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Impact simulations of climate change on hydrological extremes in the Po basin

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Climate shows a natural variability that influences the river discharge and its dynamics. In particular, short and intense precipitations and prolonged dry periods cause, respectively, floods and droughts. Climate change is expected to increase the frequency of these phenomena in the Mediterranean area due to variations in the precipitation partitioning in space and time. We aim to investigate the impacts of these changes, under the climate scenarios RCPs 4.5 and 8.5, on the Po river basin (71000 km2) in North Italy, through a climate/hydrological/hydraulic modeling chain. Before draw conclusions on the climate change impacts in the future we try to characterize the errors introduced by each component of the modeling chain.

The modeling chain is composed by (a) regional climate model: COSMOCLM with a 8 km resolution, (b) hydrological model: TOPKAPI and (c) water balance model: RIBASIM. This allows to simulate the Po river discharge at daily timescale.

The simulations foreseen will cover the period 1971-2100 divided into the periods 1971-2000 (past) and 2001-2100 (future). The first simulations refer to the past and aim to characterize the error of the modeling chain by comparing observed and simulated daily discharges at Pontelagoscuro (the closure section of the Po river basin). The second set of simulations refer to the future and will estimate the variation in frequency of floods and droughts on the Po river basin under the RCPs 4.5 and 8.5.

In the first set of simulations, 1971-2000, the regional climate model COSMOCLM will be driven by (a) ERA40, a global reanalysis of the XX century climate and (b) COSMOMED, a global climate model developed at CMCC. The use of both ERA40 reanalysis and COSMOMED as boundary conditions for the RCM COSMOCLM allows to characterize separately the errors related to GCM and RCM. The ERA40 reanalysis represents the perfect boundary conditions case for the COSMOCLM regional simulation: therefore its use allows to characterize the uncertainties related to the use of COSMOCLM as RCM. The second simulation, using COSMOMED as GCM, is necessary to characterize the error of the GCM that will be used to simulate the climate in the future. The systematic error of the climate component and its effective capability to reproduce the regional climate for the period 1971-2000 are verified through a comparison with different observational datasets. This error is therefore reduced by a statistical downscaling model that corrects the COSMOCLM outputs in both boundary conditions cases.

Thus for each GMC, the Po river discharge is simulated twice: once the hydrological/hydraulic chain is directly feed by the RCM outputs and the second time by the statistically downscaled climate. This double approach is applied to all the simulations scheduled.

Preliminary results for the period 1971-2000, for both ERA40 and COSMOMED boundary conditions, show that the performances of the ERA40 simulations are, in average, better than those driven by COSMOMED, as expected. In both cases, the climate/hydrological/hydraulic modeling chain reproduces the seasonality of climate and discharge, and the alternation of wet and dry years.