

# Study of Surface Water Mixing by Isotopic Balance Techniques and Cartography of $\delta^{18}\text{O}$ in Precipitation, at the Jarama and Lozoya Rivers (Madrid, Spain)

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## Abstract

Stable isotopes of water provide a specific signature that makes it possible to quantify and distinguish water masses with different origins, to inform about their movement through natural media, as well as to determine hydraulic connections between surface water and groundwater.

The *Centro de Experimentación y Obras Públicas* (CEDEX) together with the *Universidad Complutense de Madrid* (UCM) has carried out a hydrological study over the surroundings of the confluence between the Jarama river and its tributary the Lozoya river, that have their sources at the Central System in the northern part of Madrid (Spain). The main objective of the study has been to quantify the contribution of both rivers in the mixing area according to seasonal and daily variations on their isotopic composition. In order to characterize isotopically the different classes of waters that come from the Jarama and Lozoya watersheds, maps of the spatial distribution of  $\delta^{18}\text{O}$  in precipitation on this site have been used.

Water sampling and differential streamflow gauging have been executed throughout two consecutive field campaigns: one representing a dry period (moment of low water flow) and the other representing a humid period (moment of high water flow), both during the year 2011. The collected samples were analyzed at CEDEX by a mass spectrometer to obtain the isotopic ratios of deuterium ( $\delta^2\text{H}$ ) and oxygen-18 ( $\delta^{18}\text{O}$ ), relative to the water standard VSMOW.

The isotopic signature obtained from the Jarama and Lozoya rivers at the research area shows well differentiated values that allow for the mixing water percentages to be calculated. In these results, seasonal variations between moments of low and high water levels can be appreciated: during the humid period of the year the influence of the Jarama river predominates, whereas during the dry period Lozoya river takes over. Daily fluctuations produced by the water regulations of the El Atazar reservoir on the Lozoya river course may also be observed.

Recently, isotopic maps have been developed as a result of interpolating models and processing geographic and climatic factors at different scales, by the use of GIS tools. Data collected from the Spanish Network for Isotopes in Precipitation (REVIP), during the time period 2000-2006, has allowed for a continuous digital map of the  $\delta^{18}\text{O}$  distribution in precipitation over the Spanish peninsula to be performed. This map provides  $\delta^{18}\text{O}$  reference values that are used on these studies of surface hydrology.

Comparing the  $\delta^{18}\text{O}$  values from the water samples with those achieved from the digital cartography of isotopic distribution in precipitation at this site, helps to better understand the climatic, geographic and other water regulation factors that take part on the isotopic evolution of the Jarama and Lozoya fluvial waters. The present isotopic characterization performed in this research can be used as a reference to identify changes on the water regime of these two rivers due to possible modifications on its management in the future.

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