



The implementation of the GEOframe system in the Po River District – analysis of water availability and scarcity in the Piemonte region

Gaia Roati^{1,3}, Giuseppe Formetta², Marco Brian¹, Paolo Leoni¹, John Mohd Wani³, Silvano Pecora⁴, Matteo Dall'Amico⁵, Stefano Tasin⁵, and Riccardo Rigon^{2,3}

¹Po River Basin District Authority, Parma, Italy

²University of Trento, Department of Civil, Environmental and Mechanical Engineering, Italy

³Center Agriculture Food Environment (C3A), University of Trento, Italy

⁴Italian Minister for the Environment and the Energy Security, Rome, Italy

⁵MobyGIS, Pergine Valsugana (TN), Italy

In the last years, Italy observed more frequent and intense drought events, with a particularly severe drought in 2022, leading to significant environmental, social and economic damages.

Also at a global scale extreme events, floods and droughts, have been reported to be more likely due to climate change and environmental modification.

For this reason, already in 2021, the Po River District Authority (AdbPo) started the implementation of the GEOframe modelling system on the whole territory of the district to update the existing numerical modelling for water resource management, and then to improve the planning activity of the Authority itself, producing a better quantification and forecast of the spatial and temporal water availability.

The GEOframe system was developed by a scientific international community, led by the University of Trento, and is a semi-distributed conceptual model, with high modularity and flexibility, completely open-source.

After a starting phase of data collection, validation, spatial interpolation (for the reference period 1991-2020), and geomorphological analysis, all the components of the hydrological balance (evapotranspiration, snow accumulation, water storage and discharge) have been simulated.

Consequently, the “zonal calibration” phase was carried out on a 4 years period basis with the KGE method, consisting of the research of the values of the characteristic model parameters which fit the discharge evolution recorded in the hydrometers of the region in the best possible way, comparing the modelled discharge trend with the measured one.

With the completion of the calibration process in the Piemonte region, one of the biggest regions of Italy, which contains more than 100 hydrometers, an analysis of the water balance components

was undertaken, focusing especially on hydrological and agricultural drought events.

In particular, water availability has been modelled in the whole regional territory, evaluating its impact on agriculture, namely studying how and when a hydrological drought affects agricultural drought according to the data collected in the last 30 years.

Attention has been taken also to the snow precipitation contribution, which has a major impact in alpine regions, dominating local and regional hydrology, strongly influencing vegetation growth and the utilization of water resources (Wu et al., 2015), like the one of the Po River basin, characterized by the presence of the Alps along all of its route.

In conclusion, it was possible to carry on a historical analysis of water availability in Piemonte, assessing the capacity of GEOframe to simulate all the components of the water cycle (evapotranspiration, water storage, snow accumulation and water discharge). Furthermore, implementing GEOframe in a mountainous area underlines the importance and the influence that snow and glaciers, especially in a higher temperature scenario due to climate change, can have on water availability and, therefore, a better modelling component of these elements will be implemented in the future developments of GEOframe.