The importance of precipitation, earthquakes and erosion as triggering factors of landsliding - determining landslide activity regime

Landsliding is a movement of soil under the impact of gravitation and along a surface of rupture. Landslides may cause partial or complete destruction of buildings or other infrastructure and they often cause fatalities. They are one of the most important environmental hazards in mountain areas. Good recognition of this hazard is one of the most important tasks of geomorphology. Recognizing the pattern of landslide activity is also important for understanding the way in which landscape of mountain areas changes and evolves.

One of the elements of recognizing the pattern of landslide activity is to determine triggering factors of landsliding, i.e. factors responsible for inducing or accelerating downslope movement of landslide.

In natural conditions some landslides move due to earthquakes and some under the impact of precipitation. Some landslides are triggered by erosion of the foot of slopes by river channels. Earthquakes, precipitation and erosion undermining slopes are three main triggers of landsliding. It is common that one landslide can be affected by more than one triggering factor, e.g. precipitation and earthquakes. At the same time landsliding can be triggered by various types of precipitation: short-term downpours, long-term precipitation or long periods with increased precipitation totals. In case of earthquakes it is not only their energy (magnitude) that decides about landsliding, but also the distance between landslide and earthquake epicentre. The problem is additionally complicated by the fact that over time landsliding on one slope can be triggered by diverse factors.

Because landslides are often a subject of slow movements, invisible for observers, it is often difficult to determine which triggering factors cause landsliding. For most of the landslides we do not have any data on triggering factors or we only have information on the triggers of single, fast and catastrophic events of landsliding. There is a lack of analyses which would explain the factors deciding about landslide activity in the long-term perspective. This is due to the lack of long data sets on landslide activity.

However, thanks to the development of new research techniques we are now able to reconstruct past events of landsliding (during recent decades) and, in consequence, to determine main factors responsible for landslide activation. This is possible thanks to dendrochronology which uses annual tree rings for dating natural phenomena.

It has been found that trees growing on slopes are very sensitive to landsliding. After ground movements trees tilt and start to develop eccentric (asymmetric) annual rings with changed wood anatomy (reaction wood). By taking samples (cores) from tilted trees we can date the time when growth rings started to be eccentric with reaction wood and, thus, the time of landsliding. Thus, each tree growing on a landslide can become a sensor recording ground instability.

In the project we have planned dendrochronological dating of landsliding on 27 slopes located in the Polish parts of the Carpathians and Sudetes. Results of dating will be compared with the occurrence of potential triggering factors: various types of precipitation, earthquakes and fluvial erosion at the foot of slopes. Statistical analysis of this data sets will aim to determine regimes of landslide activity of studied slopes, i.e. to determine sets of factors which trigger movement of certain slopes. For comparison we have planned similar research for 3 landslides in the Romanian Carpathians where we expect more significant role of earthquakes as landslide triggers compared to Poland and for 3 landslides in Sichuan, China, where besides higher seismic activity there are also different precipitation conditions, typical for monsoon climate.