Cyprus

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SUMMARY – Droughts are a recurrent characteristic of the Cyprus climate, and in recent years they have become more frequent and more severe, lasting for longer periods. The repeated drought events, combined with the depletion of the aquifers, are causing acute water shortages, affecting the social life of the country, its economy and the environment. With the available natural water resources almost fully developed while water demand continues to increase, the vulnerability of Cyprus to the drought phenomena shall increase even further. Although the existing institutions are well placed and have all data and information for an effective management of the water resources even under drought conditions, the lack of legislation, the lack of scientific definition of drought, the inexperience of risk analysis, and of drought mitigation in general and the lack of preparation of proactive drought mitigation plans, all lead to the preparation of reactive plans whose implementation in the long term creates more problems and leads to more acute water shortage conditions. The Agricultural Insurance Plan is not universal. It covers meteorological drought impact events only in rain-fed cereals and dry-land forage crops. Cyprus is in need of proactive drought preparedness plans and these require the appropriate legal framework, defining among others the institutions responsible for drought mitigation and the know-how to prepare such plans. The MEDROPLAN project offers Cyprus the opportunity to acquire the know-how for the preparation and implementation of the appropriate legal framework for setting up the system for drought mitigation and for the preparation of proactive drought mitigation plans.

Key words: Drought, legislation, management.

RESUME – *"Chypre". Les sécheresses sont une caractéristique récurrente du climat de Chypre, et lors des dernières années elles sont devenues plus fréquentes et sévères, s'étendant sur des périodes plus longues. Les évènements répétés de sécheresse, combinés avec la diminution des nappes aquifères, provoquent de fortes pénuries d'eau, et affectent la vie sociale et l'économie du pays, ainsi que l'environnement. Avec le développement quasi total des ressources hydriques naturelles disponibles tandis que la demande en eau continue de croître, la vulnérabilité de Chypre aux phénomènes de sécheresse ne cessera d'augmenter. Bien que les institutions existantes soient bien placées et possèdent toutes les données et informations pour une gestion efficace des ressources en eau y compris en conditions de sécheresse, l'absence de législation, de définition scientifique de la sécheresse, le manque d'expérience en analyse des risques et en atténuation de la sécheresse en général, et la non-préparation de plans proactifs d'atténuation de la sécheresse, entraînent la préparation de plans réactifs dont la mise en place à long terme crée encore davantage de problèmes et mène à des conditions encore plus sévères de pénurie d'eau. Le Plan d'Assurance Agricole n'est pas généralisé, et ne couvre l'impact des évènements de sécheresse météorologique que pour les céréales non irriguées et les cultures fourragères en terres sèches. Chypre nécessite des plans proactifs de prévention de la sécheresse, qui requièrent un cadre légal approprié, définissant entre autres les institutions responsables de l'atténuation de la sécheresse, ainsi que le savoir-faire nécessaire à la préparation de ces plans. Le projet MEDROPLAN permettra à Chypre d'acquérir le savoir-faire nécessaire à la préparation et mise en place d'un cadre légal approprié pour instaurer un système d'atténuation de la sécheresse et pour la préparation de plans proactifs d'atténuation de la sécheresse.*

Mots-clés : *Sécheresse, législation, gestion*.

Introduction

Cyprus being one of the most drought prone areas in the Mediterranean area, with frequent droughts of high severity and long duration has great experience on drought management. The author of this chapter has been involved in the preparation and execution of drought mitigation plans in Cyprus during the last 30 years when the worst of the drought events occurred.

Data and information systems

For the preparation and implementation of water development and water management plans, including drought management plans, it is necessary to collect, record, process and provide accessibility to a number of variables of biophysical and socioeconomic nature. Table 1 outline the type of data, the institutions that collect, record and process the data, how the data is acquired, the accessibility, the data reporting and the data users. As it is seen on Table 1 most of the information and data on drought can be acquired by request from the departments that collect and use it, where a smaller portion can be required from published statistics or census reports.

Legal framework

Existing legal framework

The legal framework in Cyprus has been enacted during the colonial era (1928-1950) and still remains in force by virtue of the provisions of Article 188 of the Constitution of the Republic of Cyprus, which got its independence in 1960. Additions and modifications were made to the legislation since then to take account of changes, new developments and trends, but these are very limited. The existing legal structure and content in relation to water development, management and distribution is described below.

Water ownership

Water in Cyprus is a public good and the Constitution of the Republic of Cyprus vests all powers for the management of this resource to the Council of Ministers. The ownership of the water resources at the time of the implementation of the main legislation, which is still valid, was defined as follows thus respecting private use or ownership:

(i) Groundwater ownership: all groundwater not brought to surface before 1928 (the year the Government Waterworks Law was enacted) is vested to the Government, which is acting through the Council of Ministers. Since by that time the water quantities that were brought to the surface were very limited this means that almost all groundwater belongs to the State.

(ii) Surface water ownership: all surface water running to waste at the date the law was enforced and all wastewater resources running to waste are vested to the Government, which is acting through the Council of Ministers. Since at the time the law was enacted not much water was diverted or used almost all-surface water came under the ownership of the State.

(iii) Private water rights protected: the water rights of any citizen, physical or legal are protected and riparian rights are given to those who can prove that they are entitled or own such rights. The laws have special provisions and procedures for identifying and evaluating water rights, and recognize water rights given by "firmans", or titles, or court decisions, or for continuous use for a period of at least 30 years before 1946, the time the Immovable Property Law was enacted. Water rights can be purchased by anybody or acquired and compensated by the Council of Ministers for the public interest. Firmans are deeds issued by the sultans during the Ottoman Empire to privates, indicating that these individuals were given water rights on a specific water source, surface or underground. The Republic of Cyprus recognizes the firmans as titles of water ownership.

According to the Government Waterworks Law, access to any water is given to any individual for abstracting water for his own personal use, i.e. for drinking and washing purposes. The amount of water that can be taken is all that can be carried in the palms of the hands.

Table 1. Characteristics of the biophysical and socio-economic data and information in Cyprus

Type of data	Data and information system description
Climate	Supplier: Meteorological Service Governmental Office. Acquisition: meteorological stations manned or unmanned spread all over the island. Data collected include precipitation, temperatures (min., max., average), humidity, wind velocity, evaporation, solar radiation, etc. Accessibility: hard copies, free of charge. Reporting: not published. Data kept in database files in soft or hard copies. Users: Civil Aviation, Department of Water Development, Dept of Agriculture and other organizations
Soils	Supplier: Department of Agriculture. Acquisition: surveys and investigations, soil type, soil potential, soil classification. Accessibility: purchase of maps from Land and Surveys Department. Reporting: on maps by the Land and Surveys Department. Users: Department of Agriculture, Town and Rural Planning Department, farmers, others
Water	Supplier: Water Development Department. Acquisition: continuous measurement of stream-flow and water levels in aquifers. Accessibility: official request to the Water Development Department. Hard copy and in some instances in digital form. Reporting: not published. Data kept in database files in soft or hard copies. Users: Water Development Department
Land	Supplier: the Land and Survey Department is responsible to register all lands in Cyprus. Acquisition: compulsory registration of land ownership. Accessibility: purchase of the land registry maps. Reporting: land registry maps. Users: Government offices and individuals
Agriculture	Supplier: Department of Agriculture, Department of Statistics. Acquisition: surveys, census and investigations. Accessibility: purchase of agricultural statistics publications of the Department of Statistics from Government printing office. Reporting: six monthly, yearly statistics. Users: Government Offices and others
Water supply and use	Supplier: Water Development Department. Acquisition: continuous measuring of sales of water to communities and individuals. Accessibility: requesting data. Reporting: hard copy upon request. Users: Water Development Department
Land use	Supplier: Department of Agriculture. Acquisition: land use surveys or by agricultural census. Accessibility: purchasing of census reports or agricultural statistics reports from printing office. Reporting: annual statistic reports or census reports. Users: Department of Agriculture, Water Development Department, Land Consolidation Department
Water demand	Supplier: Water Development Department. Acquisition: measuring consumption by various users. Accessibility: requesting data. Reporting: hard copy upon request. Users: Water Development Department.
Economic indicators	Supplier: Department of Statistics. Acquisition: Department of Statistics on a regular basis. Accessibility: purchasing economics statistic publications from government printing office. Reporting: official government statistic publications. Users: Ministry of Finance, Economic and financing planners in general
Demographic indicators	Supplier: Department of Statistics. Acquisition: Ministry of Interior Vital Statistics Department. Accessibility: by purchasing demographic and population statistics of the Department of Statistics from the printing office. Reporting: hard copy. Users: economic and social planners

Powers of the Council of Ministers to develop and allocate water resources

Since the Council of Ministers is the owner of almost all the natural water resources on the island the existing legislation gives to the Council of Ministers the following powers:

(i) To manage, protect and conserve the natural water resources, and to plan, design, construct, manage, operate and maintain waterworks and the water resources and sell water at a price approved by the Parliament.

