perception of drought

The interviewee – director of the branch of Patras – perceives drought as an extended deficiency in water caused by lack of precipitation in a particular area. The interviewee believes that man can significantly limit the consequences of drought by applying an appropriate planning, organization and a national policy of drought confrontation that will control the malign consequences.

The interviewee believes that the agricultural production of non-irrigated crops is exclusively dependent of precipitation and for the irrigated crops any pause of irrigation can be disastrous. Therefore, he considers that the domain most affected by drought is agriculture, whereas domestic use is not that sensitive as their priority is always given and a provision for water reserves is often ensured. It is evident though, that the domain responsible to confront the drought consequences is the agriculture domain.

Ordering the factors of uncertainty that affect irrigation farmers, climate may be considered as having the highest level of uncertainty, as it cannot be controlled. On the other hand, the interviewee believes that the work market is rather insensitive to uncertainty.

Legal arrangements

The interviewee believes that the current legal framework defines clearly the rights of the water permit holders, but that compensations due to users are not clearly defined in the current legal framework.

The interviewee expressed the opinion that the agriculture sector should be better represented in the legal framework and that the groups that have the greater ability to make or influence decisions concerning the definition of water allowances are mainly the different scientific and technical chambers. According to the interviewee a "drought situation" is undefined as far as time is concerned, however it could be related to the end of the last rainfall.

Priorities and measures

According to the interviewee, in the case of drought, the highest priority for water supply should be given to agriculture, due to the fact that it is the domain most affected and also affects every other activity. The lowest priority should be given to recreational use of water. However those priorities do not correspond to the priorities that the administration defends, as the current legal framework does not prescribe this strategy.

In previous drought situations the Department followed through a pilot programme of precipitation increase in the highlands of Central Greece with the method of seeding clouds with hygroscopic substances. Unfortunately the programme was not accepted by the government. Emphasis should be given in the fact that no proactive neither reactive measures are taken by this department in order to combat drought.

The interviewee believes that the most important measure to be taken is the creation of reservoirs in order to ensure the water sufficiency. He also considers an increase in the regulation capacity for irrigation purposes as an important measure to be followed, as well as the improvement of irrigation efficiency. He regards the reallocation of water from irrigation to urban uses as an unnecessary measure as it will induce social problems.

The interviewee believes that measures acceptable by the public are the creation of reservoirs, the regulation capacity for irrigation purposes and the improvement of irrigation efficiency, whereas a measure not acceptable by the public is the reallocation of water from irrigation to urban uses. In general, more accepted are the measures concerning the creation of infrastructure and sound management principles, while less acceptable are considered the measures concerning modification in agricultural uses.

Economic analysis

The interviewee expressed the opinion that it is possible to treat water in a way similar to other natural resources (oil, gas, etc.) under the condition that the utilisation cost will be limited to low levels and will be spread according to the user's intentions. Water metering would involve a considerable number of users and could possibly reduce the total consumption.

A negative effect for buying and selling water is that the consumption would be disproportional to the real needs of each user, and that the users to be aggrieved would be the ones whose needs would be the greater, and particularly the irrigation farmers. The establishment of water banks is considered to be a necessary measure, but it should be governed by a well-planned water management and utilization rule and its application should be very well monitored.

Greek Committee for the Water Resources Management

The Greek Committee for the Water Resources Management is a non-governmental organization, which is active in the water resources management sector. The association has some five hundred members.

Perception of drought

The interviewee – president of the Committee – perceives drought as a natural phenomenon which

occurs from time to time and belongs to what we call climate variability. Drought has three major dimensions namely the intensity and duration and the affected area.

Although there are several definitions of drought depending on the parameter considered, the interviewed believes that the principal parameter is precipitation. All other parameters, e.g. runoff, water stored in reservoirs, etc., can result from processes involving precipitation. Drought should not be considered as exhibition of aridity and is not directly related to high temperatures which can occur during summertime causing loss in yield of many crops.

Legal arrangements

The legal system is not sufficiently comprehensive for the coverage of people against drought. Even in the Law 3199/03, which was approved recently by the Greek Parliament there is nothing concrete on drought preparedness of the country. Obviously various supplements (e.g. Presidential Decrees) to the existing law can be approved in order to fulfil the need for combating drought.

