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Cluster analysis of InSAR data for the investigation of groundwater production effects

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InSAR time series analysis is a powerful tool used in remote sensing to monitor ground deformation over time. In recent years, advanced techniques and algorithms have been developed for the application of InSAR in a more accurate manner along with the continuous availability of new satellite data. In this research, we propose the use of a developed clustering algorithm for analyzing InSAR time-series data and face the superposition of effects inducing ground movements. The investigated area is in the Po Plain in northern Italy and it is characterized by massive groundwater production for various purposes and it also hosts an underground gas storage system. The focus of the research is the identification and the quantification of the seasonal and trend behavior related to aquifer exploitation. We selected the additive approach for decomposing the time-series obtained from InSAR and applied the k-means clustering algorithm (Morissette and Chartier, 2013) over the seasonal and trend components. The results showed different seasonal behaviors attributed to areas with varying water production, rainfall precipitation and structural geology. The trend was analyzed and compared to the existing literature proving the reliability of this method.

The quantification of ground deformation due to each main source is of paramount importance for a reliable prevision of each phenomenon via the calibration of dedicated numerical models. The results of the research will be used to discriminate and quantify the effects of water production from the effects of gas storage operations and they will allow the calibration of dedicated 3D numerical fluid-flow and stress-strains models.

Reference:

Morissette, L. & Chartier, S. (2013). The k-means clustering technique: General considerations and implementation in Mathematica. Tutorials in Quantitative Methods for Psychology, 9, 15-24. https://doi.org/10.20982/tqmp.09.1.p015.