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Detection of nonlinear kinematics in InSAR displacement time series for hazard monitoring

Fabio Bovenga[1], Alberto Refice[1], Ilenia Argentiero[2], Raffaele Nutricato[3], Davide Oscar Nitti[3], Guido Pasquariello[1], and Giuseppe Spilotro[1]
[1]National Research Council of Italy, CNR-IREA, Bari, Italy (bovenga.f@irea.cnr.it ; refice.a@irea.cnr.it ; guido.pasquariello@gmail.com ; g.spilotro@yahoo.com)
[2]Department of Agricultural and Environmental Sciences, University of Bari A. Moro, Bari, Italy (Ilenia.argentiero@uniba.it)
[3]GAP srl, Bari, Italy (raffaele.nutricato@gapsrl.eu ; davide.nitti@gapsrl.eu)

Multi-temporal SAR interferometry (MTInSAR), allows analysing wide areas, identifying critical ground instabilities, and studying the phenomenon evolution in a long time-scale. The identification of MTInSAR displacements trends showing non-linear kinematics is of particular interest since they include warning signals related to pre-failure of natural and artificial structures. Recently, the authors have introduced two innovative indexes for characterising MTInSAR time series: one relies on the fuzzy entropy and measures the disorder in a time series [1], the other performs a statistical test based on the Fisher distribution for selecting the polynomial model that more reliably approximate the displacement trend [2].

This work reviews the theoretical formulation of these indexes and evaluate their performances by simulating time series with different characteristics in terms of kinematic (stepwise linear with different breakpoints and velocities), level of noise, signal length and temporal sampling. Finally, the proposed procedures are used for analysing displacement time series derived by processing Sentinel-1 and COSMO-SkyMed datasets acquired over Southern Italian Apennine (Basilicata region), in an area where several landslides occurred in the recent past. The MTInSAR displacement time series have been analysed by using the proposed methods, searching for nonlinear trends that are possibly related to relevant ground instabilities and, in particular, to potential early warning signals for the landslide events. Specifically, the work presents an example of slope pre-failure monitoring on Pomarico landslide, an example of slope post-failure monitoring on Montescaglioso landslide, and few examples of structures (such as buildings and roads) affected by instability related to different causes.

References

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