Priorities and measures

Reviewing the Greek operational system for water resources management it can be concluded that there are several measures which are taken in case of drought occurrence. However it seems that apart from some general guidelines issued by the responsible ministries, the organizations involved in water management on a national level react in a rather independent way.

Water restrictions are usually imposed on domestic water consumption whereas agricultural water use is difficult to be restricted due to various reasons (e.g. lack of measurements in water delivery, risk for destroying the crop yield, etc.). This is a rather erroneous approach given that 85% of the water is consumed in the agricultural sector. It is obvious that a more systematic and competent centralized system is needed which can then be customized for each area of the country separately.

Another great weakness of the country's system to combat drought is the fact that there is no infrastructure, no systematic monitoring, no scientific analysis of drought and no insurance of the people in the case of drought occurrence.

Strengths and weaknesses of the current structure

In this section we analyse the main strengths and weaknesses of the institutions and organizations presented above as well as the general policy of the country. We will have to point out that no specific model for confronting drought and its consequences exists in Greece and therefore we could not include a section on the validation of the mental model.

It is understandable that the interviewees face the drought phenomenon and the corresponding results from their interest and the interest of the people they represent. Obviously the big majority of people agrees that recreational uses (e.g. pools, fountains, etc.) have the last position hierarchically in the list of uses. However, according to the Law 3199/03, municipal water consumption is considered as the first priority by the authors and the majority of people involved. Regarding the other uses, there are specific interests in each area, which to some extent define the priorities.

The main *strengths* of the Greek institutional framework that stand out from the above analyses are:

(i) A NDBHMI has been established. Various software applications are linked to the central database of the NDNHMI supporting the analysis and synthesis of the data and the elaboration of secondary information. A GIS subsystem was developed to support the spatial analysis of hydrological data.

(ii) There are sufficient socio-economic data concerning water users, with the exception of incomplete information on farmers and irrigation water.

(iii) According to the existing situation, all institutions involved in drought preparedness and

mitigation, have a good experience concerning recent drought episodes. Although there are no specific plans for drought mitigation in Greece, many government and other institutions are dealing with the effects of drought in a case to case basis.

(iv) There is a sufficient number of reservoirs that are being used in drought situations and therefore the water reserves of the country are well managed.

(v) The domain of agriculture seems to have enough influence with the government and whenever irrigation farmers are affected by drought, the pressure exercised on the authorities has good results in order to combat drought.

(vi) The Law 3199/03 has been recently adopted. According to this law, all sectors affected by drought are represented in the National Council of Waters and the Consultative Committee of Waters.

The main *weaknesses* of the Greek institutional framework that stand out from the above analyses are:

(i) Up to now there is neither insurance nor compensation policy provided by the legal framework for the rain fed or irrigated agriculture.

(ii) No systematic monitoring of drought occurrence and regional extent has existed in Greece in the past. This work will be hopefully carried out by the commissions instituted according to the Law 3199/03 on "Water Resources Management".

(iii) In the past, decisions concerning droughts were taken in a case to case basis. This approach is considered unsatisfactory and it is therefore necessary to elaborate a plan for drought mitigation, based on the structures described in the Law 3199/03 on "Water Resources Management". The only conclusion regarding the case by case action against drought is that it is an indication of local creativity and the readiness of the local organization to act independently and find quick and acceptable solutions.

(iv) Up to now, there are no complete water right-holders' records. Only a small part of users are holding a water permit in Greece.

(v) Up to now there is a lack of information concerning the consumption of irrigation water by individual farmers.

(vi) Although there are institutions and organizations with experience on the subject, there is no coordination among them and there is no managerial policy in a higher level from a central administration.

(vii) In Greece, little research was carried out in the past for defining droughts for different sectors of the economy, i.e. agriculture, power production, domestic use, etc. Similarly drought indicators have not been examined with respect to their feasibility on Greek conditions.

(viii) There are no drought indicators or any other scientific objective indices used in order to call crisis situations.