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Exploring climate change impact on groundwater supporting a medium and long term water management planning, a case study in Northern Italy.

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Groundwater systems are going to play an increasingly important role in facing climate change, representing one of the most significant worldwide water sources. At the same time, climate change may inevitabily lead to considerable direct and indirect impacts on groundwater systems.

The aim of this work is the development of a knowledge framework for groundwater bodies in relation to water availability and its vulnerability to possible climate change scenarios, identifying the mitigation action that can be adopted to resiliently respond to changes. The study area is the province of Brescia, in northern Italy, including 100 municipalities served by 183 wells and 98 springs. This area includes a higher plain, hosting a unconfined acquifer, a lower plain with several layered confined acquifers and two morainic amphitheaters.

To define the evolutionary scenarios of groundwater resources at basin and sub-basin scale, hydrodynamic conditions and temporal trends, over a time span from 2009 to 2021, have been evaluated.

Groundwater availability data have been analysed in relation to hydro-nivo-meteorological data collected from the meteorological stations distributed in the area. Mann-Kendall and Sen Slope estimator have been applied for trend identification and changing point analysis to explore groundwater time series.

Regarding precipitation, a first analysis aimed at the identification of extreme phenomena through the yearly distributions of dry and rainy days and through the calculation of specific indices such as SPI (Standard Precipitation Index) and PCI (Precipitation Concentration Index).

The piezometric and precipitation series have been subjected to time series decomposition, a mathematical procedure that splits the original series into three sub-components: seasonal, trend, and random. Successively, a comparative analysis has been performed between the three components of groundwater levels and the three components of the neighboring rain stations data.

This methodology allowed to investigate the actual effect of precipitation on groundwater level variability with respect to the other components that contribute to the total water budget: it emerged that in the higher plain the effects of irrigation return flow contributes to the summer groundwater table rise more than precipitation, and that in the lower plain groundwater table depth is more related to human abstraction than local precipitation. These results provide the basis for implementing future sustainable water management plans.