(ii) To allocate and reallocate the water resources according to the existing water availability and the needs provided the existing water rights are satisfied. Originally the allocation of water from a project is made at the planning stage by defining the perimeter of the area to be benefited from the project. However this does not mean that the water users obtain legal rights on the water, which continues to be the property of the Government, and the Council of Ministers has the right to manage this at its discretion and for the public interest especially under drought conditions. There are no pre-established rights for use of water under drought conditions and there is no law explicitly defining any priorities. Priorities are decided when water shortage occurs. Of course certain rules are followed aiming at making the reallocation just and acceptable.

Rights of natural or legal bodies to use public water

Although almost all water resources belong to the Government the legislator has given the right to individuals to develop and use surface or groundwater water for their own needs, i.e. for irrigation, domestic, industrial or other uses. It has also provisions allowing to legal communal entities to develop and sell or use water. In all cases, the issue of permits for the development and use of water is governed by specific laws administered by government bodies such as the District Administration. Specifically the laws provides for the following:

(i) Give the right to private individuals or to legal bodies to sink or construct wells or drill boreholes, for groundwater abstraction for own or public use for drinking, gardening, irrigation, industrial or other use, provided they get a permit from the appropriate authority.

(ii) Give the right to owners of land to form Irrigation Divisions to construct irrigation works for using water from boreholes or from rivers or from reuse schemes. Irrigation Divisions are formed by at least ten persons who own a minimum area of land.

(iii) Give the right to communities, villages and towns to form Water Commissions for securing their domestic water supplies from boreholes, springs, from dams or from any other sources including non-conventional water sources.

(iv) Give the right to town or villages to form Water Boards for the development, treatment, distribution and sale of potable water for domestic and industrial uses. The selling price of the water is fixed by the Council of Ministers and approved by the Parliament.

(v) Give the right to town or villages to form Sewage and Drainage Boards for the collection, treatment and disposal of sewage effluents and drainage water. According to the relevant law the wastewater collected and treated by the sewage systems belongs to the Boards and they can dispose it accordingly, provided they comply with the environmental laws and regulations.

Rights of water owners to develop and use their water

The laws also provide for the development and use of privately owned water resources. For this purpose a special law titled "Irrigation Associations Law", gives the right to individuals or legal bodies, who own water rights, to form Irrigation Associations and construct, maintain and operate irrigation works for the development and use of their water. Only persons or legal bodies who own water rights, by title, or otherwise recognized by the laws can form Irrigation Associations.

Water rights protection and rights of Council of Ministers

Water rights are protected but the Council of Ministers has the right to expropriate such rights and provide compensation for the public interest. So in areas where government waterworks are planned

the Council of Ministers has the right to appoint the water commissioners with the specific duty to identify, evaluate and register in a register any existing water rights. For this purpose the commissioners have the right to carry out surveys and investigations and to make inquiries. In case the Government expropriates the water rights the owners are compensated accordingly.

Rights and obligations of the Director of the Water Development Department

The Water Development Department (WDD) is a technical Government department belonging to the Ministry of Agriculture, Natural Resources and the Environment (MANR&E) responsible for the management of the water resources, usually acting under the directions of the Council of Ministers. Accordingly this Department is given some rights and obligations as follows:

(i) The Director of the WDD has the right to carry out surveys for identifying and estimating any existing water rights for a specific water project work before the project is executed. Private water rights are registered as an immovable property and if for public interest these are acquired the owners are compensated accordingly.

(ii) The laws give the right to the Director of the WDD to refuse the issue of a building permit for the construction of any structure in areas within the hydrological catchments of a project if the construction is likely to affect the water resources in the catchments, both qualitatively and quantitatively.

(iii) The laws give the right to the Director of the WDD under certain circumstances, to enter private property for carrying out surveys for the study and execution of water development projects.

(iv) The laws give the right to the Director of the WDD to refuse the issue of a permit for the sinking of well, or borehole in an area under the Special Measures Law, if such borehole or well shall affect qualitatively or quantitatively the groundwater resources.

Environmental issues

Environmental issues on water are covered by Law No. 69/91 – "Water pollution control" – and other relevant laws, which provide for the reduction, control and abolition of water pollution for the best protection of the natural water resources and the health and the well being of the population.

Main laws

Government Waterworks Law (Cap. 341)

This is the most important law on the management of the water resources of Cyprus, which was first enacted in 1928 by the then British Colonial Government. This law was revised many times after 1960 (year of Cyprus independence from the British rule), but its basic structure and philosophy was not changed. Generally this law governs more than 98% of the natural water resources of the island and it vests all free surface water, running to waste and all groundwater (not so far brought to the surface) to the State and empowers the Council of Ministers to plan, design, construct, operate and maintain any waterworks and to sell water at a price calculated according to provisions of the law and at the approval of the Parliament. It does not provide anything on drought but provisions of the law give powers to the Government to deal under emergency situations including drought.

Wells Law (Cap. 351)

The basic law gives the power to the District Officers to issue permits for the sinking or construction of wells or drilling of boreholes for the abstraction of ground water. This law was partly improved by the Water Supply (Special Measures Law) Law of 1964, which gave to the Government the power to declare and define special measure areas for groundwater protection against overexploitation. Under the Special Measures Law the Director of the WDD is empowered to refuse the issue of a permit for the sinking or construction of wells or drilling of boreholes for the abstraction of ground water if such action is to affect qualitatively and quantitatively the groundwater. This law is the second most important law and the first most important law dealing with protection of the groundwater.

Irrigation Division (Villages) Law (Cap. 342)

This law is administered by the respective District Officer who is empowered to form Irrigation Divisions, at his own instance or upon the written request of not less than ten land proprietors, for the purpose of carrying out irrigation works. Under this law the water and the waterworks are linked to the land and not to the proprietors. This law is the third most important law and widely applied for the construction of minor irrigation schemes. The Government promotes the construction of simple, small irrigation project through this law by providing subsidy to the capital cost and for the maintenance of works constructed under this law. Committees elected by the members of the Irrigation Division govern the Irrigation Divisions. The law defines that the chairman of the committees governing the Irrigation Divisions shall be the District Officer or his representative. The committee is responsible for the construction, maintenance, operation and management of the irrigation scheme including the selling of water and collecting the bills. The selling price of water is fixed by the committee and approved by the District Officer.

Irrigation (Private Water) Association Law (Cap. 115)

This law is basically the same as the previous law with the basic difference that the proprietors must have water rights. The Government policy is not to promote the development of privately owned water rights and for this purpose it limits the subsidy on such waterworks. Committees elected by the members of the Irrigation Association govern the Irrigation Associations. The law defines that the chairman of the committees governing the Irrigation Associations shall be the District Officer or his representative. The committee is responsible for the construction, maintenance operation and management of the irrigation scheme including the selling of water and collecting the bills. The selling price of water is fixed by the committee and approved by the District Officer.

Water Supply (Municipal and Other Areas) Law (Cap. 350)

This law provides for the creation of Water Boards for the towns or villages of Cyprus under the chairmanship of the District Officer. This law allows the creation of semi-governmental organizations responsible for the development, treatment, distribution, and selling of potable water within the boundaries of inhabited areas fixed by the Council of Ministers, for domestic and industrial purposes including tourism and recreational. Boards made up from elected representatives appointed by the village or town boards participating to the Water Board and three members appointed by the Council of Ministers govern the Water Boards. The Board is responsible for the construction, maintenance, operation and management of the water supply scheme including the selling of water and collecting the bills. The selling price of water is fixed by the Council of Ministers and approved by the Parliament.

