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Assessing hiking trails condition in two popular tourist destinations in the Icelandic highlands

Rannveig Ólafsdóttir [a,*], Micael C. Runnström [b,1]

[a] Department of Tourism and Geography, Faculty of Life- and Environmental Sciences, University of Iceland, Sturlugata 7, IS-101 Reykjavík, Iceland
[b] Department of Physical Geography and Ecosystem Science, GIS Centre, Lund University, Sölvegatan 12, SE-223 62 Lund, Sweden

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ABSTRACT

Nature-based tourism in the fragile Arctic environments is emerging as a major environmental concern, mainly due to extreme seasonality in these locations, the lack of suitable infrastructures and planning, and its interference with fragile ecosystems. In Iceland tourism has increased exponentially during the past decades, causing more environmental impacts on the country's natural recourses. Hiking is one of the most popular tourist activities in Iceland, especially in the interior highlands. This study had two goals: to map the current status of hiking trail conditions in two popular tourist destinations of the southern highlands, Þórsmörk and Fjallabak Nature Reserve (FNR); and to examine the relationship between trail condition assessment and local physical properties, such as elevation, gradient, soil type, and vegetation cover, in GIS. The current status of the hiking trails is much worse in the Þórsmörk area, where over 30% of the trail system is classified as being in bad and very bad condition, compared to 12% for the FNR. Of the analyzed physical properties only elevation has a clear relationship with hiking trail condition in both study sites and gradient in the Þórsmörk area. Importantly, severe conditions never apply to a whole trail, suggesting that trail conditions are a function of trampling magnitude and local physical properties. Hence, when maintaining hiking trails in vulnerable environments, such as the Icelandic highlands, a holistic understanding of the environmental impact of trampling is critical.

Management implications

When nature-based tourism enters very fragile environments, good monitoring techniques become even more important. Such is the case on hiking trails in the highlands of Iceland, where the study produced the following findings:

- Monitoring the conditions of hiking trails is vital for understanding the major causes of trail degradation in the Icelandic highlands. Implementing a visual field assessment with a condition scale based on simplified classification system, a whole trail system can easily and cost-effectively be monitored and changes recorded. Visual interpretation of the spatial patterns of a trails' condition can further aid managers to identify problem areas and to avoid this type of area in future planning.
- During new trail design, steep slopes should be avoided as trampling easily intensifies solifluction and thus contributes to soil instability and soil erosion. In flat areas trails should be designed so hikers do not easily walk off the trails and thus increase the area of their impact.
- Inevitably, the number of users contributes the most to trail degradation. Therefore in the most vulnerable areas of the highlands the flow and number of tourists should be restricted.
- Gathering high resolution geographical data for use in Geographical Information Systems (GIS) are important in order to monitor and track changes of hiking trail conditions. The possibilities to analyze spatially distributed data and relationships between variables further provides better understanding of cause and effect regarding tourism impact in sensitive natural environments.

* Corresponding author. Tel.: +354 5255482; fax: +354 5254499.
E-mail addresses: ranny@hi.is (R. Ólafsdóttir), micael.runnstrom@nateko.lu.se (M.C. Runnström).
[1] Tel.: +46 46 2227925; fax: +46 46 222 8391.

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1. Introduction

Over the past few decades Arctic regions have experienced increasing interest from tourists. At the same time, many rural areas in the Arctic face considerable out-migration, and therefore tourism often constitutes one of the few positive economic sectors for these regions. They offer vast natural areas and mainly attract tourists who are interested in experiencing nature and nature-based activities. Newsome, Moore, and Dowling (2013) report that natural area tourism has over the past few decades grown significantly worldwide, which subsequently increases tourism impact that has the potential to change natural areas as well as tourism itself. This increased popularity of natural area tourism is likely to exert severe stress upon the planet's most vulnerable ecosystems, many of which are found in Subarctic and Arctic areas.

In Iceland tourism has grown rapidly over the past decades, from approximately 4000 foreign visitors in 1950 to 672,000 in 2012, with a mean annual increase of 8% over the last ten years (ITB, 2013). Just over half a million visitors may not seem extreme, but these annual arrivals amount to double the Icelandic population (321,800 in January 2013; Statistic Iceland, 2013). Tourism is currently the third largest industry in Iceland, contributing 19% of the entire value of exports (Statistic Iceland, 2012a). Furthermore, Iceland was ranked as a top destination for 2012 by many of world's leading travel media such as *National Geographic*, *Lonely Planet* and *The Sunday Times Travel Magazine* (National Geographic, 2012; Lonely Planet, 2012; The Sunday Times Travel Magazine, 2012). Thus, the number of visitors to Iceland will most likely continue to increase significantly over the next few years. Given the fact that most visitors to Iceland visit the outdoors, one ought to expect additional impacts on Iceland's ecosystems.

