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Sensitivity of hydrological parameters to changes in climate in two temporal and spatial scales

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This work studied the impacts of changes in two climate parameters – rainfall and temperature – on hydrological parameters. The spatial scales studied were the watershed scale and the regional scale, and the temporal scales included single extreme events and seasonal changes. The study focused on two contrasting climatic regions in Portugal, one humid and another semi-arid. Two hydrological models were applied for this study – the SWAT model for the seasonal scale, and the MEFIDIS model for the extreme event scale.

The SWAT model was applied with a range of increases to temperature and decreases to rainfall in order to study the response of hydrological parameters. The results show that evapotranspiration is less vulnerable to changes in climate than surface runoff, indicating that surface water resources are more affected by these changes than vegetation water use. These impacts vary regionally; in the semi-arid region, sub-surface runoff is more sensitive to changes than surface runoff, indicating that changes in climate impact not only the amount of available water in streams but also the temporal distribution of this availability, with a tendency for greater heterogeneity in river flows with greater changes in climate. The dominant climate and soil type within each watershed is the main responsible for variability within a region, with the most arid watersheds and those with shallower soils being the most vulnerable to changes in climate.

The MEFIDIS model was applied for one watershed in each region, with a range of changes to storm intensity to reflect changes in rainfall. Changes in temperature were simulated by their consequences to two parameters, soil moisture at the beginning of a storm event and vegetation density. The results show that peak flow rates are more sensitive than total water flow to changes in storm intensity and duration. They also show

that changes affect the runoff generation coefficient in a non-linear way, and increase the area where significant runoff generation occurs. Regional differences are also important – runoff in the humid region is sensitive to changes to both storm intensity and total amount of rainfall, while it is not very sensitive to changes in storm intensity in the semi-arid region. Finally, the watersheds show low sensitivity to changes in vegetation density, but a high sensitivity to changes in initial soil moisture, especially the semi-arid watershed.

The results show that changes in climate have different impacts at different temporal and spatial scales. Runoff appears to be more sensitive to changes at the extreme event scale; furthermore, differences in climate aridity and soil properties affect the way in which runoff responds to changes in climatic parameters.