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Evolution of low- frequency events in precipitation and run-off, and environmental changes in headwaters representative of a Mediterranean mountainous environment

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General Models forecast changes in global precipitation that will modify the distribution patterns of water resources around the world. Mediterranean areas are predicted to suffer a decrease in the total volume of water from precipitation, but the frequency of extreme events is thought to increase over time. Temperatures are also increasing and therefore the amount of water required by plants. Moreover, the physical conditions of the headwaters located in mountainous areas, such as land-cover structure, are changing due to abandonment of agricultural practices and rural life. Interaction between these processes will affect water availability in areas located downstream; therefore an appropriate assessment of the evolution of water resources is necessary to understand their future behaviour and to minimise potential risks for the population.
This study uses daily data for the time period 1959-2005 to analyse the evolution of the low-frequency events of precipitation and run-off in a river headwater located in the Sistema Central, a mountain range in central Spain. The 95th and 97th percentiles were calculated to define the thresholds for 'extreme precipitation events'. The average run-off value (Q) for the time period was multiplied by 3, 5, and 10 to calculate the thresholds for days with extreme run-off events (Q3, Q5 and Q10). It was also divided by 3 to define the "low water-level days". For the same time period (1959-2005), a water balance model (Thornthwaite) was used to assess the relation over time of the following variables: temperature, evapotranspiration (AET), precipitation and run-off. The Spearman test was applied to daily, monthly and annual data to detect tendencies in the aforementioned variables. Changes in land-cover have also been studied using aerial photos and ortho-images for the years 1957 and 2002 respectively.
The occurrence of low-frequency events decreases over time, and shows good correlation with the inter-annual evolution of both precipitation and run-off. Days with precipitation levels greater than the 95th and 97th percentiles are becoming less frequent over time (Spearman Rho = -0.43; p = 0.004). Q3, Q5 and Q10 show negative tendencies, with Spearman Rho values of -0.5, -0,46 and -0.48 respectively (p value < 0.001). Days with low water level are, on the contrary, experiencing significant increases over time (Rho = 0.39; p level = 0.007).
Temperatures show a positive trend since 1972 (+ 0,05 ºC/year), and together with lower precipitation levels over time, are responsible for the losses of water resources in the studied period. Moreover, changes demonstrated in land-cover (expansion of forest and mountainous shrubs due to the abandonment of agricultural activities) are thought to have a slight influence on the negative evolution of runoff.

Key words: Headwaters, low-frequency events, run-off, precipitation, land-cover