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Identification of large geomorphological anomalies based on 2D discrete wavelet transform

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The identification and analysis based on quantitative evidences of large geomorphological anomalies is an important stage for the study of large landslides. Numerical geomorphic analyses represent an interesting approach to this kind of studies, allowing for a detailed and pretty accurate identification of hidden topographic anomalies that may be related to large landslides.
Here a geomorphic numerical analyses of the Digital Terrain Model (DTM) is presented. The introduced approach is based on 2D discrete wavelet transform (Antoine et al., 2003; Bruun and Nilsen, 2003, Booth et al., 2009). The 2D wavelet decomposition of the DTM, and in particular the analysis of the detail coefficients of the wavelet transform can provide evidences of anomalies or singularities, i.e. discontinuities of the land surface. These discontinuities are not very evident from the DTM as it is, while 2D wavelet transform allows for grid-based analysis of DTM and for mapping the decomposition. In fact, the grid-based DTM can be assumed as a matrix, where a discrete wavelet transform (Daubechies, 1992) is performed columnwise and linewise, which basically represent horizontal and vertical directions. The outcomes of this analysis are low-frequency approximation coefficients and high-frequency detail coefficients. Detail coefficients are analyzed, since their variations are associated to discontinuities of the DTM. Detailed coefficients are estimated assuming to perform 2D wavelet transform both for the horizontal direction (east-west) and for the vertical direction (north-south). Detail coefficients are then mapped for both the cases, thus allowing to visualize and quantify potential anomalies of the land surface. Moreover, wavelet decomposition can be pushed to further levels, assuming a higher scale number of the transform. This may potentially return further interesting results, in terms of identification of the anomalies of land surface. In this kind of approach, the choice of a proper mother wavelet function is a tricky point, since it conditions the analysis and then their outcomes. Therefore multiple levels as well as multiple wavelet analyses are guessed.
Here the introduced approach is applied to some interesting cases study of south Italy, in particular for the identification of large anomalies associated to large landslides at the transition between Apennine chain domain and the foredeep domain. In particular low Biferno valley and Fortore valley are here analyzed. Finally, the wavelet transforms are performed on multiple levels, thus trying to address the problem of which is the level extent for an accurate analysis fit to a specific problem.

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