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Quantification of soil losses from tourist trails – use of Digital Elevation Models

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Tourism impacts in protected mountain areas are one of the main concerns for land managers. Impact to environment is most visible at locations of highly concentrated activities like tourist trails, campsites etc. The main indicators of the tourist trail degradation are: vegetation loss (trampling of vegetation cover), change of vegetation type and composition, widening of the trails, muddiness and soil erosion. The last one is especially significant, since it can cause serious transformation of the land surface. Such undesirable changes cannot be repaired without high-cost management activities, and, in some cases they can made the trails difficult and unsafe to use. Scientific understanding of soil erosion related to human impact can be useful for more effective management of the natural protected areas. The aim of this study was to use of digital elevation models (DEMs) to precisely quantify of soil losses from tourist trails.

In the study precise elevation data were gathered in several test fields of 4 by 5 m spatial dimension. Measurements were taken in 13 test fields, located in two protected natural areas in south Poland: Gorce National Park and Popradzki Landscape Park. The measuring places were located on trails characterized by different slope, type of vegetation and type of use. Each test field was established by four special marks, firmly dug into the ground.

Elevation data were measured with the electronic total station. Irregular elevation points were surveying with essential elements of surrounding terrain surface being included. Moreover, surveys in fixed profile lines were done. For each test field a set of 30 measurements in control points has been collected and these data provide the base for verification of digital elevation models. Average density of the surveying was 70 points per square meter (1000 – 1500 elevation points per each test fields). Surveys in each test field were carried out in August and September of 2008, June 2009 and August 2009.

Based on the gathered elevation data, several digital elevation models with spatial resolution 5 x 5 cm and 1 x 1 cm were generated. Subtraction of the DEMs from subsequent time periods gives the amount of material which was transported within the test fields and shows the spatial distribution of earth-surface changes.

Spatial and temporal analysis of transformations of trail surfaces revealed that the changes are not evenly distributed neither in time nor space. In most of the test fields only the small portion of trail were subjected to distinct (more than 1 cm per year) erosion or accumulation. Moreover, degree of changes between June 2009 and August 2009 (3 months) was similar to the degree of changes between August - September 2008 and June 2009 (9 months). Main factors influence patterns of erosion are slope and type of use.