# Applied tools to support Júcar management decisions during 2005/2007 drought

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**SUMMARY –** Droughts in arid and semiarid Mediterranean basins have an increasing socioeconomic and environmental repercussion. The problem is especially complex in basins where droughts are very frequent and intense and where water resources are submitted to massive use. For that reason in the Mediterranean basins it is necessary to manage the water resources in constant alert in order to mitigate the consequences of a drought. In the last three years the worst historical drought has occurred in the Júcar River system. This paper shows the application of the tools and methodologies to support the management decision during the current drought. The application includes the follow-up and analysis of different types of drought, rainfall status, hydrological status and the simulation of water system management to evaluate the measures to take, and their effectiveness in the system. The application of these tools support the management decision through the forecast simulation of the system. All the results obtained, during these three years, have been shown to the Júcar Drought Commission created by Statutory Law 1265/2005, 21st October, by which exceptional administrative measures for the management of the hydraulic resources are adopted to correct the drought effects in the Júcar, Segura and Ebro river basins, and have supported the different management decision of the Commission throughout these years.

**Key words:** Drought, water resources management, mitigation, water management simulation model.

## Introduction

The water resources management in the arid and semiarid regions of the Mediterranean area is an especially complex task, which includes multiple factors and a great number of different disciplines. Hydrological, climatic, environmental, social, economic and management factors must be considered to guarantee the protection of the environment and to satisfy adequately the water demands needed by different productive sectors, allowing to ensure suitable levels of quality of life.

Droughts are a frequent phenomenon in Mediterranean area and they increase considerably the complexity of the water resources management in these basins.

A suitable water resources management in hydrographical basins where droughts take place with certain frequency can reduce considerably the negative impacts in the environment and in the regional economy. For this reason water authorities must detect the occurrence of droughts with the maximum notice beforehand, and rely on the necessary tools to improve the management, such as the decision support systems, in order to mitigate the impacts that drought produces. It is necessary to add to this situation the current uncertainties due to the possible existence of a global climatic change, since the hydrographical basins of semiarid regions are, once again, the most vulnerable by climate modifications.

These circumstances have led to an important effort dedicated to the water resources management and to the analysis of the possible measures to apply both in situations of drought and in the previous phases.

Measures for the environmental protection (water saving, the improvement in the management or the search for alternative water supply) are analyzed by developing methodologies for the analysis of the efficiency of the measures that could be applied before the occurrence of a drought.

The current extreme drought of the Júcar River started in the 2004/05 hydrological year and nowadays it reaches its major crudeness, which makes it necessary to dedicate important efforts on the analysis and on the definition of mitigation measures.

Definition of the mentioned measures, as well as their execution, and estimation of the efficiency that each of them could have, require the assistance of simulation models in order to predict the behaviour of the water resource systems in case of different management alternatives.

Management Simulation Models foresee the future behaviour of the water system and quantify the risk of failure expected from the system by means of the probabilistic analysis of the water management in case of multiple possible hydrological scenarios.

This paper shows two of the main models used by the Technical Office for Drought Management that is performing for the Permanent Droughts Commission, constituted in the CHJ (Júcar River Basin Authority) by the Royal Decree 1265/2005, of October 21, 2005, to simplify de decision process and the definition of the measures to apply through the current drought. The first model is a hydrological model that is used to have more information about the hydrologic status in the basin, and the second is a water management system model, that is used to know the effectiveness of the drought measures proposed by the Permanent Drought Commission.

## Hydrologic models

The climatic information is completed by the hydrological information, registered on the appraisal stations, reservoirs, etc. that complements itself with the flows obtained by means of runoff simulation models.

The distributed conceptual model, "Patrical" (Pérez, 2005), calculates the hydrologic cycle variables in the whole extension of the basin: rainfall, soil moisture, natural river flows, outflows to the sea, etc. (Fig. 1). That information is useful to achieve a complete knowledge of the drought evolution across the hydrologic cycle and to determinate the indicators for the hydrological and the agricultural drought.

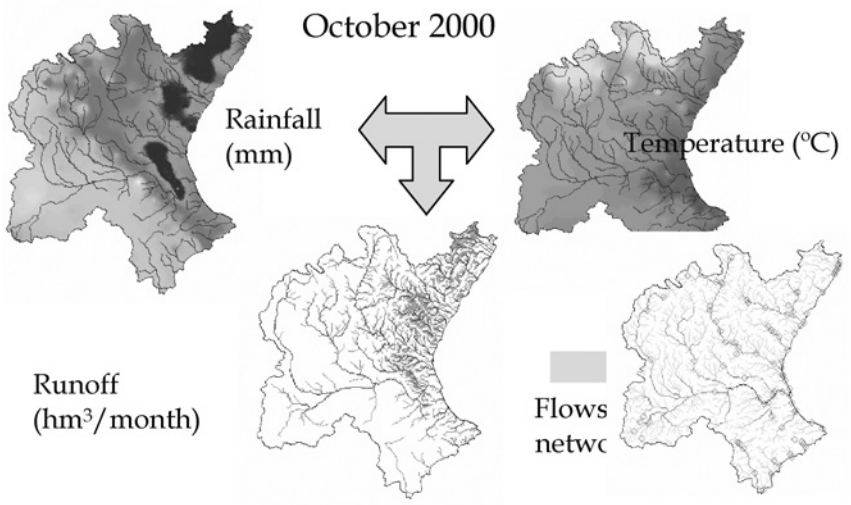


Fig. 1. Determining the natural flows in the basin by means of the distributed runoff simulation "Patrical" model.

