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Potential links between the North Atlantic Oscillation and decreasing precipitation and runoff on Sardinia

Nicola Montaldo and Alessio Sarigu
Università di Cagliari, Dipartimento di Ingegneria civile ambientale ed architettura, Cagliari, Italy (nicola.montaldo@unica.it)

Recently, climate change and human activities increased the desertification process in the Mediterranean regions, with dramatic consequences for agriculture and water resources. On the Sardinia island (Italy), runoff decreased significantly in the 1975-2010 period with a mean yearly runoff reduction of more than 50% compared to the previous 1922-1974 period. The decrease in runoff severely impacts the management of water resources on the Sardinia island, resulting in water supply restrictions even for domestic consumption. In the 10 Sardinian basins, with a longer database (at least 40 complete years of data, including data from the past 10 years), the trend of yearly runoff computed with the Mann-Kendall test is negative, with the Mann-Kendall τ values ranging from -0.39 to -0.2. The reason for the decrease in runoff is mainly the alarming decrease in the winter precipitation over the past few decades everywhere on the Sardinia island. Indeed, most of the yearly runoff of the Sardinian basins (on average, 70%) is produced by the winter precipitation due to the typical seasonality of the Mediterranean rainfall regime.
Surprisingly, the winter precipitation trend is not homogenous; the negative trend is higher on the Sardinian west coast and becomes lower as one crosses the island toward the east coast. At the rain stations on the east coast, the τ Mann-Kendall values of the winter precipitation become almost half of the τ Mann-Kendall values on the west coast, which is exposed to the western European climate dynamics.
In this sense, winter precipitation is highly correlated with the North Atlantic Oscillation (NAO), which is a weather phenomenon in the North Atlantic Ocean that controls the direction and strength of westerly winds and storm tracks into Europe. High negative correlations (up to -0.45) between winter NAO and winter precipitation are estimated along the west coast. Meanwhile, the correlations decrease as one crosses the island toward the east, encounters the high mountain in the center of Sardinia, and reaches the lowest values on the east coast (about -0.25). Hence, the general decreasing trend in the correlation between winter NAO and precipitation along the longitudinal direction (from the North Atlantic dipole to the east) is accelerating here due to local-scale topographic effects that overlap the large-scale NAO impact and affect the winter precipitation regime, thus softening the NAO impact on precipitation reduction.