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Research Note

Smartphone GPS tracking—Inexpensive and efficient data collection on recreational movement

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HIGHLIGHTS

- Smartphone GPS tracking provides useful spatial data for planning and management.
- Explored visitor spatial patterns on formal trails and informal paths.
- Mapped off-trail movement and located hotspot areas of high use intensity.
- Heavy wear observed in situ validated hotspots identified via smartphone tracking.

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ABSTRACT

This research note describes the methodological and practical applications of using smartphone GPS tracking (SGT) to explore the spatial distribution and density of recreational movement in multiple-use urban forests. We present findings from the pilot phase of an on-going case study in Keskuspuisto (Central park), Helsinki, Finland. The study employs an inventive and inexpensive approach for participatory data collection i.e. gathering GPS data from recreational users who have already recorded their routes for purposes other than research, using any kind of sports tracking application on their personal mobile phones. We used the SGT data to examine visitor spatial patterns on formal trails and informal paths, and present examples with runners and mountain bikers. Hotspot mapping of mountain bikers' off-trail movement was conducted identifying several locations with clustering of off-trail use. Small-scale field mapping of three hotspot areas confirmed that the method accurately located areas of high use intensity where visible effects of path widening and high level of wear on the forest floor vegetation could be observed. We conclude that the SGT methodology offers great opportunities for gathering useful and up-to-date spatial information for adaptive planning and management as it highlights areas where conservation and visitor management measures may need to be adjusted. We suggest that this method warrants testing also for other user-centred research and planning purposes.

1. Introduction

Knowledge about visitor movement patterns is essential to planning and management that aims to balance various societal demands and preserve and protect natural resources (Beeco & Brown, 2013; Cole & Daniel, 2003; Orellana, Bregt, Ligtenberg, & Wachowicz, 2012). Advances in spatial technologies such as Global Positioning Systems (GPS) and Geographic Information Systems (GIS) have proven to be useful tools to better plan, manage and monitor recreational use in multiple-use natural areas (Beeco, Hallo, & Brownlee, 2014; De Vries & Goossen, 2002; Wolf, Wohlfart, Brown, & Bartolomé Lasa, 2015). GPS tracking has been increasingly used to study human movement patterns in a variety of natural resource applications such as park and protected area management, tourism and outdoor recreation (e.g. D'Antonio et al., 2010; Hallo et al., 2012; Meijles, de Bakker, Groote, & Barske, 2013). Previous studies have showed great potential of the method to gather accurate and detailed spatial data on the distribution and intensity of use while capturing actual movement behaviour on and off the formal trail network (Taczanowska, Muhar, & Brandenburg, 2008; Wolf, Hagenloh, & Croft, 2012). Off-trail movement creates spontaneous

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path systems making it difficult to predict where and when visitor impacts occur. From a management perspective this process can be hard to control or reverse, therefore up-to-date understanding of the creation of informal paths is crucial for managing recreational impacts.

A common practice in GPS tracking studies of outdoor recreation in natural areas is to hand out a GPS device to participants, which bears several disadvantages such as high equipment investment costs, concerns with retrieval of units and possibly affecting human spatial behaviour due to participants' awareness of the device (O'Connor & Zerger, 2005; Wolf et al., 2012). Using GPS-enabled mobile phones (i.e. smartphones) to collect route data is another, relatively new, but rapidly advancing technique used in research. In urban settings, smartphone GPS tracking (SGT) has been employed mainly in transportation and mobility studies e.g. for creating road inventories or analysing transportation modes and popular routes (Higuera de Frutos & Castro, 2014; Hood, Sall, & Charlton, 2011; Nitsche, Widhalm, Breuss, Brändle, & Maurer, 2014). Data is usually collected by providing study participants with mobile phone devices or using a designated software application for the specific research purpose. On the other hand, the rapid emergence and increasing popularity of volunteered geographic information (VGI) presents new opportunities for research as citizens are actively engaged in the use and production of geographic information driven by individual or community interests (Feick & Roche, 2013; Goodchild, 2007). Using sports tracking applications can be seen as such activity as data is voluntarily generated and often shared in online platforms for different personal reasons e.g. to monitor health and fitness performance, share routes, experiences and photos, guided by self-promotion or social reward that are common motivations for contribution in VGI (Oksanen, Bergman, Sainio, & Westerholm, 2015). This can be also described as self-tracking (in some studies referred to as 'participatory sensing' (Burke et al., 2006) and 'self-surveillance'(Albrechtslund & Lauritsen, 2013)) of individuals who use mobile phones to gather and share various data on their everyday lives, routes or environment. Here we aim to contribute to this growing area of research by illustrating the utility of available, voluntarily collected smartphone GPS self-tracking data for applications in urban forest management. The study employs an inventive and low-cost approach for participatory data collection i.e. gathering movement data from recreational users who have already recorded their routes for purposes other than research, using any kind of sports tracking application on their personal mobile phones.

