GIS AND REMOTE SENSING TECHNOLOGIES FOR TOPOGRAPHIC CHARACTERIZATION OF SEISMIC STATIONS

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Topographic Amplification Factor (TAF) due to ground surface irregularity could be one of the reasons of earthquake wave amplification and unexpected damage of buildings or other tangible structures located on the top of hills in many previous studies (Pessina and Fiorini, 2014). This paper presents application of joint GIS-RS method for characterization of seismic stations in Iran. A semi-automatic indexing procedure of GIS was combined with remotely-obtained topographic data (ASTER). The ASTER GDEM is a very large digital elevation product which covers the vast parts of the global land surface. Known as Topographic Positioning Index (TPI) is a clever and simple algorithm which is based on classification system and is simply the difference between a cell elevation value and the average elevation value of the neighborhood around the cell. Positive values mean the cell is higher than its surrounding and negative values mean that it is lower. The degree to which it is higher or lower and the slope of the cell, can be used to classify the cell into slope positions. If it is considerably higher than the surrounding neighborhood, then it is likely to be at/or near the top of a hill or a ridge. On the contrary, significantly low values mean that the cell is at/or near the bottom of a valley. TPI values near zero interpret either a flat area or a mid-slope area, so the cell slope can be used to distinguish the two. Must be noted, TPI basically depends for the scale of the projects (Jenness et al., 2013). Usually ridge area is more important factor of site characterization irrespective of secondary hazards. Therefore in order to characterization of record stations in Iran, a mid-scale project has been assumed and coefficient factor in all stations is considered to be one. We classify topography into 5 classes: 1- ridge area, 2- upper slope, 3- middle slope, 4- lower slope, and 5- valley.

We divided Iranian seismic stations into 3 groups according to their operated organizations. 1- IGUT seismic network belongs to Institute of Geophysics in University of Tehran (121 stations), 2- IIEES broad band network (31 stations) has been established by International Institute of Earthquake Engineering and Seismology, 3- Geological Survey of Iran (GSI) operated 31 stations in north and south of Iran (Nemati et al., 2013).

The results show that the valley and ridge are the largest categories with percentages ranging between approximately 31% (50m), 36% (100m), 31% (50m) and 33% (100m) respectively. For radius 50m, the rest of the categories are lower slope (5%), gentle slope (22%), steep slope (4%), upper slope (7%) and for radius 100m each of the four categories are 4%, 17%, 7% and 3% respectively. By increasing the radius of 50m to 100m, the trend lines move down for lower, gentle and upper slopes. The ridge and valley categories mostly are detected in the Alborz & Azerbaijan, Zagros and Central Iran block due to the mountainous nature of these blocks. Nevertheless, some categories were not recognized very well. For example unexpected lower percentage of lower or gentle slopes in Lut and Central Iran blocks which contain two main deserts of Iran remains a question why these categories were not detected properly. It seems that for both radius sizes (50 and 100m), detectable lower slope is unsatisfactory and it depends to the extent of certain landscape features.

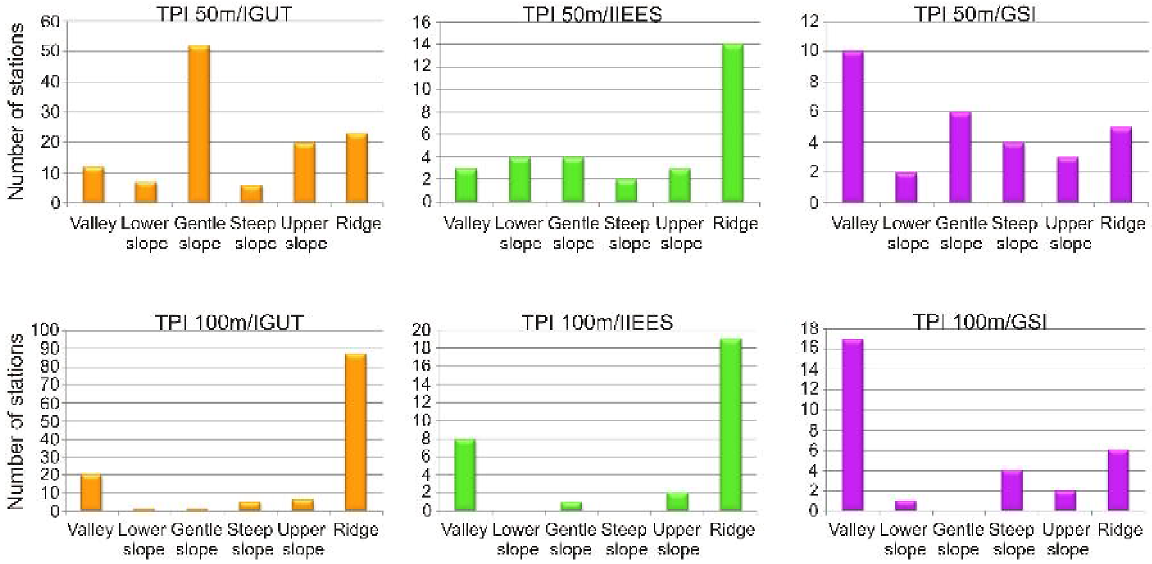

Figure. 1. Number of seismic stations based on TPI analysis for different topographic position classes and different neighborhood sizes (50m and 100m)

Individual analysis of the landscape in radius size 50m shows that for IGUT stations, about 43% of the stations are classified as gentle slopes, 18% as ridges, 16% as upper slopes. Twenty-three percent of the remaining stations are distributed between valley, lower slope and steep slope classes. At the same radius, 43% of the IIEES stations are classified as ridges, 13% as lower slopes, 13% as gentle slopes and the rest of the stations are distributed between the remaining 3 categories (valley, steep slope and upper slope). At the GSI network (with almost homogeneously distribution between recognized categories), thirty-three percent of the stations are classified as valleys, 20% as gentle slopes, 17% as ridges, 13% as steep slopes, 10% as upper slopes and 7% as lower slopes. Overall, 23% of the all stations are located in ridge areas based on TPI analysis with 50m radius. The ridge position manifests itself in the radius 100m more than radius 50m, so that 72.5% of the IGUT stations are recognized as ridges. At the IIEES network, 63% of the stations are placed in ridge positions. But at the GSI network, 57% of the stations are recognized as valleys, 20%, 13%, 7%, and 3% are classified as ridges, steep slopes, upper slopes and lower slopes respectively (Figure 1). As said before, TPI is a scale-dependent analysis and generally as the neighborhood size (radius) changes, the obtained results also change. Although the chosen radii (50m and 100m) are mid-scale, the interpretation of the classified stations depends on defined ground motion equations and standard procedures used in station implementations.

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