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DYLAM - Dynamic model of Landslide Hazards Assessment

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GIS is widely used for natural hazard assessment. Although GIS is an excellent tool for spatial data handling, its main drawback is the processing of dynamic phenomena, e.g. runoff. Our model (DYLAM) is developed in the MATLAB environment, which is designed mainly for matrix computing and allows dynamic visualization of the modelled phenomena. Currently, we are working on the implementation of DYLAM as a GIS GRASS module.

DYLAM tracks precipitation (the current version does not work with snow) and its transformation into runoff. The input files are: DEM grid and time-vector of precipitation sums, colluvium and bedrock parameters (thickness of colluvium, angle of internal friction, factor of transmissivity, hydraulic conductivity), land-use and a grid file of initial conditions, which provides information about water storage in the watershed at the beginning of the modelled period.

Precipitation is intercepted by the vegetation cover, becomes subject to evaporation and is lost from the system. Further non-intercepted precipitation gradually infiltrates the colluvium, if the infiltration capacity is exceeded, then the surface water storage begins to fill and even surface runoff may occur. If no information about spatial distribution of the colluvium is available, its thickness is computed as a linear function of the steepness of the slope. The maximum (critical) slope for colluvium occurrence is obtained from the angle of internal friction of the particular material. Immediate surface runoff occurs on slopes without vegetation and colluvial cover (bedrock outcrops or artificial surfaces).

Infiltration process and water flow inside the colluvial cover is modelled by the mean velocity in pipes, which is by several orders higher than the velocity described by the

Darcy law only. Subsurface runoff direction and velocity is a function of slope steepness and azimuth. The model sends proportional runoff to downslope neighbouring grid cells.

During each time step, the model evaluates whether the critical sheer stress in colluvium is exceeded by calculating the value of the Factor of Safety. If a landslide occurs, all important triggering factors are recorded. They can further be used for the construction of probabilistic forecasts of landslide occurrence in regions with similar natural conditions, where the lack of precipitation records would not allow us to use DYLAM directly.

The DYLAM algorithm consists of two parts: The data preparation phase includes the DEM adjustment (fill-sink procedure), the calculation of slope and proportional runoff distribution and linear interpolation of the colluvium cover thickness. In the second part, the model works in time steps. Each step consists of adding new precipitation, infiltration process, surface and subsurface runoff, evaluation of the actual sheer stress and its comparison with the critical stress.

DYLAM is now being tested on the real data describing an extreme landslide event, which took place in the Outer West Carpathians in July 1997.