



Assessment of groundwater storage to estimate water availability for the Metropolitan City of Turin (NW Italy)

Rajandrea Sethi¹, Giovanni Pigozzi², **Alessia Amendola**¹, Elisa Brussolo³, Edoardo Burzio³, Alessandro Casasso¹, Daniele Cocca², Diego Colombano³, Domenico De Luca², Elena Egidio², Manuela Lasagna², and Tiziana Tosco¹

¹Politecnico di Torino, Dipartimento di Ingegneria per l'Ambiente, il Territorio e le Infrastrutture, Torino, Italy

²Department of Earth Sciences, University of Turin (DST-UniTo), Turin, Italy

³Società Metropolitana Acque Torino S.p.A. (SMAT), Turin, Italy

Groundwater resilience is a key factor for water security and climate change adaptation in densely populated regions. This study proposes a robust methodology to estimate gravitational groundwater storage (Sethi and Di Molfetta, 2019) in unconfined and deep aquifers within the plain sector of the Metropolitan City of Turin (2,600 km²). This assessment was performed in response to a recent regulation issued by the Italian National utility authority ARERA, which introduced an extensive set of indicators for evaluating service quality and sustainability at province or larger scale. In this framework, it is necessary to estimate freshwater availability (including both surface and groundwater bodies) and withdrawals at the large scale. If on the one hand the estimation of surface water and some type of withdrawals are relatively straightforward, the evaluation of the overall groundwater availability is challenging, and requires a detailed knowledge of aquifer properties, three-dimensional extent, recharge and discharge fluxes which is in most cases not available. This work proposes a simplified approach to meet this target and its application to the plane of the Metropolitan City of Turin (North-Western Italy).

The methodology involves a high-resolution GIS-based approach (250 × 250 m) and assumes the presence of two main groundwater bodies, namely an unconfined (shallow) aquifer and a confined (deep) aquifer. Two hydrogeological surfaces bound the domain: the water table of unconfined (shallow) aquifer (WTSA) from De Luca et al. (2020) and the interpolated surface of well bottoms (ISBW) drilled in the confined aquifer, derived from 340 active wells operated by the local water utility SMAT. An additional intermediate surface, the base of shallow aquifer (BSA), separates shallow and deep aquifers and was previously derived from an extensive historical set of borehole core analyses.

The groundwater storage is estimated as the volume of gravitational water in the two compartments, accounting for impermeable layers and effective porosity. In particular, permeable volumes are determined using depth-dependent granulometry maps, while gravitational groundwater volume is calculated using effective porosity values reported in regional literature. Results indicate that gravitational groundwater reserves amount to approximately 7.68 km³ for the shallow aquifer and 17.57 km³ for the deep aquifers, assuming intermediate values of effective porosity. When porosity variability is considered, total estimates range between 10 and 40 km³.

Although subject to epistemic uncertainties related to surface interpolation and the assumption of special uniform porosity, this preliminary assessment provides a solid and transferable methodological foundation for water resource governance and regulatory compliance under European and Italian environmental legislation.

References:

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