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The use of wood anatomy features for landslide-risk assessment and early warning – an example from Western Carpathians, Poland

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Trees, which grow on active landslide slopes have stems deformed due to the impact of instable ground. Their stems become tilted and bent which results in developing mechanical stresses which influence the structure of wood formed. Deformations occur during the whole life span of a tree and are recorded year-by-year in tree rings. Therefore it is possible to analyse the activity of landslide slopes in the past – through the analysis of tree-ring sequences obtained from living trees. It is also possible to date even small ground movements, otherwise imperceptible without using specialist detectors. Within the studies conducted we have analysed features of wood anatomy of Norway spruce, diagnostic for active landslide slopes: eccentricity and compression wood. The aim of presented study was to check, if it is possible (1) to detect the presence of week, initial ground movements with the use of established dendrochronological approach, (2) to forecast the possible catastrophic landslide event following preparatory phase.In order to fulfill the aim we have analysed the anatomy of spruces growing on landslide slope in Milówska village (foots of Mt Prusów 1020 m a.s.l., southern Poland, flysch Western Carpathians). The slope, basing on geomorphic mapping and observations conducted before 2010, was considered as inactive. However in consequence of heavy rainfalls in May-June 2010 the landslide was abruptly activated. Fast ground movements were catastrophic for inhabitants and buildings in the area. In 2012, in the area affected by landsliding 2 years earlier, we have taken samples (cores) from 25 spruce trees. We have analysed samples in search for growth disturbances: eccentricity and compression wood. We have found that in sampled trees not only the heavy landsliding in 2010 was recorded, but also: (1) symptoms of earlier instability for the last 10-20 years (probable initial landsliding), (2) symptoms of older events from over 50 years ago were detected. Results show that using dendrochronological approach (tree-ring eccentricity and compression wood) in the case slope studied in Milówka it would be possible: (1) to determine – well in advance – the generally high landslide hazard (due to landslide activity recorded in trees half a century ago), (2) to detect – also well in advance – the approaching risk of catastrophical landsliding, which was increasing during the last 10-20 years (due to increase in wood anatomy disturbances), when the slope was also a subject of building and recreational development. Conducted studies have shown that dendrochronological analysis of growth disturbances in trees is a promising approach for determining landslide hazards in whole vast mountain ranges. It allowes one to analyse landslide activity even up to hundreds years ago (depending on the stand age), while modern systems of geodetic or remote monitoring can only cover the last few years, since they were launched into use. The dendrochronological approach can be applied in a wider range – as it is cheap and requires only simple instruments and the presence of coniferous forests in the study area. It can serve in early warning against appearing risk of catastrophic landsliding.