The footprints of tourism: Environmental sensitivity and impact of tourism on hiking trails in Iceland and Japan

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The number and size of protected areas (PAs) has grown steadily in recent decades. PAs are designated for various reasons, and managed to balance conservation needs and human interests. Often, PAs are means by which governments can preserve an area of particular interest for future generations. These areas are often spaces characterized by delicate ecosystems, and are thus very sensitive to human impact. In many cases, the designation of a national park is welcomed by local business to promote tourism. However, with consistent increases in tourism, and especially hiking, in these sensitive areas, the threat of land degradation increases, making proper management of nature-based tourism and conservation critical.

Most research into the environmental impact of tourism focuses on the measurement of physical and ecological parameters, and, has been conducted in vegetated rather than less vegetated areas. Whether the findings are generlaizable to less vegetated areas remains unknown, but is an aim of this study. The impact of climate as an important factor influencing ecosystem degradation in PAs has not been investigated in association with ecological sensitivity to determine environmental sensitivity, although research suggests the importance of different climate factors (e.g. Li et al., 2006, Liu and Liu, 2010, Tomczyk, 2011). Our research is the first to integrate various climate factors to complete an environmental sensitivity analysis using the less vegetated areas of selected case sites in national parks in Iceland and Hokkaido (northern Japan).

Hiking trails can be used as an indicator of tourism-related degradation in PAs. This research combines environmental sensitivity with the assessment of hiking trail degradation, using well-known hiking trails at the case sites. We combine ecological sensitivity modelling (Ólafsdóttir and Runnström, 2009) with climate modelling to create a environmental sensitivity analysis. Three ecological factors were assessed to create the ecological sensitivity: top soil, vegetation cover, and a digital elevation model (DEM). Basing the climate model on existing DEM data enables us to account for micro-climate in particularly large areas of mountainous PAs. Our model is based on the assessment of temperature (e.g. solar radiance), precipitation (e.g. topographic wetness index), and wind direction. The climate model combines these factors and is incorporated in the ecological sensitivity analysis to derive the environmental sensitivity. For the hiking trail assessment, we used a regular measurement interval of 100m, to measure four indicators: trail width, trail depth, overall vegetation cover change, and erosion type. Leung and Marion suggest that to ensure a high resolution of data, the measurement interval has to range around 100m (Leung and Marion, 1999). Measurement intervals shorter than 100m would increase the accuracy for further analysis, but at the expense of much higher costs (e.g. time for measurement and analysis), and longer loose accuracy for assessing the whole trail (op. cit.). We also extend the existing method of hiking trail assessment to acknowledge the specific needs of more barren environments, by adjusting the factors according to hiking trail zone, the resilience of the vegetation and top soil to physical impacts. The environmental sensitivity (theory) and the hiking trail assessment (reality) are compared (Figure 1).

Current results show that there is a higher ecological sensitivity of the terrain in Hokkaido than in Iceland. In Japan, 94% of the land shows a medium and 6% high sensitivity, whereas in Iceland 37% of the area show a low and 63% medium impact. We used the measurements of the hiking trails, but adjusted them according to the additional impact zone, and the prevailing vegetation and top soil. This adjustment yields in a more accurate representation of the reality of the trail and its potential for future degradation. The results of the hiking trail analysis show that the adjustments factor shift the average of measurements away from lower impact towards a higher impact (especially in the case of Hokkaido). In Iceland, the peak impact on hiking trails shifts from low impact towards medium impact. Comparing the measurements from Iceland and Japan, we see that the majority of hiking trails in Hokkaido show a much higher impact than the trails in Iceland. Most trails in Iceland show a medium impact (43%), whereas in Hokkaido most show high impact (63%). We speculate that this difference could be accounted for by higher use of trails in Hokkaido than Iceland, since sufficient data about hikers are missing in Iceland. Incorporating the climate model, it can be seen that it accounts for a change in that sensitivity classification. The analysis is not complete, but will be presented at the conference. Initial analysis with solar radiance suggests that the climate model adjusts the ecological sensitivity in the way that it fits more with the reality, which derives from the measurements of hiking trails.

Comparing the sensitivity of the area at the point of measurement along the trail, it can be seen that the measurements show a much higher impact on the trail, than the sensitivity analysis would suggest at the same point. This is because the measurement of the hiking trial represents a much finer resolution than available from measuring the trail in the field, then the environmental sensitivity analysis model in the computer. In addition, the difference suggests that the degradation of hiking trails has already reached a level exceeding the carrying capacity set by the environmental parameters, and the capability of the environment to regenerate and overcome the physical impact of hiking. Notably, the difference between the measured impact on hiking trails and the environmental sensitivity of the area also differs, even though the assessment uses only the initial measurement of impacts.

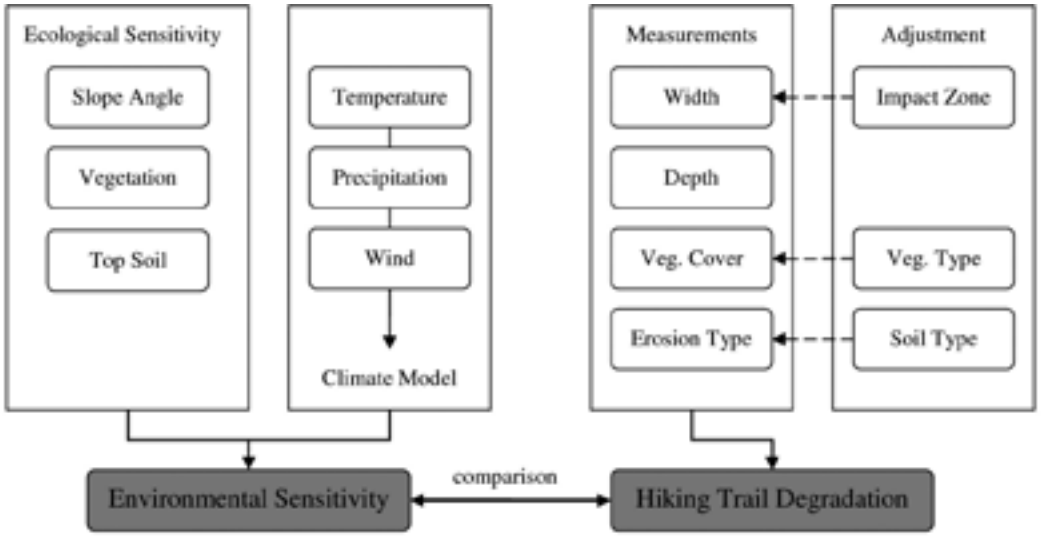

Figure 1. Comparison of Environmental Sensitivity (theory) and Hiking Trail Degradation (reality)

These preliminary data indicate that climate modelling is a key parameter in environmental sensitivity analysis. Temperature and precipitation have an important influence in the model to understand hiking trail condition and degradation potential. We show that the combination of environmental sensitivity analysis with hiking trail assessments is crucial to providing the necessary resolution of measurement points to make accurate judgments of actual trail conditions in mountainous PAs.

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