Feasibility of using mobile phone GPS for visitor monitoring in a national park: a case study in Oku-Nikko, Japan

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Introduction

Global positioning system (GPS) tracking has become a promising method for visitor monitoring in protected areas around the world. High-resolution data, including not only simple patterns of visitor movement but also walking speed and duration of stops, can be collected by distributing GPS receivers to individual visitors. This method, however, also has disadvantages, such as the high cost of distributing a large number of GPS receivers, risk of loss, and constraints on visitor movement for device distribution and collection.

Our study focused on using the GPS equipped in many mobile phones today as an alternative tool. The use of mobile phone GPS functions could reduce the noted costs, risks, and constraints, because this method would use visitors' own devices. Meijles et al. (2014) mentioned that the use of smartphone GPS functions could improve data acquisition, but to the best of our knowledge, no research has yet been published on the use of GPS in mobile phones and smartphones for visitor monitoring in a protected area. Our objective was therefore to test the feasibility of these uses of the technology.

Methods

Study site

Our study site was in the Oku-Nikko area of Nikko National Park in Japan (36°46'N, 139°26'E). Oku-Nikko is characterized by striking scenery and diversity of plant species, making it a popular area for hikers. Visitors can use a shuttle bus for transfer within the study site, as they are not permitted in with their own vehicles.

Interview survey

To investigate visitor's attributes, in September 2015, we conducted interview surveys near three bus stops that serve as the primary starting points for hikes. Questions covered parameters such as respondents' age, duration of stay, means of transportation, frequency of visit to the area, and frequency of visits to other natural areas. Prior to the questions, we asked respondents if they were willing to allow us to collect GPS data from their mobile phones for the study while in the area. Respondents who answered "no" were asked for their reason(s), and they only participated in the interview survey.

Collection of mobile phone GPS data

In Japan many people use smartphones that operate on a global standard, but an older 3G standard of mobile phones unique to Japan is also still popular here (referred to as "feature phones," or *gara-kei*). Free applications were readily available for smartphones to record GPS data, so we asked smartphone users to use those existing apps, and then send us the recorded GPS data when they left the area. However, no such apps existed for feature phones, so we developed a special system by which visitors would access our website, and their feature phones would send GPS data automatically to our server as long as access to the website continued. Visitors were able to terminate the access and data transmission at any time.

Data analysis

We scrutinized the validity of the survey in terms of (1) efficiency of data sampling, (2) bias of sampled data, and (3) implementation difficulties. Specifically, we (1) examined the ratio of visitors who did not want to join the survey, their reasons, and the quality of collected GPS data; (2) used generalized linear mixed models, incorporating visitors' attributes as fixed effects, sampling locations as random effects, and visitor's inclination to join the survey (yes or no) as the response variable; and (3) summarized the practical challenges we faced when doing the survey.

Results and discussion

Efficiency of data sampling

The ratio of visitors who participated in the GPS survey was 15% (17/115). We actually obtained data from12 of them, and the percentage of intact GPS data was 58% (7/12). Consequently, the final sampling rate was 6% (7/115). The percentage of intact data was a level comparable to earlier research using GPS receivers, e.g., 38% (Meijles et al. 2014) and 59% (Taczanowska et al. 2008), but our eventual sampling rate was very low due to the small number of participating visitors.

The top reason not to participate was "no time/inconvenient," which would probably be the most typical response to this type of survey. However, the response rate was over 90% when we conducted a similar interview survey in this area during the same season. The only difference between the two surveys was whether or not GPS information was collected. This implies that the answer "no time/inconvenient" indicates a psychological barrier to participate in a technically unfamiliar survey. Furthermore, privacy concerns appeared explicitly in our survey, unlike previous studies using GPS receivers (Meijles et al. 2014; Taczanowska et al. 2008). Our results demonstrate a challenge specific to the use of GPS in mobile phones for visitor monitoring.

Bias of sampled data

Our statistical analysis showed that the sampled data was biased; for example, younger people, groups (not alone), smartphone users, and first-time visitors to this area tended to be more likely to join the survey. Visitors' attributes were statistically different between participants and non-participants, indicating that the results of the survey could not represent the whole population.

Implementation difficulties

One of the major practical challenges we faced was functional differences in mobile phones between carriers, models, operating systems, and versions. It was difficult for every investigator to master all the functional differences and be able to respond to technical questions from visitors. This constraint impeded the smooth implementation of the survey.

Conclusion

We concluded that mobile phone GPS functions cannot be used for visitor monitoring in the study area at present because of low sampling efficiency, the bias of sampled data, and the diversity of mobile phones. These challenges appear to be related to people's insufficient familiarity with information technology, which might be generally common in Japan. These factors will not likely change in the near future. The development of GPS logger applications that are much easier to use and compatible with any type of mobile phone could make a difference. Further investigation in other protected areas could also provide new insights.

Meijles, E.W., de Bakker, M., Groote, P.D., Barske, R. (2014). Analysing hiker movement patterns using GPS data: Implications for park management. *Computers, Environment and Urban Systems*, 47, 44–57.

Taczanowska, K.; Muhar, A.; Brandenburg, C. (2008). Potential and limitations of GPS tracking for monitoring spatial and temporal aspects of visitor behaviour in recreational areas. In: *The Fourth International Conference on Monitoring and Management of Visitor Flows in Recreational and Protected Areas.* Montecatini Terme: MMV, 451–455.