



### **3D determination of landslide block movements**

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As one of the most hazardous phenomena, landslides and their potential risks are of a major research interest for the scientific community. Monitoring is an important phase of landslide investigation providing essential information regarding the stability conditions of unstable or potentially unstable landslide fields. There are several monitoring techniques employed in landslide investigation, e.g. geodetic applications are widely used here. One of the several methodologies used in geodetic landslide monitoring is geodetic transformation, i.e. transformation of a cluster of points in a coordinate system into another system. Within the transformation process, transformation parameters are calculated based on the common points, of which coordinates are known in both systems. Transformation strategy applied is chosen depending on the general objectives and the number of such common points.

This study focuses on the application of such transformation strategies in boundary determination of landslide blocks. Fuzzy Inference Systems (FIS) were also applied in the numerical application. The chosen transformation strategy is affine transformation rather than similarity transformation. This is because of the characteristics of moving masses, i.e. the blocks may have different tendencies towards the horizontal axes.

In fact a 3D affine transformation can be conducted. However, this can also be accomplished by the combination of horizontal (2D) and vertical (1D) positional components of observation points. In this approach, less number of common points in the landslide field is needed. Especially, this approach can be used for the determination of landslide blocks. As an initial step for the determination of block boundaries, dis-

placement vectors of observation points are tested through a 2D affine transformation. Afterwards, vertical displacements for the observation points are calculated. The determination of observations on different blocks is done by an iterative solution. Some steps of the solution algorithm can be accomplished by FIS. The input parameters of FIS are the strain parameters, direction of displacement vectors, their values and root mean square value. These parameters are obtained by the transformation. In addition some other data like the mean value of height changes can also be employed as input parameter.

In the numerical application, the mentioned landslide block determination strategy was applied on a data set collected at a landslide area near Gürpınar village of Istanbul city.