Water (Domestic Purposes) Village Supplies Law (Cap. 349)

This law provides for the creation of village water commissions for village water supply. The District Officer administers this law, and all requests for studies and construction of water works are submitted to the Water Development Department, which designs and implements the water projects. The responsibility for the management, operation and maintenance of the small schemes is with the village water commission headed by the District Officer.

The Sewage and Drainage Law

This law provides for the creation of Sewage Boards for the collection, treatment and disposal of sewage effluent and drainage water (flood) from areas defined by the Council of Ministers as "Sewage and Drainage Law Areas". The Sewage Boards are responsible for the planning, design, construction, operation and maintenance of all works required. Boards made up from elected representatives appointed by the village or town boards participating to the Water Board and are chaired by an elected member. The Board is responsible for the construction, maintenance operation and management of the sewage schemes including the collection of the bills for the services offered. The service cost charged to the beneficiaries is made up of two components, the fixed cost, which represents the capital cost and the variable cost, which represents the maintenance, operation, energy and management costs.

Water Pollution Control Law (Law No. 69/91)

The law provides for the abolition or reduction and control of water pollution in Cyprus, for the best protection of the natural water resources and the health and well being of the population. It also provides for the protection and improvement of the environment and the animal and plant life in water. It defines "what is waste" and vests power to the Minister of Agriculture Natural Resources and the Environment to control the disposal of wastes into the water environment, surface or underground and on the ground or underground. For this purpose a Technical Committee is established which advises the Minister on quality standards. The law contains provisions for the protection of the natural water sources from the disposal of wastes and the pollution of water from industrial and domestic sources of pollution and wastewater treatment plants. The Council of Ministers and/or the Minister of Agriculture, Natural Resources and the Environment may issue regulations, for the declaration of certain areas of environmental importance, forbidding the disposal of pollutants. The Minister of Agriculture, Natural Resources and the Environment and the Minister of Social Insurance and Labour may issue permits for the disposal of wastes or treated wastes defining the method, the quantities, the frequency of disposal, the location and the contents of pollutants, etc. The Ministers may also appoint "inspectors" for the examination of applications and the enforcement of conditions and control of the permits. Pollution of surface or groundwater is a criminal offence and people found guilty are subject to a fine up to 17,000 € and/or to imprisonment up to one year.

Agricultural Insurance Law

This law, which was established in 1978 provides for the compulsory insurance of deciduous fruits against losses due to hail, frost and windstorm and due to rain only on cherries at ripening stage, of grapes against losses due to hail, frost and heat waves, of citrus against losses due to hail, frost and windstorm and due to "water spot" only on "local and clementine" mandarin varieties, of cereals against hail, drought and rust, of dry-land forage crops against drought and hail, of potatoes against hail, frost and flooding, of beans against hail, frost, flooding prolong rainfall and hot dry wind and of artichokes and loquats against hail and frost. The premium paid by the farmers equals to 3% of the total crop value and is the same for all crops covered by the scheme. The insurance is public and the Agricultural Insurance Law defines the premiums. The Government subsidizes this premium with an amount equal to the amount of premiums paid by the farmers. The ultimate aim of the organization is the gradual improvement and expansion of the legislation and the formulation of an integrated insurance scheme, which shall cover the main crops against all the major calamities.

Legal framework under consideration

Because the existing legislation is considered inadequate to deal with the new conditions and challenges on the water resources management in relation to the socioeconomic and environmental needs with respect to the European requirements and vision and the new approaches related to the integrated and sustainable management, a new law is under consideration. This law provides for the creation of a water entity, within the Government, to undertake the management of the water resources of Cyprus all in accordance with the integrated water resources principle and taking into consideration the EU Framework Directive.

European Water Framework Directive

At the time of drafting this Work Package Cyprus is preparing to join the European Union. Specifically next May Cyprus is officially becoming a member of the European Union and accordingly it has to adopt the European Water Framework Directive. According to the decisions taken, due to its size (only 9125 square kilometres) the whole of Cyprus shall be considered as one basin and it is already mobilized to carry out the necessary studies related to the protection of the natural water resources.

Under the European Water Framework Directive there are no additional laws dealing with water resources management except those related to environment and the new Framework Directive of the European Union adopted by the Government of Cyprus. There are no any laws or regulations relating to proactive or reactive drought policies.

Modifications of the Agricultural Insurance Law

The farmers usually do not obtain any other insurance against any hazards, except the one provided by the Agricultural Insurance Law.

The existing insurance scheme does not cover against losses due to drought, with the only exception of the cereals and dry-land forage. During the period 1978-2000 the farmers paid premiums amounting to 53.32 million € and the total amount paid by the organization as compensations to the farmers was 103.2 million €. Totally, the Government subsidy to the organization during the same period amounted to 67.6 million €, of which 30.8 million € were allocated during the drought period 1996-2000.

Need for further legal development

Although Cyprus experienced very acute water shortages due to repeated droughts, no attempts were made to introduce new legislation on drought mitigation. A few measures through legislation were promoted to the parliament, one for enforcing the prohibition of use of hoses for car cleaning, which was approved, and the second legislation providing for the installation of separate plumbing systems within the houses for enabling the use of second quality water for sanitary purposes and for the installation of separate waste-water collection systems enabling the collection of the grey water for treatment and reuse at the house level. The Parliament did not approve yet the second bill.

The updating, revision and/or totally new water legislation, taking into account the new trends in water management (water demand oriented), the recently approved European Water Framework Directive and the directives on the environment, were on the agenda of the various Governments since the 1960's. During 2002 a new legislation was drafted and approved by the Council of Ministers and then submitted to the Parliament for approval. This new legislation, which is not yet approved by the Parliament due to differences between the parties in the Parliament, provides for the creation of a water entity, within the Government, to undertake the management of the water resources of Cyprus all in accordance with the integrated water resources principle and taking into consideration the EU Framework Directive. However the new law does not deal with the preparation of drought mitigation plans.

Water resources and drought management plans

The WDD of the MANR&E is responsible for formulating and, after approval by the Government, executing the Government's overall policy on water resources management (planning, design, construction, operation and maintenance of the projects and the management of the water resources). Plans, designs and policy proposals are prepared by the Water Development Department, which are then submitted to the MANR&E and after approval is secured from the Council of Ministers they are implemented.

The financing of the Government waterworks, the Irrigation Division projects, the village water supplies and the town water supplies are made either through Government funds or through loans from international financing institutions such as the World Bank, the Kuwait Fund or the European Investment Bank. In case of sewage projects constructed by the Sewage Boards or for works carried out by the Water Boards the plans are prepared and implemented by the respective organizations, and their financing is done by the organizations themselves. Generally the Water Development Department, although no legally defined as the administrative authority for water resources management, acts like one, carrying out water resources balance for each project including water availability evaluation (surface and groundwater) and water demand evaluation, keeping water resources inventory and to some extent exercises control over the surface water supplies and the ground water abstraction.

Structure of the institutions, organizations and stakeholders

Water administration relates to all non-physical measures taken to provide beneficial, efficient and

effective use of water resources and prevent harmful effects. Such measures include legislation, which has been dealt in the previous section and the institutional arrangements (organization), required for implementing the laws.

In the document non-physical includes non-material, spiritual, moral, mental measures, as opposed to structural measures, such as the ones related to staff, buildings and works. Water stakeholders are people, legal entities or institutions that hold any interest in the water resources. Users are people or entities that continuously use water, or deal with water management and development.

The organization map linking all relevant institutions, organizations and stakeholders representing the existing arrangements (as depicted in the relevant laws) for water resources administration is shown on Fig. 1. The map shows three levels of activity, i.e. the policy level, the executive level and the water users level.