This research note reports on the pilot phase of a larger ongoing empirical study in Helsinki's Keskuspuisto (Central Park). The overall goal of this paper is to: (1) demonstrate the use of SGT for examining spatial patterns and density of recreational movement and (2) outline the potential and limitations of the method based on our pilot data. More specifically, the aim is to test whether the method can be used to locate movement on formal trails and informal paths, identify hotspots of heavy off-trail use, and to validate the accuracy and usefulness of the SGT data by observing path and vegetation wear on site.

2. Methods

2.1. Study area

Keskuspuisto is the largest single green area and one of the seven "Green Fingers" in the city of Helsinki, Southern Finland (hemi-boreal vegetation zone; population of 620 715 (Statistics Finland, 2014)). Over 10 km in length and up to one km wide, it includes 100 km of formal trails (City of Helsinki Urban Facts, 2005). Keskuspuisto covers 1100 ha of land, with several nature protection areas and 700 ha of old-growth forest (City of Helsinki Urban Facts, 2005). It is a multiple-use urban forest offering opportunities for a range of outdoor activities (e.g. walking, dog-walking, jogging, cycling, horse-riding, mountain biking, mushroom picking, observing nature and skiing), as well as for commuting. It is intensively used with over two million yearly visits (Ilvesniemi & Saukkonen, 2013).

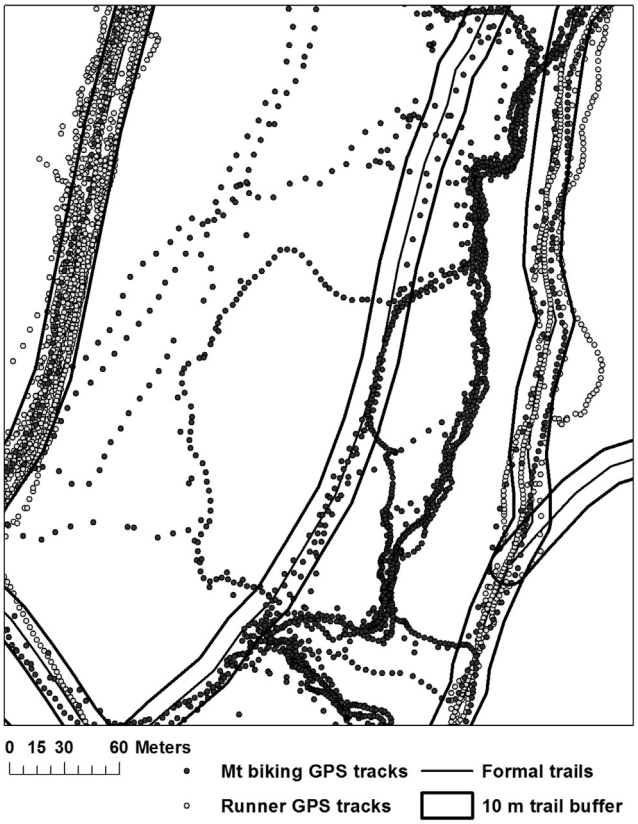

Fig. 1. A segment of typical GPS tracks and the 10 m formal trail buffer. Formal trail network available from National Land Survey of Finland.

2.2. Data collection and analysis

The pilot phase of this study, conducted in collaboration with Public Works Department of City of Helsinki, began in summer 2014 when GPS route data was gathered from volunteers who used any sports tracking application (e.g. Sports Tracker, Strava) on their personal smartphones. Participants were recruited both on-site (approaching visitors inside Keskuspuisto) and online (contacting users who had shared routes on the Sports Tracker website). The study was carried out in accordance with the principles of informed consent i.e. all volunteers were asked to sign a letter of "Consent to Participate in Research" (available both in English and Finnish) providing clear terms and conditions of participation. Furthermore, to address privacy issues related to using SGT data, personal identifying information (name and email) was processed so as to guarantee confidentiality and anonymity i.e. no individual could be recognized from the study results. Finally, only those parts of the GPS tracks within the boundaries of Keskuspuisto (intra-site tracks) were used so that human subjects cannot be traced to home, work or other location outside of the study site.

We did not hand out GPS units/phone devices or use a designated tracking application; instead we explored the usefulness of data that was already collected by recreational users for other purposes than research. When sending their GPS tracks by email,