Comparison of Several Anomaly Detection Methods on the Seismic Groundwater Level Series

Tzong-Yeang Lee[1], Shu-Chen Lin[2], Youe-Ping Lee[3]
Wei-Chia Chen[2], Feng-Sheng Chiu[2],Tzu-Cheng Chiu[2]

1. Department of Information Management, Leader University, Tainan, Taiwan, R.O.C.

2. Department of Resources and Environment, Leader University, Tainan, Taiwan, R.O.C.

3. Water Resources Agency, Ministry of Economic Affairs, Taipei, Taiwan, R.O.C.

ABSTRACT

The earthquake incident will often react out through the interface of the environment; the groundwater is a comparatively apparent one in a great deal of variables. The groundwater is apt to receive influences of the environmental factors, like as rainfall, tide, atmospheric pressure, river water-level and artificial pumping. It increases the difficulty to analyze the variability of groundwater induced by the earthquake. To analyze this effect objectively, the noises to affect the groundwater must be filtered out in advance. This purpose is convenient for analysis and the interpretation of phenomena. In this study, the noise factor of original groundwater level (GWL) is filtered out by the BAYTAP-G model or transfer function model (TFM). The former is developed from Japan and the latter is developed from this research. Next, the several anomaly detection methods are used to check the anomaly of groundwater level caused by the earthquake. There are four methods to explore the anomaly of the seismic GWL series. The first one is the outlier analysis (OA) based on the statistical theory and the others are the variation of the grey-window shifting (Di for short), the measure of the grey variation information series (Ei for short) and the cutting series of the grey progressive sliding (Em for short) based on the grey theory.

The data sources come from the observation stations of the Water Resource Agency, Ministry of Economic Affairs (the title of project: The Study of Groundwater Anomalies Associated with the Earthquake). Firstly, the BAYTAP-G model and TFM are used to filter the influences of affecting the original GWL data series, including the atmospheric pressure, tide, rainfall and irregular signal. After the noises filtering procedure, the data can be taken as the cleansing data. Next, four proposed detection methods are applied to the cleansing data and the results are compared with the "Anomaly Announcement Form (AAF)" established by the Disaster Protection Research Center, National Cheng-Kung University. To compare the results of four detection methods to the AAF, the AAF with seven-step procedure is moderately subjective, but four detection methods with the standard operation procedure are more objective. The OA method is conscientious, but the execution procedure is not easy to automatize. The OA method is used as a quantitative method, in which the earthquake is regarded as an intervention event. The response function is established based on the changes of the GWL before and after the earthquake. The purpose is to realize the impact and extent

of the GWL variation of observation wells in the magnitude of earthquake. Three methods based on the grey theory have lots of merits, including the simple, fast and automatic, but the threshold value to test anomaly needs to set from different observation stations. All four methods may offer the tools for exploring the groundwater micro-behavior and contribute to explaining the relationship of earthquake and groundwater.