Iceland's ecosystems are highly susceptible to external physical impacts (e.g. Arnalds et al. 1997; Arnalds, 2011; Ólafsdóttir & Runnström, 2009). To a large part Iceland owes its ecological fragility to its young geological origins and its location in the middle of the North Atlantic Ocean. The oldest known geological formations are no more than 15 million years old and the youngest are still in the making (e.g. Jóhannesson & Sæmundsson, 2009). The volcanic content of the Icelandic soils greatly reduces the soil's capacity to resist erosion as it lacks cohesion and has a high sandy content (Arnalds, 2008, 2010). Iceland's location in the North Atlantic exposes it permanently to strong winds and intense precipitation, leading to intensive wind and water erosion (Arnalds, 2010; Arnalds, Gísladóttir, & Orradóttir, 2012). The short summer season reduces the extent of the vegetative cover, and intensifies the main period of tourism further. Consequently external impact, as caused by tourism can easily disrupt the delicate equilibrium of Icelandic ecosystems and be a catalyst for severe land degradation resulting in loss of geo- and biodiversity. Therefore, it is of vital importance to increase our knowledge and understanding of the environmental impact of tourism in such environments in order to support future mitigative interventions, as well as the development of suitable tourism policies for sustainable visitor use in vulnerable Arctic environments.

For a long time hiking has been one of the most popular tourist activities in Iceland, especially in the interior highlands. Research on recreational trampling in arctic ecosystems identifies trampling as one critical factor in the alteration and degradation of ecosystems (e.g. Chrisfield, Macdonald, & Gould, 2012; Forbes, Monz, & Tolvanen, 2004, Monz, 2002; Scott & Kirkpatrick 1994; Pounder 1985). Monz (2002) proved that the disturbance threshold of the Arctic tundra is relatively low and emphasized the importance of managing tourism so that its impact is kept below each area's disturbance threshold. Degradation of hiking trails by overuse is a recognized problem worldwide. The most common indicators include trail widening and deepening, multiple tread formations, root exposure and damage, and soil erosion (e.g. Cole, 1983, 1986; Leung & Marion, 1996, 1999; Jewell & Hammitt, 2000; Rochenfort & Swinney, 2000; Dixon, Hawes, & McPherson, 2004; Hawes, Candy, & Dixon, 2006Marion, Leung, & Nepal, 2006; Tomczyk & Ewertowski, 2011). Monz, Cole, Leung, and Marion (2010b) believe that trampling is the most widespread and systematically-studied mechanism of recreational disturbance on natural systems, largely because trampling is the most visible form of disturbance from outdoor recreation activities. However, most studies focus on comprehensive field measurements that are time-consuming and economically unfeasible for large areas. In Iceland very few studies have been carried out about the environmental impacts of tourism in general and trail disturbances in particular. Hitherto, only Gísladóttir (2001, 2003a, 2003b, 2006) has undertaken research into tourist trampling, focusing on detailed measurements of the change in vegetation cover, vegetation resistance to trampling, and changes in soil properties on selected hiking trails at several popular tourist sites in Iceland. She concludes that of these three variables assessed vegetation cover is the major indicator for trail condition, and that moss-heath is the most vulnerable type of vegetation cover to trampling. Yet moss heath is the most typical type of vegetation on the Icelandic interior highlands (Guðjónsson & Gíslason, 1998).

In order to manage the environmental impact of nature tourism and to plan tourism in a sustainable manner, a holistic overview of the condition of hiking trails in Iceland's most popular tourist destinations is critical, together with a better understanding of the relationship between the trails' location and their physical properties. This paper aims to evaluate environmental trail conditions as a function of tourism use in two popular tourist destinations within the Icelandic southern highlands, firstly by mapping and analyzing the severity of current trampling impacts, and secondly by using GIS to examine the spatial relationship between trail condition and select physical properties related to the trail's location, such as elevation, gradient and ecological sensitivity.

2. Study areas

2.1. Environmental settings

Iceland has a land mass of approximately 103,000 km^2 extending approximately from latitude 63°23′ to 66°32′N and longitude 13°30′ to 24°32′ (NLSI, 2012). The country is a volcanically active island situated on the Mid-Atlantic Ridge where the boundaries of the American and Eurasian tectonic plates are continually spreading apart. Elevation ranges from sea level to 2110 m. More than one-third of the country's surface area lies above 600 m and only about a quarter below the 200 m contour line (NLSI, 2012).The Icelandic population inhabits the coastline, leaving the interior highlands uninhabited. The highlands are characterized by a large mountainous plateau and in many place a desert-like terrain. It is mainly made up of vast post-glacial lava fields, glaciofluvial deserts, and ice caps which currently cover approximately 11% of the country's surface area (NLSI, 2012), the majority of them located within the highlands. Yet to date there is no official definition of the Icelandic highlands. In 1998 the first and only regional plan for the highlands was produced (i.e. Icelandic Central Highlands, 1998) and appropriate boundaries for the central interior highlands were proposed, stating that it encompasses 40% of the country's surface area (Fig. 1). The Icelandic interior highlands have for a long time attracted both native and foreign nature lovers and are today regarded as a valuable resource for Icelandic tourism.

Icelandic soils are mainly of volcanic origin with *Histosols, Andosols* and *Vitrisols*, Andosols being the most common (Arnalds, 2008, Arnalds & Óskarsson, 2009). The volcanic content of the Andosol makes them highly susceptible to erosion because of their high sandy content and lack of cohesion, which result in an increased susceptibility to erosion by wind and water, but according