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Driver detection of water availability changes in a large Alpine river basin

Stefano Mallucci, Bruno Majone, and Alberto Bellin

Department of Civil, Environmental and Mechanical Engineering, University of Trento, Trento, Italy
(stefano.mallucci@unitn.it)

The Alpine region is widely recognised as an area with a particularly sensitive environment, where climate change is expected to modify the river flow regime, which effects on freshwater ecosystems and water resources have not been explored at depth. In the middle of the last century the Alpine region has been characterised by an intensive exploitation of water resources for hydropower production and irrigated agriculture that, in combination with climate change, induced significant and spatially uneven alterations in the flow regime. Disentangling the effects of human activities from climate change is a difficult task, which only recently attracted the interest of scientists and stakeholders. In this study historical time series of hydro-climatic data (i.e. streamflow, precipitation and temperature) recorded since 1920 in the Adige river basin, located in the southeastern part of the Alps, were analysed in order to quantify alterations of the main hydrological fluxes due to climate change and water uses and separate their reciprocal contribution. Spatial and temporal patterns of change are identified by comparing the water budget performed in 4 representative sub-basins of the Adige river basin: Adige at Trento (9852 km2) and Bronzolo (6891 km2), Gadera at Mantana (394 km2) and Avisio at Soraga (207 km2). These sub-catchments are characterised by different climatic and water uses conditions. Disentangling the effects of water uses from climate change is difficult because none are known through measurements, such that the water balance equation contains two unknowns. We overcome this difficulty by calibrating a real evapotranspiration model in the period 1920-1950, when the effects of both climate change and water uses are deemed small to negligible. This model is then included into the water balance equation, to obtain water uses in the following period, under the usual hypothesis of no significant interannual accumulation. The effect of climate change is therefore included in the external drivers (precipitation and temperature) and manifests itself through changes in precipitation and evapotranspiration, besides possible changes in runoff due to seasonal shifts in the precipitation. The northern part of the catchment (Adige at Bronzolo) does not show significant alterations of the hydrological balance, due to water uses, whereas a significant reducing trend of streamflow volumes is found in the middle course of the Adige (at Trento) since the ‘70s, which can be attributed to the intense development of irrigation agriculture in the drainage area of the Noce river, one of the main tributaries of the middle course of the Adige river. Conversely, Gadera at Mantana shows a significant positive trend in streamflow as a result of the complex interplay between shifts in the seasonal distribution of precipitation and rise of the temperature. This study shows that climate change is the main driver only in headwater basins, while water uses overcome its effect in the lower part of the catchment.