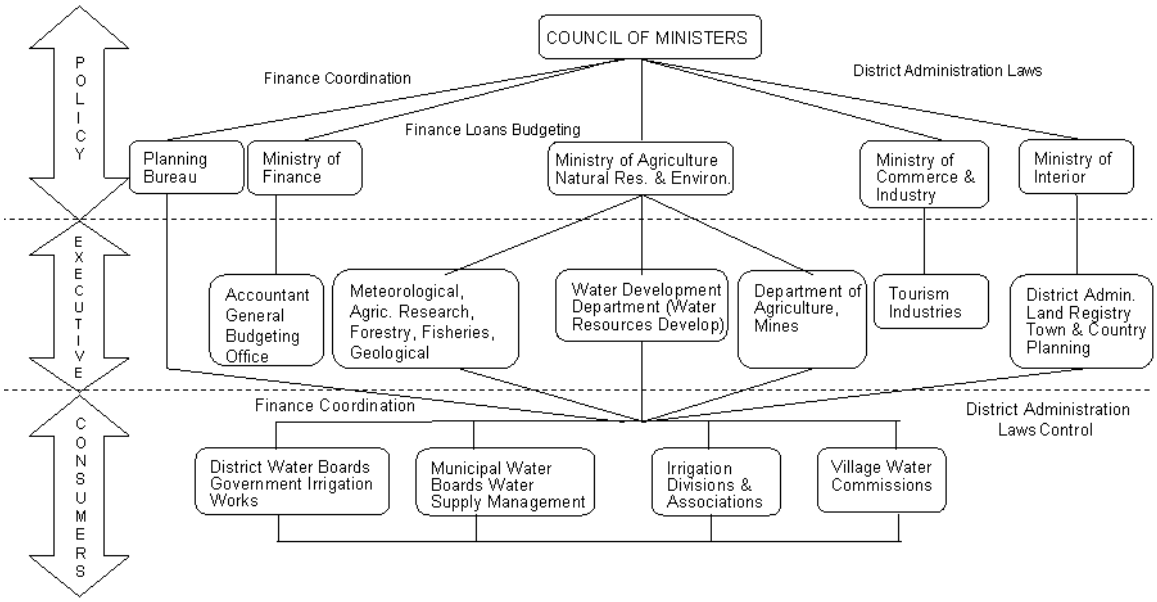

Fig. 1. Cyprus water resources management organization.

The institutions involved in drought preparedness and drought management are the same involved in the water resources management, but they are engaged in different actions for meteorological and hydrological drought preparedness planning and mitigation. This separation is made because meteorological-agricultural drought is faced mainly within the context of the agricultural insurance scheme, where the hydrological drought is faced by a more complex setup of departments and organizations. A complete description of agricultural and hydrological drought management is included in the following sections.

Policy level – The Council of Ministers

The ultimate responsibility for all policy on water resources management and administration is with the Council of Ministers made up of eleven Ministers and joined by various independent services such as the Attorney General, the Audit Office and the Planning Bureau. In formulating the water policy four ministries are involved, being the MANR&E, the Ministry of Interior, the Ministry of Finance and the Ministry of Commerce and Industry. The Planning Bureau is the coordinator of all development projects. The MANR&E provides the technical support through the Departments of Water Development, the Geological Survey, the Agriculture and other departments such as the Meteorological Services, the Fisheries Department, and the Agricultural Research Institute, etc. Through the Department of Agriculture and the Agricultural Research Institute it also provides the

services for better use of the irrigation water. The Ministry of Interior supervises the local government such as municipalities, and villages who manage the water supply and water distribution services both for domestic and irrigation purposes. The Ministry of Commerce and Industry deals with water for industries and tourism, where the Ministry of Finance provides the financing for the execution of the waterworks. The Attorney General is the legal adviser to the Council of Minister and to the departments dealing with the management and administration of the water resources.

Executive level – Water Development Department of the MANR&E, and the Ministry of Interior

Responsibilities for water administration at the executive level are primarily divided between the MANR&E and the Ministry of Interior. The MANR&E through the Water Development Department, a competent technical organization, formulates the water resources development policy. This department is responsible for formulating and executing the Government's overall policy on water resources planning, design, and construction on the island. It also operates and maintains most of the Government waterworks and gives advice to other local organizations with regard to the operation, maintenance and management of local projects. Other Departments of the MANR&E are the Department of Agriculture and the Agricultural Research Institute, closely concerned with the efficient and effective use of irrigation water, and the Geological Survey Department dealing with ground water surveys and investigations. The Ministry of Interior has the legal power, mainly through the District Officers, both at the executive and the water user levels, dealing with the supervision of the administration of the Town Water Boards, the Irrigation Divisions, the Village Water Commissions, and the Town and Village Sewage Boards, carried out by committees poorly elected and poorly appointed by the Government.

User level – Water Boards and Unions

At the water user's level we have the Water Boards, that manage the distribution of town water supplies and are semi-governmental organizations, the Improvement Boards and Village Water Commissions that manage the domestic water supplies in small towns and villages, the Municipal Water Supply and Sewage Boards that manage the town water supplies and town sewage collection treatment and disposal and are chaired by the town Mayor, and the Irrigation Divisions and Associations that manage the irrigation water supplies to small irrigation schemes and are chaired by the correspondent District Officer of the Ministry of Interior. Other organizations at the water users level are the Waterworks Committees that manage some of the Government waterworks for the supply of irrigation water (mainly local projects) and are chaired by the correspondent District Officer of the Ministry of Interior, the Major Waterworks Division (Irrigation) of the WDD that undertakes the management operation and maintenance of the major irrigation projects supplying irrigation water to the farmers and the Major Waterworks Division (Domestic) of the WDD that undertakes the management operation and maintenance of the governmental domestic water supply systems (water conveyance pipelines, water treatment plants, desalination plants, etc.) which deliver domestic water to Water Boards, Village Water Commissions and other organizations.

In addition to the above there are the farmers unions, that take care of the farmer's interests including the supply of irrigation water, the environmentalist organizations (governmental and non-governmental) which look after the interests of the environment. Cyprus does not use water for power production, where the use of water for industrial purposes is very limited.

Hydrological drought management

Although Cyprus is frequently hit by drought phenomena, droughts in most instances are faced as crisis management phenomena under the General Disaster Laws. In the case of extreme drought, the Government mobilises in a proactive manner but all its actions are reactive in nature as explained below. The proactive plans are not implemented unless the situation is really very bad, i.e. the population already feels the drought effects and the adverse effects are already occurring.

The proactive action plan, not envisaged by any law, but developed by the WDD during the recent droughts, is materialized through the following steps covering mostly the water scarcity problems. Figure 2 outlines the drought mitigation proactive steps.

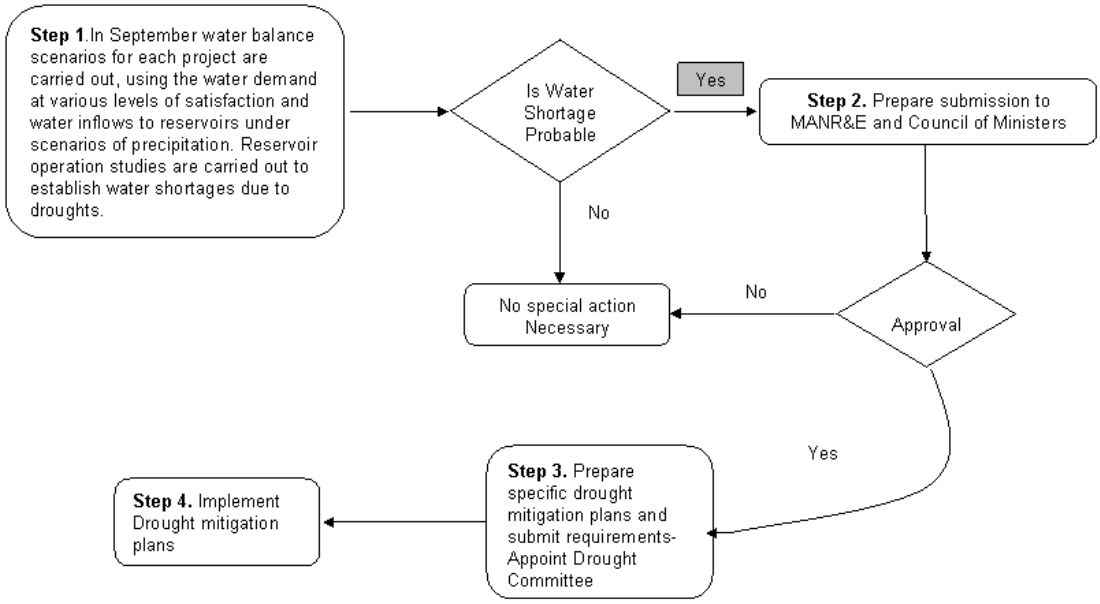

Fig. 2. Drought mitigation proactive plan steps undertaken by the WDD in Cyprus.

