



Digital Elevation Models of Differences (DODs): implementation for assessment of soil erosion on recreational trails.

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Introduction: Tourism's negative impact on protected mountain areas is one of the main concerns for land managers. The impact on the natural environment is the most visible at locations of highly concentrated activities such as 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, trail widening, muddiness and soil erosion. The last one is especially significant, since it can cause serious transformation to the land surface. Such undesirable changes cannot be repaired without high-cost management activities and in some cases they can make the trails difficult and unsafe to use. The scientific understanding of soil erosion in relation to human impact can be useful for a more effective management of protected natural areas (PNAs). The main objectives of this study are: (1) to analyse the spatial aspect of surface changes in microscale; (2) to quantify precisely the short-term rate of soil loss and deposition.

Study area and methods: To gather precise and objective elevation data, an electronic total station with microprism were used. Measurements were taken in 12 test fields, located in two protected natural areas in south Poland: the Gorce National Park and Popradzki Landscape Park. The measuring places were located on the trails characterized by different slope, types of vegetation, and types of use. Each of the test fields was established by four special marks, firmly dug into the ground. Five sessions of measurement was carried out for each test field: August/September 2008, June 2009, August/September 2009, June 2010, August/September 2010. Generated DEMs (based on field surveys' results) were subtracted from each other, and thus we obtained a spatial picture of the loss or deposition of soil in each cell of the model, from one survey session to another. The subtraction of DEMs from subsequent time periods (DEMs of Difference – DoDs) gave the amount of soil which was transported within the test fields and showed the spatial distribution of earth-surface changes as well.

Results: The use of precise elevation data provided by the electronic total station and DEMs of Difference allows us to assess the volume of the surface changes. Spatial and temporal analyses of transformations on the trail surfaces revealed that the changes were not evenly distributed neither in time nor space. During a two-year period (2008-2010), soil loss dominated within 10 test fields, while a predominance of deposition was recorded for the remaining two. The average net volumetric change of the trail surface varied from -0.035 m³/m² per year to $+0.005$ m³/m² per year. Short-term dynamic was high and several test fields had a positive balance (predominance of deposition) in one period and negative balance (predominance of soil loss) in the next period.