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Soil moisture variability associated with climate change and land levelling in Mediterranean vineyards of NE Spain

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In recent years, the strengths of climatic variations and their impact on water resources and their effects on agriculture has attracted the attention of numerous researchers. However, the high climate variability occurring in some regions make difficult to assess tendencies on distribution patterns. On the other hand, during the last decades, social and economical constrains and the introduction of mechanisation has led to great land transformations to adapt fields to mechanisation works. Most of soil and water conservation measures used in the Mediterranean area are being abandoned or eliminated, and farmers change the landform through earth movements when necessary. Degraded soils resulted after these landform changes are poor in organic matter and weak structural surfaces, and soil depth tend to be very irregular. These soils have low holding capacity and low hydraulic conductivity, which decrease infiltration rates. All these facts are contributing to accelerate erosion processes, which has been identified as the major type of human-induced land degradation in a global perspective. The combination of these two aspects: changes on rainfall amount and/or its distribution throughout the year and changes in the management systems, could have important repercussions on soil hydrological processes, particularly in dryland areas. Among the different hydrological parameters soil moisture has particular interest, not only because it affects runoff processes, which takes place after saturation particularly in shallow soil layers, but for the understanding of changes in plant growth.

The spatial pattern of the hydrological response to rainfall events may therefore be non-uniform, with overland flow localized in specific areas, being the runoff producing areas spatially isolated and unconnected. The spatial distribution of soil water content

of the top horizon uses to be the result of complex processes depending on relief, topsoil characteristics (such as water retention capacity, soil sealing and crust), and its links to climate.

The aim of this work is to analyse the effects of changes in the distribution of rainfall throughout the year and its concentration in a lesser number of events separated by long dry periods, on soil moisture spatial and water available for crops in land levelled plots with mechanized vineyards and their influence on yield.

The study was carried out in a vineyard plot planted 12 years ago, after mechanisation of the fields. Soils are highly calcareous and, the parent material (Tertiary marls) is on top of the surface. One of the main soil characteristics is the high silt and fine sand content, which made these soils very susceptible to seal.

The plot was instrumented at 12 points distributed across the plot to control soil moisture periodically by TDR at different depths: 0-20cm, 20-40 cm, 40-60 cm. At the same locations, Gerlach box type collectors, 50-cm width, were installed to collect runoff samples. Soil moisture and runoff were evaluated once a month for 2002-2004, period including long dry periods and extreme events. Rainfalls were recorded at 1-minute intervals in the experimental farm using a pluviometre linked to data-logger. In each plot, crop productivity was evaluated at the three positions along the slope.

The results show, that the important soil profile alterations produced by land levelling, previous to the plantation of the mechanised vineyard, produce a high spatial variability of soil water content across the plot. Areas located at the top of the plot, where soil depth is 50 cm as maximum, recorded soil moisture contents in the top layer up to 5% lower than down slope, although with high variability across the plot.

Soil moisture in the whole profile depends on the intensity at which rainfall takes place more than on total rainfall. At high intensities, soil moisture increments only occur in the surface layer, but no significant increases are observed in deeper layers, where vines have most of the roots. However, under low intensity rainfalls the increase in soil water content occurs in the whole profile.

The irregular distribution of the rainfall throughout the year has a considerable impact on yield production. For the same annual rainfall, the season of the year in which rainfall is recorded and if rainfall falls at low or high intensity is critical, because it condition the effective rainfall. In addition, the differences in soil depth created by soil movements in the filed mechanisation give rise to significant yield reductions between deeper and the shallow areas, which can be up to 50%. In years with dry or very dry winters yield resulted strongly affected.