Step 1: Evaluation. Early in September the WDD prepares the water balance sheet for each project based on the projected water resources available by the end of the year, the projected water inflow to the dams and to the aquifers during the coming wet season (October-May) and on the projected demand for the next year. Different scenarios are developed for different inflows and different levels of demand satisfaction.

Each water balance sheet, presenting one scenario depicting a different situation is a spreadsheet containing for each project the available water sources (groundwater, surface, reuse and desalinated water) and the water demand (domestic, irrigation, industrial and environmental). The water balance is made for a period of at least one year starting in August-September and ending in December next year. Each balance sheet contains the available water quantities at the start of the period, and the estimated inflows to the project as a fixed quantity for a specific scenario (four or five inflow scenarios are made).

For each inflow scenario and using as variable inputs the water demand (using again different scenarios of water demand for various levels of water demand satisfaction) and the losses to evaporation, reservoir operation studies on a monthly base are carried out for finding out what level of satisfaction for each project can be obtained. The results for each scenario are then evaluated and the scenarios are rated according to the level of satisfaction and a table of results is prepared.

A preliminary evaluation of the probability of occurrence of the different inflow scenarios is also made, which is listed on the table of results. Using the results shown on the table of results, the impacts on the economy, the social life and the environment are preliminarily outlined and suggestions are made as to the actions that must be taken. The different scenarios take into account strictly technical data (i.e. hydrological, hydro-geological, agricultural and environmental).

Step 2: Reporting. The outcome of the exercise including the balance sheet, the table of results, comments and suggestions are referred to the MANR&E for consideration. If the probability for water shortage is very high then plans are initiated to study the impacts and what to do to mitigate any adverse effects. The situation is somehow on hold until the end of January next year when re-

evaluation of the water balance is carried out taking into account the actual precipitation that occurred in the first winter months, the river-flows, the inflows to the surface and ground reservoirs, with the objective of finding out if there is any hydrological drought and how severe it is. The revision of the scenarios helps the planners to drop a number of them being out of reality because of the changes that already occurred. In parallel to this the Agricultural Insurance Organization is monitoring any developments with respect to agricultural drought, which affects mainly the rain-fed agriculture.

Step 3: Plan preparation. Based on the outcome of the revised scenarios, the most probable scenario is chosen and an action plan based on this scenario is prepared early in February, which is referred again to the MANR&E, and then to the Council of Ministers, for decisions. The plan chosen is based mainly on its projected effects and to the level of probability of occurrence. The plan includes drought mitigation measures, such as water transfer, new emergency schemes, water cuts, water reallocation, water saving campaigns, etc. For the implementation of the plan an *ad hoc* Drought Management Committee is formed which meets and examines the implementation of the proposed measures and approves the measures and the budgets on a biweekly basis or earlier if it is necessary.

The Drought Management Committee is made up from the Director General of the MANR&E or his representative as chairman, and officers from the WDD, the Department of Agriculture, the Geological Survey Department, the Ministry of Interior (District Office level), the Planning Bureau and, depending on the issue under consideration, officers from other Government organizations as members. The Committee does not include any water consumers or their representatives. To a certain extend however they are represented by the District Officers. The composition of the Committee indicates that the subjects dealt with are mainly technical and to some extent environmental. Economic and social impacts are referred to other departments or ministries, to be dealt within the general law and the Government policies.

Step 4: Plan implementation. The implementation of the Drought Plan starts in May and lasts until the end of the drought phenomena or until the effects are minimized. The Drought Management Committee does not examine applications for compensations or subsidies to persons or communities suffering from the adverse effects of droughts. Such claims are received and examined at other levels of the Government and decisions are taken by the Council of Ministers.

The funds for financing the implementation of the Drought Management Plan are provided from the Government Budget, either from previously approved funds under the heading "Damages from Drought and other Natural Calamities" or under the heading "Contingencies and Reserve", under the responsibility of the Ministry of Finance.

For the meteorological drought the Agricultural Insurance Organization mobilizes later in May-June to evaluate the damages caused by the drought and payments are made from its own resources (see section below).

In conclusion, from the above it is seen that the action to drought management is not proactive but reactive and is based not on the principle of risk management but on the principle of crisis management. The above procedure has been used in the recent droughts faced in Cyprus during the period 1990-2000.

Agricultural drought management

The institutions involved in the process for facing the meteorological and agricultural droughts are the Agricultural Insurance Organization, the Department of Agriculture, the Planning Bureau, the Ministry of Finance and the Council of Ministers. Since the existing insurance scheme covers only losses against drought from cereal and dry land forage crops, losses from the remaining crops due to drought are in many cases covered by the Council of Ministers using government funds, by using the Agricultural Insurance Organization and/or the cooperatives for transferring the funds.

The process for responding to the agricultural drought effects is reactive and involves the following steps.

Step 1: Evaluation. Upon realization of the agricultural drought effects the Agricultural Insurance Organization mobilizes by itself for the evaluation of the losses in cereals and dry land forage. For crops not covered by the Agricultural Insurance scheme the Government usually acts by itself providing compensations to the farmers. In such situations the Council of Ministers through the MANR&E gives instructions to the Agricultural Insurance Organization or the Department of Agriculture for the evaluation of losses.

Step 2: Compensation. Upon evaluation of the losses the Agricultural Insurance Organization proceeds with the payments of losses from crops covered by the insurance plan all in accordance with the valid agricultural insurance scheme. For those crops not covered by the insurance plan the procedure is quite long since it involves further considerations before a decision is taken by the Council of Ministers and the Parliament for approval of the funds.

Historical drought events in Cyprus

During the last 14 years starting in 1989 Cyprus has suffered from a number of severe droughts as shown on Table 2. In all cases, the events are initiated as meteorological droughts but very quickly they develop into hydrological droughts since Cyprus has no perennial rivers and the rivers length is very short. By studying the contents of Table 2 it can be easily concluded that drought phenomena in Cyprus are very frequent and severe since reduced precipitation in drought conditions is between 65-88% of the normal with runoff reduced from 17 to 52% of the normal runoff.

Table 2. Drought events in Cyprus in the period 1989-2000

Year	Precipitation (mm)	Percentage of average precipitation	Percentage of average runoff	Remarks
1989/90	363	68.1	18	Two year drought
1990/91	282	52.9	0	39.5% deficit on precipitation
1993/94	417	78.2	35	One year drought
1995/96	383	71.9	20	Five year drought
1996/97	399	74.9	30	24.7% deficit on the
1997/98	388	72.8	28	average per year
1998/99	473	88.7	52	on precipitation
1999/00	363	68.1	18	

Of importance is the period 1996-2000, during which the average precipitation was only 75.3% of the long-term average and where the average inflow to the reservoirs was only 24.7% of the average runoff. This shows that meteorological droughts in Cyprus quickly develop into hydrological droughts causing acute water shortages.

The relationship between precipitation and runoff is shown in Fig. 3 below, which shows the actual precipitation, expressed as the percentage of the long-term average, versus the actual reservoir inflow, expressed as the percentage of the average annual. The average annual inflow is the one calculated at the planning stage of the project, which corresponds to the average normal precipitation.

As seen in Fig. 3, the relationship is not linear due to the changing hydro-geological and other conditions prevailing in the different catchments, with runoff decreasing at a higher rate than precipitation. As an example for precipitation around 82% of the average the runoff is only 40% of the normal, i.e. for precipitation reduction of 18% from the average the runoff reduction is 60%. It is also seen from the Fig. 3 that the recorded percentage of inflows versus the recorded precipitation is not always the same but shows different percentages these being due to the time and space distribution of the precipitation as well to other parameters such as temperature, wind, humidity, etc. Although the above is not fully studied and the relationship not scientifically defined this relationship can be used to give a measure of the severity of water scarcity in the various projects.

