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The impacts of drought on groundwater resources in the Upper Volturno basin, Southern Italy

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Highlights

- The study area is prone to low-duration drought events.
- Groundwater resources have been slightly impacted by drought events.

In this research, the Standardized Precipitation Index (SPI) (McKee, 1993) and the Standardized Precipitation Evapotranspiration Index (SPEI) (Vicente-Serrano *et al.*, 2010) were applied to identify the drought severity in the Upper Volturno basin. The study area is located in the northern part of the Campania province, Southern Italy, and covers 1532 km^2. The mean precipitation is 1039 mm and the mean annual temperature is 15.7 ^{o}C, with an increasing trend of atmospheric minimum temperatures observed in the last years (Mastroccico *et al.*, 2019). According to the climate classification by Köppen (1936), the study area is characterized as Csa (Hot summer Mediterranean).

The Upper Volturno basin is located in the Central-Southern Apennines. The average elevation of the study area ranges from 20 m to 1,618 m where steep slopes and a valley of a long extent which is covered by agricultural fields are observed. From the geological point of view, the area consists of (i) late orogenic molasses and terrigenous units (Upper Miocene-Pliocene), (ii) pre-orogenic and syn-orogenic terrigenous units of inner and thrust-top basins series (Cretaceous-Upper Miocene), (iii) siliceous-marly units of outer basin series (Trias-Paleogene), (vi) limestone and dolomitic limestone units of carbonate platform series (Jurassic-Paleogene), and (v) dolomitic units of carbonate platform series (Trias-Jurassic) (De Vita *et al*., 2012). In the study area, the mountainous part is covered by karst and fractured aquifers while the valley is constituted by alluvial aquifers. Most of the area is covered by mixed systems that are generally low-permeable, with few discontinuous aquifers (Ducci *et al*., 2017).

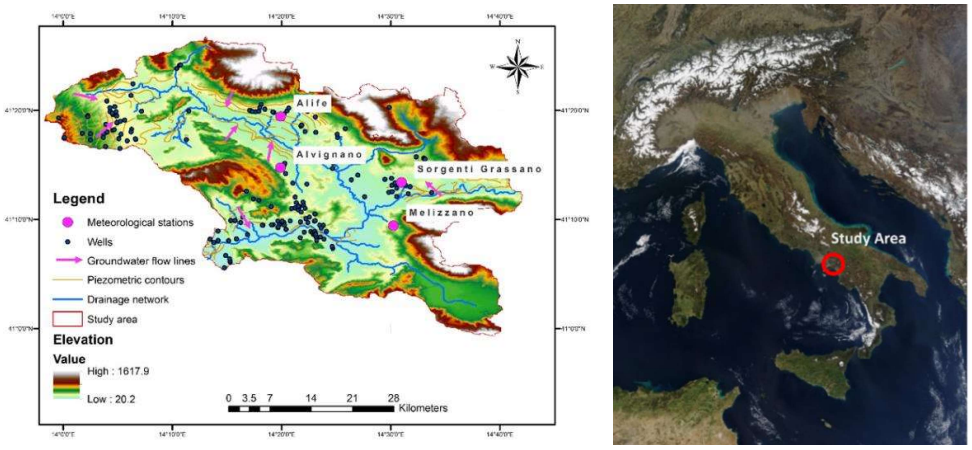

Figure 1. Morphological map of the study area.

Methodology

Monthly data of minimum, maximum temperature, and rainfall values were collected from four meteorological stations (Alife, Alvignano, Melizzano, and Sorgenti Grassano) for a period of nineteen years. Moreover, groundwater level data have been collected and analyzed to investigate the groundwater flow directions in the area (Figure 1). Statistical assessment of the two drought indices is performed using Pearson correlation coefficient and root mean square error (RMSE). Both drought indices were calculated for different aggregation periods (1, 3, and 6 months) in R programming. SPEI was calculated with Hargreaves method, which requires minimum and maximum temperature values and latitude of the point data. The selection of these two drought indices was applied due to their limited data needs.

Results

According to the statistical analysis, all correlations are significant at a 99% coefficient level. The results of Pearson's correlation between SPI and SPEI showed the higher correlation on the 6-month time scale. SPEI has the same RMSE value in all aggregation periods and less error than SPI (Table 1). Although both indices are highly correlated with each other, SPEI performed better than SPI because evaporative demand has a positive impact on defining drought conditions.