## Evaluation of drought management measures through mangement system models

The Decision Support System Aquatool (Andreu *et al*., 1996), more specifically the Management Simulation Module Simges (Andreu *et al*., 1992) is used as operative drought indicator of the Júcar

system (Fig. 2) (OPH, 2002) to foresee with certain anticipation the behaviour of the water system and the possible failures under different hypotheses.

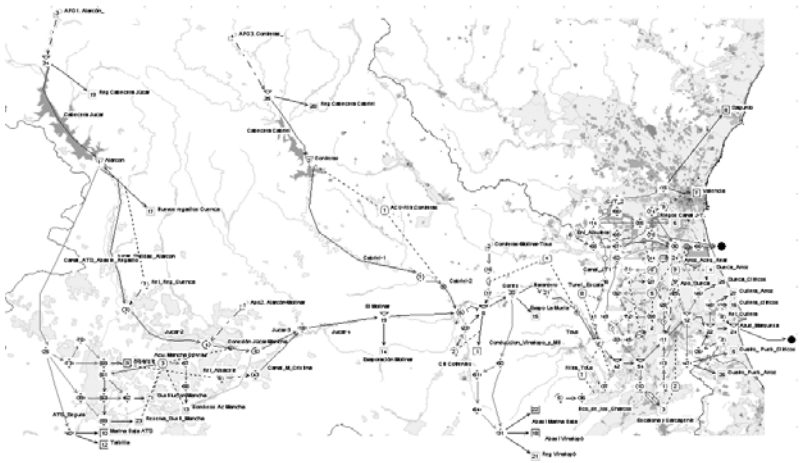

Fig. 2. Júcar River system simulation model.

This model has been used during the last three years, and its results are being showed to the CPS every month, for example during the 2005/06 year the forecast was made considering the hypothesis of giving the different users the same amount of water as the previous year (2004/05), subject to the condition of having the same inflows as the last years, the third worse natural inflows of the last 65 years. This hypothesis is defined as the repetition of the last campaign, and provides the decision makers, which come from different professional backgrounds, with an easy to understand information.

Under these hypotheses, the water storages in the system's reservoirs would become exhausted by mid July 2006 (Fig. 3), reaching the technical reservoir exploitation limit of 55 $hm^3$. Clearly the application of the management simulation models constitutes a system operative drought indicator.

On the other hand, the storage forecast expected in case of complete application of the approved measures and in case of no intervention is calculated and compared considering the last year inflows. The results (Fig. 3), are unlikely but easy to understand by experts and users.

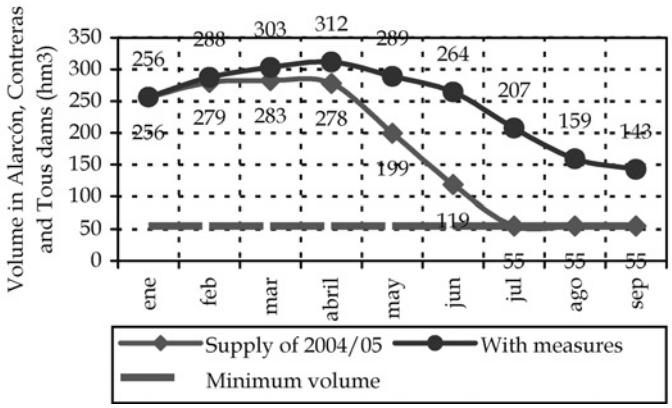


Fig. 3. Water storage forecast in the Júcar system through the 2006 campaign, with and without the drought mitigation plan.

## Conclusion

The tools developed for the water management institutions to foresee and to mitigate the effects of droughts have been described in the present paper. The tools purpose is to define as well as evaluate the efficiency of the drought mitigation measures.

This tools have been applied to the Júcar River basin in the hydrological year 2004-05, during one of the worst hydrological droughts of the modern history. The main advantage of the use of these tools is the ability to calculate, in the short and medium term, the future water storages and supplies depending on the mitigation measures that are going to be adopted. The forecasts provided using this methodology increase stakeholders' sensitivity to water saving and improve the efficiency of water management policies.

## References

Andreu, J., Capilla, J. and Ferrer, J. (1992). *Modelo Simges de simulación de la gestión de recursos hídricos, incluyendo utilización conjunta. Manual del usuario*. SPUPV-92.1097, ISBN 84-7721-169-8.

Andreu, J., Capilla, J. and Sanchis, E. (1996). AQUATOOL, A Generalized Decision-Support System for Water-Resources Planning and Operational Management. *Journal of Hydrology*, 177: 269-291.

OPH (2002). Consultaría y asistencia para el estudio de utilización conjunta de los recursos hídricos superficiales y subterráneos de las cuencas media y baja de los ríos Júcar y Turia.

Pérez, M.A. (2005). Modelo distribuido de simulación del ciclo hidrológico y calidad del agua, integrado en sistemas de información geográfica, para grandes cuencas. Aportación al análisis de presiones e impactos de la Directiva Marco del Agua.

### Acronyms

CHJ, Jucar River Basin Authority (Confederación Hidrográfica del Júcar).
CPS, Permanent Drought Commission (Comisión Permanente de Sequías).
OTS, Drought Technical Department (Oficina Técnica de Sequías).