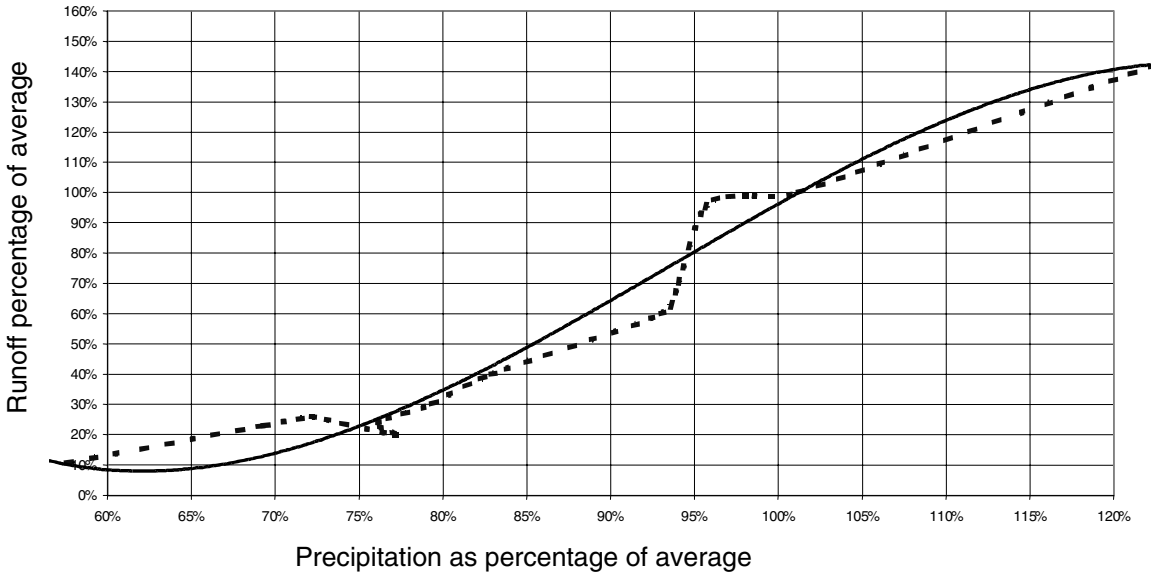

Fig. 3. Rainfall and runoff relationship in Cyprus.

Stakeholders

Five stakeholders were interviewed to validate the mental model and to enhance the understanding of droughts and water scarcity problems in Cyprus. Below is a summary of the information provided in the interviews relevant to the drought definition and understanding and to the validation of the reactive model applied in Cyprus during the period 1990-2000.

Water Development Department

This Department is the technical adviser to the MANR&E, and to the Government in general and contributes mainly to the formulation of the Government's water policy. This department is also the main contractor who, under the direction and authority granted by the Council of Ministers, undertakes to plan, design, construct the waterworks and implements in general the Government's water policy. The main insights from the interview are outlined below.

Drought monitoring

The meteorological drought usually leads to hydrological drought affecting the availability of the water resources, surface and groundwater. People sense drought by monitoring rainfall records, water availability in dams, river flows, reduction in spring flows and lowering of water phreatic levels. The department does not use particular index or indices to recognize or define droughts. The drought is recognized and alarms are set off as a result of the low rainfall, the reduced inflow to the reservoirs and the low recharge of the aquifers and generally by the observed water shortage.

The department keeps daily records of inflows and outflows from the main reservoirs, and periodic water levels in a number of boreholes in important aquifers. It also keeps records of water demand from the various projects (irrigation or domestic). The department is responsible for the major projects operation and maintenance and for the management of the water resources. It also monitors the extraction of groundwater from the aquifers. There are no legal water rights on the majority of the water since more that 98% of it belongs to the State.

Drought definition

There are no drought inceptions defined or established. The department prepares a water balance for all major projects and if sensed, either from the precipitation records or from the amount of water in

storage or river inflow or from a combination of the three, it prepares the drought management plans, which are presented to the Government for decisions.

Drought management

Mankind cannot have control over droughts or floods phenomena because they are natural phenomena, occurring in an irregular manner, affecting domestic water supplies, irrigation, etc. The factors affecting irrigation farmers are mainly climate and agricultural policies.

The Department is responsible for the implementation of the technical measures of the drought management plans. Based on the water availability it prepares allocation and rationing of the available water resources, giving priority to domestic water supply (including tourist and industrial) to permanent crops, to green houses and finally to the annual crops and to the environment.

Water use

Water users in Cyprus do not have legal water use rights or permits. All water belongs to the Government and water use rights or permits are given to communities, legal bodies or individuals on the basis of availability. The existing legal framework does not cover drought or water permits. Groups of farmers have the capacity to influence the decisions on water allocation distribution.

Agriculture is the largest consumer of water in Cyprus, with great diversity, with annual crops and permanent crops growers. The administration has largely succeeded to enforce the decisions on water allocations because it was firm, right and just and there was close cooperation with the affected stakeholders.

Although farming is very important especially for social and environmental reasons, tourism is more important from the point of view of economy.

Necessary actions

The most necessary drought mitigation measures are the implementation of water demand measures (reduce losses and leakages, improve efficiencies of use), the increase of supply (temporarily or permanently, by expediting execution of natural water projects, introduce wastewater reuse and desalination and use of lower quality water for certain uses), introduce water reallocation to meet basic needs and by raising public awareness.

The best drought plan would be a proactive plan, but this is not possible at this time due to the inadequacy of the legal and institutional setup. A mixture of proactive and reactive measures was used during the last drought events (1990-91 and 1996-2000) and they were successful but the adverse effects are still on the horizon. The WDD managed to overcome the water shortage caused by the repeated droughts but the economic and environmental sectors were not given the appropriate attention and the measures taken were not satisfactory.

During a drought period it is much easier to promote projects of treated effluent reuse than in normal conditions.

Value of water

Water cannot be treated totally as an economic good. The water is used in some instances as a social and environmental instrument for promoting social, environmental and to a lesser degree for economic development. Water is also used in some cases exclusively as an economic commodity and in these cases it must be treated as such. However the principle "the user and the polluter pays" (not yet adopted) must be adopted and applied wisely. The best water pricing system is the volumetric since it encourages the most efficient and economic use and users are charged the quantity they actually consume.

All agree that water is a very valuable commodity and that all measures must be taken to reduce or avoid losses, avoid misuse and use it wisely, efficiently and effectively.

Water pricing for domestic use should reflect the total cost, where irrigation water price to farmers should take into account the environmental and social benefits that such water brings to the nation.

Water reallocation

Since almost all of the water resources belong to the State and the conflicts are not so acute the reallocation of water or water cuts for certain uses is easier than in areas where water belongs to the private.

Water reallocation is a necessity for adjusting the water market. While domestic water demand increases and the supply volumes remain the same or even decrease due to human interventions, water allocation must adjusted by transferring fresh water from the irrigation sector to the domestic sector.

Trends

Following the observed reduced rainfall since the 1970's the WDD carried out a special study for the re-evaluation of the availability of the natural resources. The conclusions of the study are that the natural resources are by 40% less than those estimated in 1970 and according to which all major projects have been designed, constructed and operated. Cyprus is very vulnerable to drought because it has developed almost all its natural resources and does not have additional resources to develop. On the other hand the steady, dependable groundwater resources were overexploited and are now very little due to depletion.

Meteorological Service

This Service is a government department belonging to the MANR&E and it is in charge of collection, processing and storing of all the meteorological data and preparing the weather forecasts for the civil aviation, travellers, agriculture and for any other users. Below is a summary of the key points of the interview.

Monitoring

The Meteorological Service collects and processes all meteorological information. The Meteorological Service continuously monitors the weather conditions in Cyprus and from studies carried out by the Service it is concluded that there is a climatic change with a temperature rise of 0.5°C during the last century and with precipitation declining at a rate of 1 mm/year, during the last 40 years. These climatic changes if continue shall seriously and severely affect adversely the availability of the natural water resources and shall cause an increase in the water demand.

