Assessing visitor spatial behaviour in mountain protected areas with crowdsourced photos: Examples from Argentina and Australia

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Introduction

Mountain summits, valleys, lakes, and glaciers are often desirable destinations for a range of nature based tourism activities. However, these ecosystems are particularly sensitive to visitor impacts due to factors such as cold temperatures and limited soil cover and low diversity, slowing recovery from disturbance (Barros et al. 2013; Leung et al. 2011). Effective management of prominent mountains including those conserved within protected areas requires information about the spatial and temporal patterns of visitor use, yet these data are often limited (Newsome et al. 2012). Data on visitors use can be collected using direct observation, trail counters, visitor passes, camping logbooks and personal tracking technology. However, due to constraints such as limited funding and staff, and the remote nature of many mountains, crowdsourced data is starting to be used to complement other sources of visitor data (Levin, et al. 2017). Crowdsourced data includes geotagged photos publicly shared through social media sites such as Flickr. Geotagged images can serve as proxies of visitor numbers, as well as reflect spatial and temporal variation in visitor use. This study explores how geotagged photos on Flickr can reveal spatial and temporal patterns of visitor use for managers of mountain protected areas.

Methods

The study was conducted in two remote protected areas of high conservation value: Aconcagua Provincial Park in the Argentinean Andes, and Kosciuszko National Park in the Australian Alps. Each park is named after a prominent peak, e.g. the highest summit in the Southern Hemisphere, Mt Aconcagua (6962 m a.s.l.) and the highest summit in Australia, Mt Kosciuszko (2228 m a.s.l.). Both parks collect on-ground visitor data. In Aconcagua this includes entry permits and registration books at the main entrances providing data on the number of visitor-days, locations and activities. For Kosciuszko visitor data are collected at entry gates, through park surveys and point counters on roads and trails. These data highlights the popularity of the parks with approximately 40,000 people visiting Aconcagua annually and more than 2,200,000 visits to Kosciuszko in 2016.

Metadata for Flickr photos were obtained using an application-programming interface to select all geotagged photos within park boundaries taken from 1 November 2010 to 31 March 2016. Metadata for the photos included location (longitude and latitude), the date when the picture was taken and uploaded, and user details. Analysis of the metadata was conducted in SPSS and ArcGIS, as well as the distribution modelling software MaxEnt to assess the associations between visitors' spatial distribution and environmental and infrastructure factors.

Results

A total of 981 photos for Aconcagua and 5985 photos for Kosciuszko posted by 130 and 316 users respectively, were downloaded from Flickr. Spearman's rho analyses revealed a significant correlation between the total number of visitors and the number of photos on Flickr for Aconcagua in main tourist season. Also, Flickr data showed clear seasonal differences in visitation, which is consistent with on-ground data. For instance, 80% of Aconcagua photos were taken in the warmer months when there is easy access to the Park. Photos in Kosciuszko showed differences in the popularity of particular locations between the winter ski-season and summer public holidays.

Flickr photos also revealed important spatial patterns with the Kernel and MaxEnt distribution models predicting high use near visitor centres and main trails in both parks (Figure 1). For Aconcagua, winter months showed that visitor use was restricted to the main road and visitor centre, while in summer areas of high use included two main trails to the summit of Aconcagua. For Kosciuszko, photos were concentrated in ski resorts in winter while in summer trails around the Kosciuszko summit were more popular.

MaxEnt models also provide insights into factors influencing visitation patterns. For instance, during the summer in Aconcagua the most important explanatory factors predicting use were formal trails (permutation importance of 81%) followed by buildings (9%). During winter months, buildings (64%) were most important followed by informal trails (11%). In addition to infrastructure, some environmental variables such as slope contributed over 30% to the model, with more photos on gentle slopes in valleys. Similarly, for Kosciuszko in summer, the most important factors were hardened (27%) and unhardened (11%) trails followed by roads (17%). Winter months in Kosciuszko indicated ski trails (22%), roads (22%) and ski resorts (21%) were most important, but not environmental factors.

Discussion

Results demonstrate how social media data complement on ground visitor monitoring, providing spatial and temporal information on visitor use for site-specific and park-level management of protected areas (Hausmann et al., 2017). Flickr data were an effective proxy for visitor counts as well as providing detailed information about spatial and temporal patterns of use. The ability of social media data to highlight patterns of dispersion and hotspots demonstrates its potential for other areas where there is limited or no data on visitor use, including remote areas. Further analysis including of the content of the photos could indicate not only were photos were taken, but also which aspects of the parks visitors value.

References

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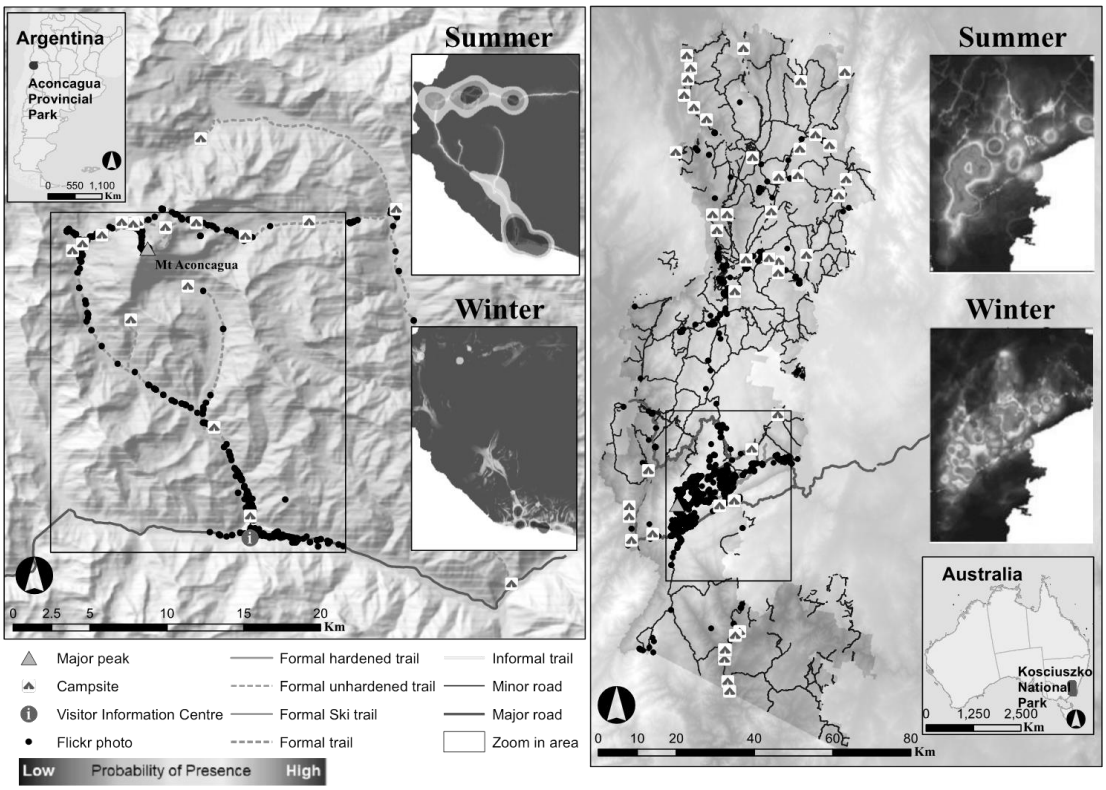

Figure 1. Location of Aconcagua Provincial Park and Kosciuszko National Park showing Flickr photo points. Zoom in area for both parks shows the Kernel density analysis over the MaxEnt visitor usage probability models based on presence of photos.