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EVALUATION OF THE HYDRIC RESOURCES IN THE HYDROGRAPHIC SYSTEM OF MIJARES-LA PLANA. EFFECTS UNDER A SCENE OF CLIMATIC CHANGE[1]

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I. IMPORTANCE AND OBJECTIVES

The present research acquires a great importance in accordance with the predictions that the models of climatic change establish on the Mediterranean region. In this order of knowledge, the Fourth Assessment of the IPCC (Intergubernamental Panel for the Climatic Change), Climate Change, (2007), and the presentation of the scientific bases of the last Assesssment, Fifth Assessment (IPCC WGI AR5, 2013), based on the models of the Hadley Centre, establish that our Mediterranean region will be most vulnerable from Europe to the effects of the climatic change. Vulnerability specially due to the intensification of the hydrologic cycle because of the global thermal increase.

Consequently with these forecasts and their importance, this study has two complementary objectives:

1. The determination of the present hydrologic process for the evaluation of the hydric resources available. In synthesis, to respond to a basic question, How much water do we have?.
2. To project the impacts that a climatic change could have on the hydric resources of the river basin.

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II. THE EVALUATION OF THE HYDRIC RESOURCES ON THE HYDROGRAPHIC SYSTEM OF THE MIJARES-LA PLANA: CALCULATION METHODOLOGY

The methodology used for the evaluation of the total, superficial and underground hydric resources, is based on the conception of the hydrológical cycle and its narrow dependency with the climatic data. The value of the run-off (E), or annual total contributions (A), highly are tributary of the relations between the values of the precipitation (P) and those of the potential or real evapotranspiración (ETP-ETR):

$$E \text{ and } (A) = P - ETR$$

Consequently, the two basic conditions to obtain a good result are: the rigorous evaluation of the rainfall contributions and the best possible calculation of the evapotranspiración. Values that have been obtained or calculated on a spatial grid of 31 observatories.

The values obtained from the meteorological observing points have been projected with techniques of kriging to get a regular spatial grid. The regional averages has been calculated by means algebra of maps carried out through SIG-IDRISI. In synthesis, a cartography, on 4,846 km^2 of the total surface of the Mijares-La Plana hydrographic system, that has allowed to know the hydric resources and to project the possible impact by climatic change.

II.1. The Rainfall contribution (P)

It has been averaged with data from 31 observatories (AEMET-UJI), properly homogeneized with SNHT (Standard Normal Homogeneity Test). The mean precipitation arrives to 56.85 cm. Over 4,846 km^2 of the Mijares-La Plana system, they determine 2,755 Hm^3/year.

II.2. The evapotranspiración (ETP-ETR)

The second condition for a good result is the rigorous measurement of the evapotranspiration. This is a complex process whose rate and intensity are modulated by all the climatic elements in a territory, through the laws of Dalton, Jeffrens and Stefan (Quereda, 2008). Indeed, the shortage of observatories of first order, has determined that, the evaluation of the evaporation process has rested on theoretical formulations with the temperature.

In this order of knowledge, as opposed to the use of the classic formulations of Thornthwaite and Turc, more easily applicable to the existing meteorological data, the evaluation of the evapotranspiración has been carried out by means of the method of Penman-Monteith (Penman, 1948, 1953; Monteith, 1965, 1985). This aerodynamic and radioactive formulation, developed by Penman in 1948 and completed by Monteith in 1965 is specially recommended by the FAO from 1990. Its application to the Mijares-La Plana hydrographic system constitutes the main methodologic innovation of our study. The formulation applied has been the adaptation of Penman-Monteith for automatic stations (AWSET, 2001). It has been possible thanks to university network of fourteen weather stations. These stations have allowed to get an exceptional cartography of the potential evapotranspiración, through their own registries of ET and the later correlation with other stations of the network.

The obtained results allow to get 59.06 cm like potential demand by the atmosphere. It is equivalent to 2,862 Hm^3/year.

II.3. The run-off

The available water amount does not allow to balance the value of the ETP. Consequently, the value of the total run-off reaches more clearly through from the ETR or real evapotranspiration concept. This evaluation of the ETR has been carried with Thornthwaite monthly hydric tables and Penman-Monteith ETP values. The annual average value for ETR over the whole research area is 50.76 cm. It is equivalent to a real evapotranspiración of 2,460 Hm^3/year.

With this formulation the FAO, the obtained average value for the regional run-off, calculated with map algebra, is 7.20 cm., equivalent to an annual total of 349 Hm^3. Hydric resources that would be at the same level that the demands considered by the PHN for a yearly horizon.

III. ANALYSIS AND PROJECTION OF THE IMPACTS THAT A CLIMATIC CHANGE COULD HAVE ON THE HYDRIC RESOURCES OF THE HYDROGRAPHIC SYSTEM

This fit balance between availability and demands of hydric resources, seriously seems threatened knowing the desertification forecasts by the ocean-atmosphere models for the Mediterranean region. The verification and evaluation of this risk constitute the greater scientific challenge for the Mediterranean climatology at the moment. In this order of knowledge, and considering the great inherent uncertainties to the hypothesis of climatic change, it has been possible to make a projection of possible impacts on the hydric resources. This new scene can be get with a thermal increase of one Celsius degree for 2050 and, perhaps, with a decrease of 5% in the average precipitation. The methodology used for these projections has been derived from the calculation of the water cycle parameters.

The derived cartography allows to consider that an elevation of the temperature in 1 ºC could decrease the average run-off up to 6.66 mm, with diminution of 8% for the present hydric resources. The same methodology of projection allows to consider the reduction of resources that could occur in a climatic scene with a thermal increase of 1ºC and a 5% reduction in the average precipitation. Average value of the run-off, 5.59 cm, represents one strong reduction, 22.5%, in the hydric resources of the Hydrographic System.

IV. CONCLUSIONS

The present work constitutes a contribution to one of the main scientific challenges for the Mediterranean climatology. This challenge is centered in the desertificación process that could happen by the intensification of the water cycle by a potential global thermal increase, always according to IPCC forecasts.

Consequently with these forecasts and their importance, the present research over the Mijares-La Plana Hydrographic System has looked for two objectives: the present water cycle definition to respond a basic question, How much water do we have?, as well as to project the impacts that a climatic change could have on the present hydric resources of the river basin.

The evaluation of the evapotranspiración, fundamental hinge of the water cycle, has constituted the main methodologic innovation of our work. Obtained values have constituted the cartographic base of the hydrographic system. The regional mean values has been calculated by algebra of maps with SIG-IDRISI software. In synthesis, this hydrographic system Mijares-La Plana (4,846 km^2) cartography has allowed to know hydric resources. These resources are very fit in their average value to take care of a demand calculated in 350 Hm^3/year for 2025-30 period (PHN, 2001), but that could be seriously threatened by forecasts announcing a remarkable reduction (22%) in a warmer and drier future climate.