No particular index or indices are used by the Service to identify drought. The drought is recognized and alarms are set off as a result of the low rainfall, higher temperatures, etc.

Trends

During the last 30 years it has been recorded that the frequency of occurrence of droughts has increased, their duration time has increased, and they are more severe than before.

Forecasting

Although droughts cannot be forecasted by continuous monitoring of the weather parameters it can be sensed when drought commences.

Users of information

Irrigation farmers are affected mainly by the climate, and by the level of guarantee of water supply.

Department of Agriculture

This Department belongs to the MANR&E and it is responsible for the implementation of the agricultural policies of the Government. It also participates to the formulation of the policies. Below is a summary of the key points of the interview.

Drought types considered

From the point of view of this Department both meteorological and hydrological droughts affect the agricultural sector. Meteorological droughts affect directly the rain-fed agriculture, where hydrological droughts affect the irrigated agriculture.

Droughts cause water shortages in irregular and unforeseen frequency and severity. Meteorological droughts affect mainly the rain fed farming, where hydrological droughts, which usually follow the meteorological droughts, affect the irrigated agriculture supplied with water from the surface reservoirs. Groundwater supplies are less affected by short-term droughts.

Management

The Agricultural Insurance Organization evaluates the adverse effects on rain-fed agriculture cereals and dry-land farming from droughts and provides the compensations in accordance with the provisions of the relevant law. The Department of Agriculture provides technical assistance on the better use of the limited quantities of water, and contributes in the formulation of the agricultural policies on drought mitigation measures for those crops affected but not covered by the existing insurance law.

There is no formal procedure to declare a drought situation. The Government and the farmers sense the drought once it is well in the process. No indicators or indexes are used.

In case of drought water supply priority is given to satisfy basic needs (domestic supplies) where the remaining needs are satisfied according to the availability of water as agreed between the stakeholders based on criteria. No one sector is fully satisfied where other sectors are left without water.

The drought mitigation measures depend on the severity and duration of the droughts that affect the country and the capabilities and potential for taking any measures. The necessary mitigation measures should include measures to increase supply of water, to reduce waste of water and avoid wasteful uses, keep regularity of supply, reduce water demand, etc.

Multiple stresses

The factors of uncertainty that affect the irrigation farmers are the climate, the level of guarantee of supply of irrigation water and the agricultural policies.

Users

Farmers do not have legal water rights but assigned water rights given by the Government to lands within irrigation perimeters. The existing water laws do not contain anything on water rights or assigned water rights during droughts.

Irrigation farmers have the capacity to influence decisions concerning the allocation of irrigation water during drought conditions. Such groups are the potato growers, the permanent crop growers, the exporters of annual crops, etc.

Irrigation farming in Cyprus is much diversified. The only factor that gives homogeneity to this sector is the need of irrigation water. Water distribution during drought periods should take into account many factors such as the social and economic factors, the marketing, the water rights, the irrigation methods used, and the crop use/need by the population, etc.

Although tourism is very important from the point of view of economy, very important is also the

irrigated agricultural sector for its social and environmental contributions. Irrigated agriculture's importance comes from the fact that it produces food, it creates jobs and keeps the population in the countryside.

Irrigation water demand will continue to increase due to increase in population and development of irrigated agriculture. The increase in demand can be satisfied using treated domestic effluents. On the other hand, more fresh water may be diverted to the domestic sector, meaning that percentage-wise the water for agriculture shall decrease, while agricultural production per drop of water is expected to increase.

External pressures

The political system in a democratic environment is vulnerable to pressures from various groups. The extent to which such pressures shall be effective depends on the arguments and on the economic, social and environmental interest that are at stake.

Value

Water cannot be traded as an economic commodity since the owner of the water is the Government and although under normal conditions it is distributed to the irrigators upon demand and payment of charge under drought conditions the Government usually reallocates the available water to the various sectors according to the priorities and real needs.

Water pricing should be made on a volumetric basis and this is how is done in Cyprus. Water prices to irrigators should not reflect the full cost of the water but should take into account the contribution of the irrigation water to the society and to the environment.

Water in Cyprus belongs to the state and at the present time there is no water market. There is a small market but it involves the sale of a certain volume of water between farmers pumping water from individually owned boreholes.

Climate change

Climate change is an issue that is under consideration. No exact definition of climate change has been given and not all parameters that are changing are defined. However it is sure that the increases in temperature and precipitation reduction are expected to affect the rain-fed and irrigated agriculture since water demand will increase. Climate change is a big issue and its effects have not yet being evaluated. So it is not easy to take decisions or make recommendations on water supply measures to face climate change effects, unless the impacts of the climate change are evaluated.

Water Boards

These are semi-governmental organizations charged with the responsibility of distribution of domestic water in towns and cities. A Board of Directors made of a varying number of members, three of which are appointed by the Government and the rest being elected members from the municipalities govern the Water Boards. Below is a summary of the key points of the interview.

Information

The Water Board being a water distribution organization is usually not involved in the definition of the drought. However it is informed by the WDD about the drought onset and termination and senses the drought effects by the reduced supply of water and the increased water demand by the consumers.

Management

Droughts and floods cannot be controlled, because they are natural phenomena, but can be mitigated through proper planning and preparedness. The sectors mostly affected by droughts are the agricultural sector and the environment since priority of water supply under drought conditions is always given to the satisfaction of the domestic needs.

The most effective drought mitigation measures is the reallocation of the minimum sustainable volume of water, by transferring water from other sectors to the domestic sector thus avoiding water supply deficiency which always affects adversely the standard of living, the social life and endangers the health of the population.

It is worth investing in improving the efficiencies of the domestic distribution system and water metering. Also because of water scarcity substitution of high water consuming crops with low water demanding crops will be beneficial for the economy and shall improve the water resources management. The water pricing system should be such so as to encourage efficient and wise utilization of the water while it will discourage the wasteful use, and it must reflect the full cost of the development cost including resource depletion and environmental cost. Probably higher water cost for irrigation water shall reduce irrigation water consumption.

Our capacity to face water scarcity due to droughts has improved but also droughts are becoming more frequent, more acute and more severe. Only proactive plans shall enable us to face future droughts.

Users

Water Boards supplying domestic water can influence to a certain degree the decisions concerning the allocation of water.

Today water allocation ratio between the two main sectors, that of domestic supply and irrigation, being 1 to 3, shall change in the immediate future with more domestic water and less irrigation water.

Climate change

Climate change is more probably a fact, which shall affect the water supply, the water demand and finally the water distribution among the various sectors of the economy.

Farmers union organizations

The farmer's union organizations are non-governmental organizations whose objectives are to promote and protect the interests of the farmers. There are four such organizations in Cyprus representing the various political fractions of the constituent. The interview was confined only to those sections of the questionnaire that are of interest to the farmers. The conclusions of the interview are outlined below.

Impacts

The farmers are aware of the drought events and their effect on rain-fed and irrigated agriculture. For them drought is translated to reduction of income, loss of jobs, loss or disruption of the marketing procedure, and uncertainty for their future in the farming business.

Irrigated agriculture is affected by climate and the agricultural policies, but it is also affected by the level of guarantee of irrigation supply.

Monitoring

The farmers perception of drought comes with the reduction of precipitation, which they sense in the records of the Meteorological Service, disruption of the growth of their crops and reduced supply of water from the distribution systems.

Users

Water should be allocated to farmers and given to them as legal water rights being one of the main inputs to their operations.

During a drought, irrigation demand comes second to domestic water demand. The farmers do not

participate in the decisions of water allocation between the sectors but participate actively in the allocation of water between the various types of crops. Under conditions of drought there is mild conflict between the irrigation and the domestic sectors because there is strong competition. Sometime there are conflicts between regions in the cases the water is transferred from one region to the other.

Irrigated agriculture gives work to the farmers with a decent income; it avoids immigration from the countryside, contributes to the development of the countryside and improves the environment.

The present allocation of water to the irrigation sector represents 75% of the total resources. With increasing demand mainly in the domestic sector due to population growth, if new resources are not developed there will be a need for transfer of more water from the irrigation sector to the domestic sector.

