ASSESSMENT OF THE POTENTIAL OF INSAR TIME SERIES TO SUPPORT SUSTAINABLE GROUNDWATER MANAGEMENT IN THE EMILIA-ROMAGNA REGION

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Abstract

The sustainability of groundwater resources is influenced by various factors, such as the decrease in groundwater storage. A significant challenge in achieving groundwater sustainability lies in fully comprehending the implications of different alternative management strategies [1]. Previous studies based on satellite measurements have exploited the potential of Interferometric Synthetic Aperture Radar (InSAR) time series to monitor aquifer-related deformation [2,3], detect aquifer storage changes [4], estimate aquifer hydraulic properties [5,6], model hydraulic head at well locations [7] and calibrate three-dimensional (3D) finite element groundwater flow and geomechanical models [8].

The alluvial plain of the Emilia Romagna region (Italy) is a sedimentary basin affected by subsidence induced by natural and anthropic factors for decades. Since the 1950s, various agencies have established different monitoring networks for subsidence, employing geodetic leveling techniques and for groundwater monitoring in areas where the phenomenon has become relevant [9,10]. Both coastal and internal areas experienced land subsidence due to groundwater extraction [11–13]. In this region, the subsidence has reached alarming levels, forcing regional and local authorities to take legislative measures aimed at controlling the process [14].

In this study, we aim to evaluate the benefits and limits of the use of free available Copernicus Sentinel-1 European Ground Motion Service (EGMS) data [15] to support sustainable groundwater management. The proposed approach focuses on assessing the relationship between InSAR-based ground deformation and piezometric level changes in the Emilia Romagna region during the period 2018-2022. Specifically, the analysis will utilize the groundwater monitoring database provided by the Regional agency for environmental protection, and the technical institute for the Region of Emilia-Romagna (ARPA Emilia-Romagna) (Figure 1).

Various statistical analyses [17,18] will be performed to distinguish the different components of the movements and to verify the correlation between these variables at the well locations (Figure 2).

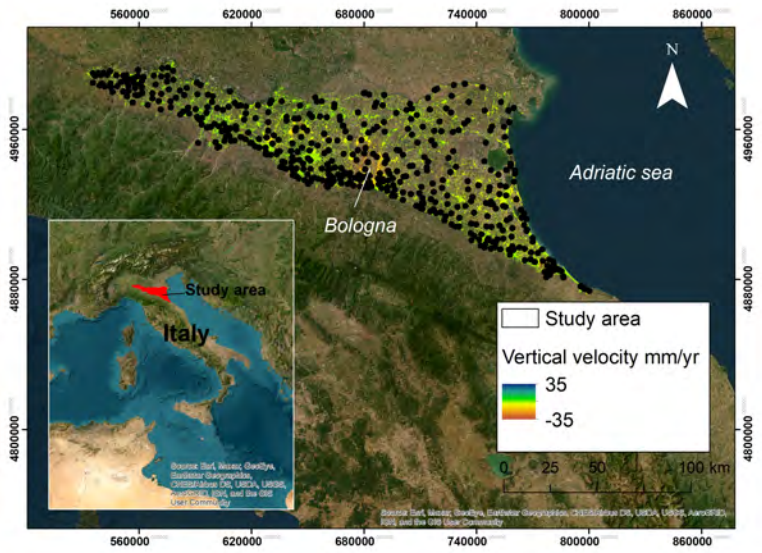

Figure 1. Location of the Emilia Romagna region.
EGMS Sentinel-1 average vertical velocity for the period 2018-2022 [15] and distribution of the groundwater monitoring wells (black points) of the ARPA-ER [16] in the study area.

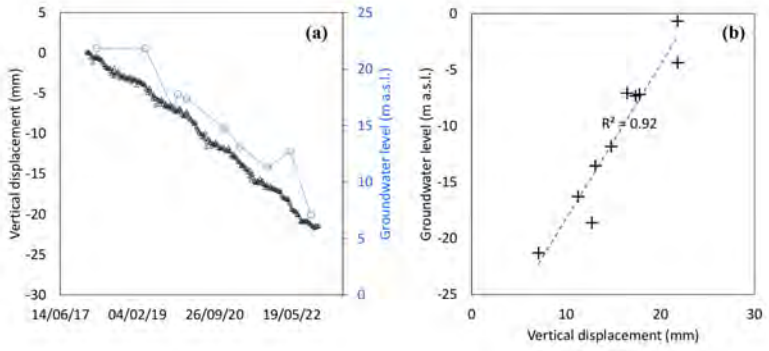

Figure 2. Example of cross-correlation between InSAR-based vertical displacement and groundwater level changes for one piezometer located in Bologna (see the city location in figure 1). (a) Time series comparison and (b) correlation scatter plot. The coefficient of determination, denoted as R^2 is also reported.

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