

## **A Multiple Algorithm Approach to the Analysis of GNSS Coordinates Times Series for Detecting Geohazards**

Mohammed Habboub (1), Panos Psimoulis (1), Richard Bingley (1), and Markus Rothacher (2)

(1) University of Nottingham, United Kingdom (Mohammed.Habboub@nottingham.ac.uk), (2) Mathematical and Physical Geodesy, ETH Zurich, Switzerland

In this study, a multiple algorithm approach to the analysis of GNSS coordinates times series for detecting geohazard was developed. Spatial, temporal and spatiotemporal analysis methods were used to develop three algorithms. In the spatial analysis algorithm, the spatial autoregressive model was used assuming that the GPS coordinates time series of a network are spatially dependent. In the temporal analysis algorithm, it is assumed that the GPS coordinates time series of a station is temporally dependent. Accordingly, Artificial Neural Networks were used to extract this dependency. However, In the spatio-temporal algorithm, a combination of these techniques was used. These three methods were evaluated by applying them as early warning systems for the GPS network for the case of Tohoku-Oki Mw9.0 2011 earthquake. The results of these three algorithms were compared with those deriving from using the basic method of  $\pm 3\sigma$  thresholds for detected the seismic signal in the GPS time series. The comparison showed that the temporal analysis algorithm detected the earthquake 3 seconds before the conventional method, while the spatial algorithm was delayed by 2 sec relatively to the conventional method. On the other hand, the spatiotemporal algorithm in between. The results showed that even though the three algorithms behave differently through space, their performance close to the epicentre reflected less variation. This study concluded that the temporal algorithm is the most reliable algorithm while the spatio-temporal algorithm can be used as a tool to indicate spatial correlation of the observed phenomenon and its propagation. However, the spatial algorithm seemed to be the least effective algorithm as it was the latest algorithm to detect the geohazard and the more valuable to false alarms.