Compensation

There is no law or regulation or agricultural insurance organization, except in the cases of the rain-fed cereal crops, to regulate the compensation to farmers suffering from drought.

In many instances the administration enforces the decisions if they are just and the affected sector has been persuaded that the allocation has been made without a bias to any of the parties and those benefited have a high priority and they use the water wisely and efficiently.

Further activities

The Government should increase the supply of water and should increase the reliability of supply by constructing more waterworks including reuse and desalination plants. For irrigation farmers, irrigation satisfaction comes first.

Value

Water costing should not be treated as any other natural resource since water has social and economic attributes, which vary with respect to time, space and the environment in which it is used (social life, traditions, religion, etc.).

Pricing of water should not be made on strict economic criteria, but it should be made after taking into account many other parameters such as return from the use of water, farmers' income and capacity to pay, location of the irrigated area, etc.

Summary of the interviews with stakeholders

Drought definition

Droughts constitute a permanent feature of the Cyprus climate and are recognized by all by the lower than normal precipitation, lower flow in rivers and inflows to dams, and by reduced moisture in the plants root zones. No indices or other specific parameters are used to identify drought. It is also recognized that droughts cannot be avoided but can be mitigated through proactive planning and actions.

Water value

Water is a socioeconomic good and as such it must be priced accordingly. Although almost all water belongs to the Government, the irrigators' and other users' rights to use the water cannot be totally removed. In cases of droughts water is reallocated according to the priorities set by the Government. The Government through its agencies monitors the climatic and hydrological parameters and keeps records enabling its agencies to intervene in cases of droughts.

Trends

During the last 30 years it has been observed that droughts are occurring more frequently with longer periods than before. It is also recorded that there is a climate change with reduction in rainfall by 1 mm/year and increase of the ambient temperature by 0.5°C per 100 years.

During the 1990-2000 decade Cyprus has faced successfully the 5 year severe drought, because the measures adopted were accepted by the public and were just and not one sided. The Government also provided limited compensation to those that were severely affected.

Management

Cyprus is very vulnerable to droughts because it has developed most of its natural water resources but the existing legislation does not provide for drought preparedness plans and no specific actions for drought mitigation.

The exiting agricultural insurance plan against droughts is inadequate and cannot be considered as a drought mitigation measure. It does not cover losses suffered by the irrigated agriculture due to droughts and in case of rain-fed agriculture it provides cover for a very limited type of crops.

Model structure validation

The mapping model presented above was implemented and validated in a number of occasions during the period 1990-2000 by the writer. This model is not based on a specific law or regulation but on the necessity to mitigate the adverse effects of water shortage caused by repeated droughts. Since there is no law or regulation, the model was the best possible under the circumstances of acute water shortage. The model made the best use of the existing institutions and organizations and its success was based on the good will and understanding of all stakeholders.

The model, although not covering all affected sectors, is validated in recent drought situations, observing that the model current structure provided support of the following essential points:

(i) *To satisfy the basic needs* of water with priority in the supply of drinking water but without neglecting the needs for other sectors. This necessitated the reallocation of the very limited water resources available at the time.

(ii) *To alleviate the impacts* of the water shortage by promoting water saving measures and methods, and augmenting the water resources availability, where possible, by mobilizing natural water resources, by recycling domestic effluents, by introducing seawater desalination and by using lower quality water, where possible.

(iii) *To promote water savings* in all sectors of the economy, indicating that water is a problem concerning all consumers irrespective of the priority given to one or the other sector for satisfaction.

(iv) *To raise public awareness* and to educate the population on the importance of the water and how to use wisely and efficiently the limited water resources. It was also stressed and understood by all that the best method to mitigate droughts and avoid the repetitions of water shortage due to droughts was to save water when it is available.

The model was validated also form the conclusions of the stakeholders' information:

(i) *Perception of drought*. The perception by the professionals and the population that droughts are a natural phenomena that occur periodically affecting the water resources availability and that the drought mitigations plans should be part of the water resources management plans.

(ii) *Actions*. The legislators and the Government understood how serious could be the impacts from the droughts and embraced all the plans that could alleviate the adverse effects and relief the consumers, domestic users, irrigators and industrialist from the difficult situation created by the shortage of water. For this purpose they approved and authorized the expenditure of funds for new

projects, for promoting water saving, and for compensations to those adversely affected, mainly farmers.

(iii) *Collective approach*. The population understood very soon that mitigation of the adverse effects could not be undertaken individually but only under the direct supervision of experts, who provided the expertise and the know-how.

The validation of the model does not mean that the model is the best or it is always adequate or does not have weaknesses. The main weaknesses of the model are the following:

(i) *It is a reactive and not a proactive plan.* Although the plan is drafted ahead of time its implementation is commencing after political decisions are taken. Water saving plans and measures included in drought preparedness plans are abandoned once the crisis is over, where other measures involving emergency plans for additional water continue to operate thus increasing the water demand and depriving the authorities of a source that could be used again in the future. This occurs often with the drilling and operation of emergency boreholes, which continue to operate after the crisis is over mainly depleting the strategic sources and increasing the permanent water demand.

(ii) *Lack of legal framework.* The procedure and criteria for development of the drought preparedness plan and its implementation are not based on any specific law or regulation. The implementation of most actions is not based on legislative articles but on the good will and understanding of those affected, positively or negatively.

Strengths and weakness on existing drought mitigation setup

Legislation

Since no specific legislation exists for the preparation of drought mitigation plans no strengths and weakness can be reported, but the absence by itself is a great weakness in fighting drought. Generally the absence of laws and regulations (defining drought, the preparation of drought mitigation plans, when drought mitigation plans are to be implemented, and when drought is terminating, as well as criteria, rules and priorities for water reallocation, who shall be compensated, how much and to what extend, how economic, environmental and economic issues are mitigated, as well as defining the responsible institutions and their powers, etc.), is a serious weakness of the whole system.

In general actions on drought are left to the good will of some organizations or persons who do not have a legal responsibility or the obligation to watch and prepare plans for facing situations under drought.

Another dimension of the drought impacts is the fact that the impacts are not confined to water scarcity but extend to a number of other activities not easily manageable under a crisis management approach.

The power of the Council of Ministers to declare "a situation of emergency" under certain conditions, requires the approval of the Parliament and contains too many other considerations which Governments usually do not exercise unless the situations is very serious and lives are at stake.

Institutions

The comments on strengths and weakness of the existing institutions dealing with drought are based mainly on the complete absence of a legal framework, on the lessons learned and the experiences gained in facing the recent drought events.

From the point of view of collection, processing and storage of data on meteorology and water resources, the institutions do not show weaknesses. There is a good network of meteorological and hydrological stations which collect on a regular permanent basis the basic information. Although there is no provision in their duties and responsibilities to deal with drought phenomena, since such phenomena are recurrent in Cyprus the institutions and organizations are collecting and processing such data with a view to identify drought events.

The same is true with the water resources management where the responsible institution is continuously monitoring the availability of surface and groundwater resources and prepares scenarios for future actions. The data on water availability and use, like the hydro-meteorological data are continuously updated and analysed for the identification of droughts events, and the Ministry of Agriculture being the ministry responsible is continuously informed. However this does not mean that the institutions are fully staffed to monitor and analyse drought events in a comprehensive manner, or to prepare drought preparedness plans or to initiate actions for drought mitigations. Knowledge and know-how are not available since nobody has the responsibility by law or regulation for acquiring such expertise or specialty. All above weaknesses lead in many instances to the preparation of incomplete proactive plans or to reactive plans in the case of plans to mitigate the effects on the social and economic sectors.

In conclusion it can be said that the weakness of the existing system is the total absence of legislation for drought preparedness plans, for drought definition and for definition when drought initiates and when drought terminates. Also the absence of legislation defining the obligations, duties, responsibilities and powers of institutions to act under drought conditions is a fatal weakness since neither complete monitoring systems are guaranteed, nor can integrated drought proactive mitigation plans be prepared or organization or institution be named with the duties and responsibilities to act accordingly. The inadequate reactive drought mitigation plans usually lead to high cost measures, but ineffective in the long term. The institutions also lack experience on risk analysis and drought preparedness plans.