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Are large karstic springs good indicators for Climate Change effects on groundwater?

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Climate changes are expected to decrease the water availability in the Mediterranean area especially during summer, due to the concurrence of a generalized negative trend in the precipitation and an increased frequency of droughts. The use of groundwater can mitigate droughts, because many aquifers have a large storage capacity and are potentially less sensitive to climate change than surface water bodies, which often rely on groundwater discharge to maintain their baseflow. However, the real effects of precipitation decline on water availability must also account for human impacts, which conversely tend to increase, partly as a result of climate change. Especially, the so called secondary impacts of climate change, resulting from human intervention in water systems, are expected to have the largest short-term effects on groundwater resources. Typical examples of secondary impacts on groundwater are the increased abstractions particularly for irrigation. For these reasons, groundwater heads are hardly directly usable as indicators of climate change effects. On the other hand, large springs in mountain aquifers, which are very little or not affected by well pumping, could be helpful to evaluate the primary impacts of climate changes on groundwaters, although the paucity of long-term historical data often limits an effective assessment of the direct consequences of climatic forcing.

In this research we analyse three different unconfined karstic aquifers in Central Italy, with average discharge ranging from 120 L/s to nearly 18 m^3/s, which exhibit consistent signals of the direct effects of climate changes on groundwater resources. The analysed time series, although discontinuous, indicate declines of about 20% of the initial discharge rate (10 years average) in the period 1938-2007. The detected trends are also coherent with that of the regional standardized precipitation index and the Tiber river discharge. Additionally, they show a fair correlation with the opposite of the winter NAO Index, witnessing of a regional extent phenomenon and not just a local behaviour.

On the grounds of these findings, we postulate that the primary effects of climate change may be estimated also on heavily impacted groundwater bodies, comparing them to the analysed springs. These signals are of paramount importance because two of the analysed resources serve the large urban area of Rome with nearly 3 million inhabitants, and the possibility of occurrence of water scarcity conditions, even for these huge groundwater systems, could be a challenge in the next decades.