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Water planning and management in the lower Cornia valley by means of advanced modeling tools

Rossetto, Rudy[1], De Filippis, Giovanna[1], Mantino, Alberto[1], De Peppo, Margherita[1], Fabbrizzi, Alessandro[2], Rinaldi, Sandro[1], Ravenna, Calogero[3], Benucci, Claudio[3], Masi, Marco[4], Menonna, Valentina[4], Leoni, Riccardo[4], Lazzaroni, Federico[4], Guastaldi, Enrico[5], Sabbatini, Tiziana[1]
1 Scuola Superiore Sant'Anna, Pisa, Italy
2 Consorzio di Bonifica 5 Toscana Costa, Italy
3 ASA S.p.A., Livorno, Italy
4 Regione Toscana, Italy
5 GeoExplorer Impresa Sociale S.r.l., Cavriglia, Italy

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ABSTRACT

Since the middle of the 1950s, the Olocenic alluvial aquifer of the River Cornia coastal plain (southern Tuscany, Italy) has been progressively exploited for drinking supply, irrigation, and industrial uses, thus causing a remarkable potentiometric drawdown (up to 12 m inland), water balance deficit (about 8 Mm^3 from the 70s to 2001), subsidence, reduction of groundwater dependent terrestrial ecosystems, and the occurrence of seawater intrusion. Therefore, an urgent intervention is necessary in order to restore qualitative and quantitative imbalance of the impacted aquifer.

Within the LIFE REWAT project (sustainable WATer management in the lower Cornia valley through demand REduction, aquifer REcharge and river Restoration; http://www.liferewat.eu/), this is achieved through developing a participated strategy for integrated water resources management at sub-catchment level. Such strategy aims at rebalancing the complex system of the lower Cornia valley in terms of water budget, through optimizing water consumption and increasing intentional infiltration rates. To achieve this objective, five demonstration measures are foreseen: (1) setting up a Managed Aquifer Recharge facility; (2) river restoration of a Cornia river reach; (3) water saving in the civil water supply sector; (4) water saving in agriculture; (5) reuse of treated wastewater for irrigation.

These demonstration interventions are supported by hydrogeological modelling activities through the application of a Geographic Information System and advanced modeling tools integrated in the FREEWAT platform (developed within the H2020 FREEWAT project - FREE and open source software tools for WATer resource management; Rossetto et al., 2015). FREEWAT is a free and open source, GIS-integrated modelling environment which provides spatially distributed and physically based codes (e.g., MODFLOW and USGS-family codes) for the simulation of the hydrologic cycle. The model developed is based on a conceptual representation of the local physical conditions and it allows to: (i) simulate groundwater availability over the last decades; (ii) assess issues related to salinization and water quality, (iii) evaluate water consumption for agriculture purposes, and (iv) manage the demonstration pilot design and operation.

The model is built on a spatial domain 17.0 km x 18.6 km large, using a dynamic process by which, starting from an initial grid based on 200 m x 200 m large cells, the investigated domain is further refined and new elements are added as soon as new data are gathered. Data implemented are related to surface water and groundwater hydraulic head, detailed riverbed bottom profiles, hydrodynamic parameters, depth of aquifer bottom assessed by both existing boreholes and passive seismic measurements, water quality data. The final model is achieved with cells 50 m x 50 m large and detailed information on surface water bodies/aquifer interactions are input. The main outcomes expected are related to the analysis of conjunctive use of ground- and surface-water and the assessment of saltwater intrusion.

The model allows to plan scenarios of rational exploitation of groundwater resources and to set the stage for a governance process (Basin Contract) aimed at sharing a long medium term strategy for water planning and sustainable water management in the lower Cornia valley.

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