Evaluate trail surfacing effectiveness in Yangmingshan National Park, Taiwan ROC: an index approach

Hsiu-Chuan Lin[1], Yu-Fai Leung[2], Sheng-I Hsu[1]

Keywords: trail surfacing, impact management, Yangmingshan National Park, Taiwan

Trails and recreational activities occurring on them have negative effects on soil and vegetation resources in national parks and other protected areas (Leung and Marion, 2000; Pickering et al., 2010). Surfacing of trail treads using rocks, gravels, and other materials is a common solution which park managers use to control resource degradation on and around formal trails. However, there is a paucity of research on the environmental impacts resulting from different types of trail surfacing and on the effectiveness of trail surfacing in minimising trail degradation (Hill and Pickering, 2006; Nepal and Way, 2007). This study explored ways in which the effectiveness of trail surfacing can be evaluated and examined. The specific objectives are:

- to construct an index to quantify trail surfacing effectiveness;
- to compare the effectiveness of different trail surfacing options based on the index and other common measures;
- to identify factors that are important in explaining the variation in trail surfacing effectiveness.

Yangmingshan National Park (YMSNP) (Figure 1) is located in northern Taiwan adjacent to the Taipei metropolitan area where over 6 million people reside. It is one of the most popular attractions on the island, attracting over 4 million foreign and domestic tourists every year (YMSNP, 2009). The park contains high biodiversity levels with more than 1,300 plant species recorded (Chen2004). A network of trails has existed in the park for long time. According to the YMSNP, different types of trail surfacing were paved from 1990 to 2003 in the hope to control soil erosion and provide trail users with higher quality of recreation experiences.

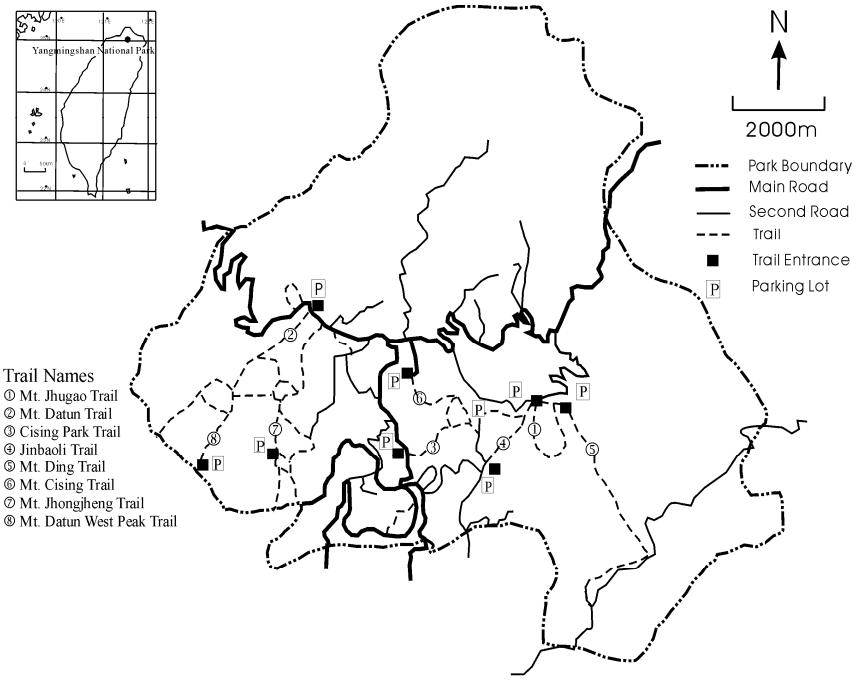

Figure 1: Trail network in Yangmingshan National Park.

[1] Department of Geography, National Taiwan Normal University, Taipei, Taiwan ROC, 89423001@ntnu.edu.tw (Lin) and sihsu@ntnu.edu.tw (Hsu)

[2] Department of Parks, Recreation and Tourism Management, North Carolina State University, Raleigh, NC, USA, Leung@ncsu.edu

We adopted an after-the-fact approach to investigate the trail conditions, taking samples at every 20m on eight trails with a total length of 16km. We constructed the Surface Effectiveness Index (SEI) to quantify trail surfacing effectiveness based on two main parameters: the designed surfaced width and the bare soil width beyond the surfaced tread. The SEI was calculated for six different surfacing types, including rock slabs, rock steps, wooden frame turnpike, wooden frame steps, gravel and concrete. The SEI values were analysed in association with environmental (topography and vegetation), trail design (surface width and materials) and use-related variables using multiple regression and other statistical techniques.

Our results show that the dominant forms of recreation impact on surfaced trails of Yangmingshan National Park are widening and erosion around surfaced trail treads. In terms of tread widening, the average bare soil width beyond the surfaced treads is greater at wooden frame turnpikes. Trails surfaced with rock steps and wooden frame steps exhibit higher levels of soil erosion. Surfacing with gravel appears to be more effective in controlling bare soil width than that with rock slabs. Results from multiple regression analysis indicate that slope alignment angle (angle between trail slope and landform slope) and lateral expansion potential along trail corridors had a significant relationship with trail surfacing effectiveness as represented by SEI, with slope alignment angle showing a positive influence on surfacing effectiveness and lateral expansion potential showing a negative influence. Trails surfaced with rock slabs or rock steps appear to be more effective in minimising trail impacts in open grassy areas than in forest areas.

While this empirical study was limited to a small number of trails in one protected area, our work illustrates the utility of examining trail surfacing effectiveness by applying the SEI and reveal some interesting relationships between trail surfacing effectiveness and environmental attributes. The research findings may inform future decisions of trail surfacing and maintenance in high-use protected areas in Taiwan and East Asia.

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