Table 1. Correlation coefficient (r) and root mean square error (RMSE) between SPI and SPEI.

Drought indices	R	RMSE
1-month SPI	0.93	1.06
1-month SPEI	0.93	0.97
3-month SPI	0.94	1.03
3-month SPEI	0.94	0.97
6-month SPI	0.96	0.98
6-month SPEI	0.96	0.97

Figure 2 presents the monthly temporal time series of drought index (SPEI6) based on the data from meteorological stations Alife and Sorgenti Grassano. The spatial distribution is not possible due to the absence of meteorological stations with the same recording period in all the extent of the area. However, according to the categories of drought by McKee *et al.* (1993), extreme drought events were highlighted during 2006-2008 and 2017-2018. In addition, many periods of moderate and severe droughts are observed during the years. Thus, the area is prone to low-duration drought events. The deeper groundwater values appear in the NW part of the basin while in the SE and SW parts are mentioned the higher levels of the aquifer with approximate values of 210-170 m and 80-20 m, respectively. The small extent of the aquifers in combination with the low drought events in the valley of the basin represents a favorable condition for groundwater recharge.

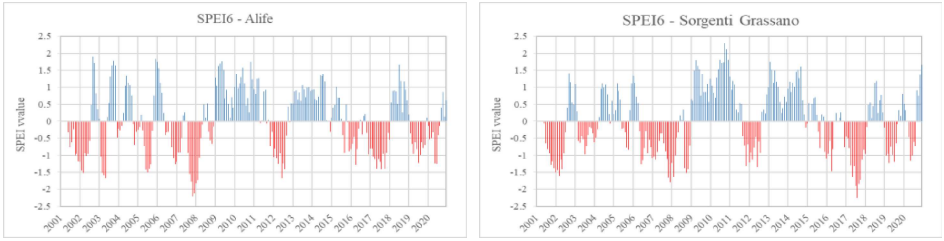

Figure 2. SPEI in the period 2001-2020 for (a) Alife and (b) Sorgenti Grassano meteorological stations. The year marks are centered on 1 January of each year.

Discussion and Conclusion

The complex hydrogeological system with the absence of long-period data sets in the area presents a significant challenge. For this reason, the current study provides a brief drought analysis using SPI and SPEI and demonstrates their potential use for drought analysis with minimal data requirements in connection with the hydrological regime of the area. The results showed that the area is affected by short-duration droughts. The small extent of the aquifers in combination with the low drought events in the valley of the basin represents a favorable condition for groundwater recharge. The current approach provides the results of the first drought analysis in the Upper Volturno basin and therefore, it has to be mentioned that multi-indices of drought assessment are required in order to reach a robust conclusion.

Acknowledgments

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References

De Vita, P., Allocca, V., Manna, F., and Fabbrocino, S., 2012. Coupled decadal variability of the North Atlantic Oscillation, regional rainfall and karst spring discharges in the Campania region (southern Italy), Hydrol. Earth Syst. Sci., 16, 1389–1399.

Ducci, D., Della Morte, R., Mottola, A., Onorati, G., Pugliano, G., 2017. Nitrate trends in groundwater of the Campania region (southern Italy). Environmental Science and Pollution Research, 26, 1–12.

Köppen, W., 1936. Das geographische System der Klimat. Handbuch der Klimatologie, 46.

Mastrocicco, M., Busico, G., Colombani, N., 2019. Deciphering Interannual Temperature Variations in Springs of the Campania Region (Italy). Water, 11(2), 288.

McKee, T.B., N.J. Doesken, J. Kleist, 1993. The relationship of drought frequency and duration of time scales. Eighth Conference on Applied Climatology, American Meteorological Society, Jan17-23, 1993, Anaheim CA, pp.179-186.

McKee, T.B., Doesken, N.J., Kleist, J., 1993. The relationship of drought frequency and duration to time scales. In Proceedings of the Eight Conference on Applied Climatoligy, Anaheim, CA, USA, 17–22.

Vicente-Serrano, S.M., Beguería, S., López-Moreno, J.I., 2010. A Multi-scalar drought index sensitive to global warming: The Standardized Precipitation Evapotranspiration Index – SPEI. Journal of Climate, 23, 1696-1718.