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Research article

More than A to B: Understanding and managing visitor spatial behaviour in urban forests using public participation GIS

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ABSTRACT

Planning and management needs up-to-date, easily-obtainable and accurate information on the spatial and social aspects of visitor behaviour in order to balance human use and impacts, and protection of natural resources in public parks. We used a web-based public participation GIS (PPGIS) approach to gather citizen data on visitor behaviour in Helsinki's Central Park in order to aid collaborative spatial decision-making. The study combined smartphone GPS tracking, route drawing and a questionnaire to examine differences between user groups in their use of formal trails, off-trail behaviour and the motivations that affect it. In our sample (n = 233), different activity types were associated with distinctive spatial patterns and potential extent of impacts. The density mapping and statistical analyses indicated three types of behaviour: predominantly on or close to formal trails (runners and cyclists), spatially concentrated off-trail behaviour confined to a few informal paths (mountain bikers), and dispersed off-trail use pattern (walkers and dog walkers). Across all user groups, off-trail behaviour was mainly motivated by positive attraction towards the environment such as scenic view, exploration, and viewing flora and fauna. Study findings lead to several management recommendations that were presented to city officials. These include reducing dispersion and the spatial extent of trampling impacts by encouraging use of a limited number of well-established informal paths away from sensitive vegetation and protected habitats.

1. Introduction

In many countries, forests are an essential part of the urban green infrastructure offering a wealth of ecosystem services that are crucial for the quality of life in modern cities (Baró et al., 2015; Faehnle et al., 2015; Tyrväinen et al., 2007). Urban forests are multiple-use green areas providing citizens with important social, health and psychological benefits. Though, intended for public use, they often experience heavy pressure from a variety of everyday outdoor activities such as dog walking, running, cycling or seeking restorative experiences (Arnberger, 2006; Hauru et al., 2012; Verlič et al., 2015). Such intensive recreational use may pose ecological and social challenges and have direct and indirect impacts on the natural resources.

Impacts of recreational activities include soil compaction and erosion, decrease in vegetation cover and tree regeneration, changes in species composition and fragmentation (Ballantyne and Pickering, 2015b; Lehvavirta, 1999; Leung and Marion, 2000; Malmivaara et al., 2002). Ecological impacts that are of most concern to managers often occur in areas without formal trails (D'Antonio and Monz, 2016), however, it is difficult to predict where and when informal paths develop. Informal path systems could become significant environmental threats when spatially extensive, substantially impacted or located in sensitive habitats (Hamberg et al., 2008; Wimpey and Marion, 2011). Proliferation of informal paths may also lead to extensive trail-based fragmentation (Ballantyne et al., 2014; Leung et al., 2011; Wimpey and Marion, 2011) and great cumulative vegetation loss across the whole landscape (Ballantyne and Pickering, 2015b). In order to manage undesirable ecological change, it is critical to understand visitor spatial behaviour inside the area (Orellana et al., 2012) and the

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factors that affect it.

Recreational use consists of complex behavioural, temporal and spatial patterns (Arnberger, 2006; Wolf, Hagenloh and Croft, 2012). Visitor needs, values, attitudes and recreational modes vary on an individual and group level, and change over time. However, studies that analyse qualitative and spatial differences among activity groups are still relatively scarce (Andkjær and Arvidsen, 2015). This research aims to gain such insights on visitor behaviour in urban forests, while using recent developments in spatial technologies and participatory approaches.

Modern spatial technologies can provide decision-making with immediate and efficient ways to understand human spatial behaviour. Geographic Information Systems (GIS) and Global Positioning Systems (GPS) can help better plan, manage and monitor recreational use and impacts in a variety of natural resource applications (Beeco et al., 2014; de Vries and Goossen, 2002; Wolf et al., 2015). At the same time, the increasing integration of technology in our everyday lives provides novel opportunities for crowd-sourced research. Recent studies demonstrated the potential of smartphones in gathering detailed, useful and timely information on the spatial patterns of recreational behaviour (e.g. Doherty et al., 2014; Korpilo et al., 2017a; Santos et al., 2016). Moreover, the rapidly advancing fields of Volunteered Geographic Information (VGI) and Public Participation GIS (PPGIS) acknowledge citizens as valuable source of knowledge as they become more actively engaged in the use and production of geographic information (Brown and Reed, 2009; Brown and Kyttä, 2014; Feick and Roche, 2013; Goodchild, 2007).

This study combined VGI and PPGIS approaches to gather up-to-date data on the density, distribution and motivations of visitor use, all of which represent important variables to monitor and manage use-related impacts (Walden-Schreiner and Leung, 2013). The article presents empirical results from Helsinki's Central Park where the aim was to: 1) analyse spatial behaviour patterns of different user groups; 2) examine the spatial distribution and motivations for off-trail behaviour; and 3) outline implications for planning and management.

2. Materials and methods

2.1. Study area

Central Park is a very intensively used recreational area in Helsinki, Finland, receiving around two million visits every year (Ilvesniemi and Saukkonen, 2015). It covers 1100 ha of land and stretches over 10 km in length, making it the largest single green area in the city (City of Helsinki Urban Facts, 2005). The 103 year-old park includes several nature protection areas and 700 ha of mature forest that offers rich and varied nature and wildlife (City of Helsinki Urban Facts, 2005). The terrain is diverse including forested (e.g. coniferous forests, spruce mires, groves, sparsely forested rocky outcrops) and non-forested habitats (e.g. agricultural fields, river and stream ecosystems, community gardens, fresh meadows). The most popular activities include walking, cycling, running, seeking peace and quiet, exploring nature, dog walking, commuting, and skiing during winter (Ilvesniemi and Saukkonen, 2015).

2.2. Data collection

This study used a web-based PPGIS tool called 'MyDynamicForest' (MDF) to gather information on visitor spatial behaviour in Helsinki's Central Park (Fig. 1). The website was launched in the summer of 2015 and advertised via traditional (local newspapers and radio) and social media. During the data collection period of six months (June to December 2015), different types of spatial (GPS-tracked and drawn routes) and questionnaire data were collected. Participants were asked to submit their route from a recent visit in

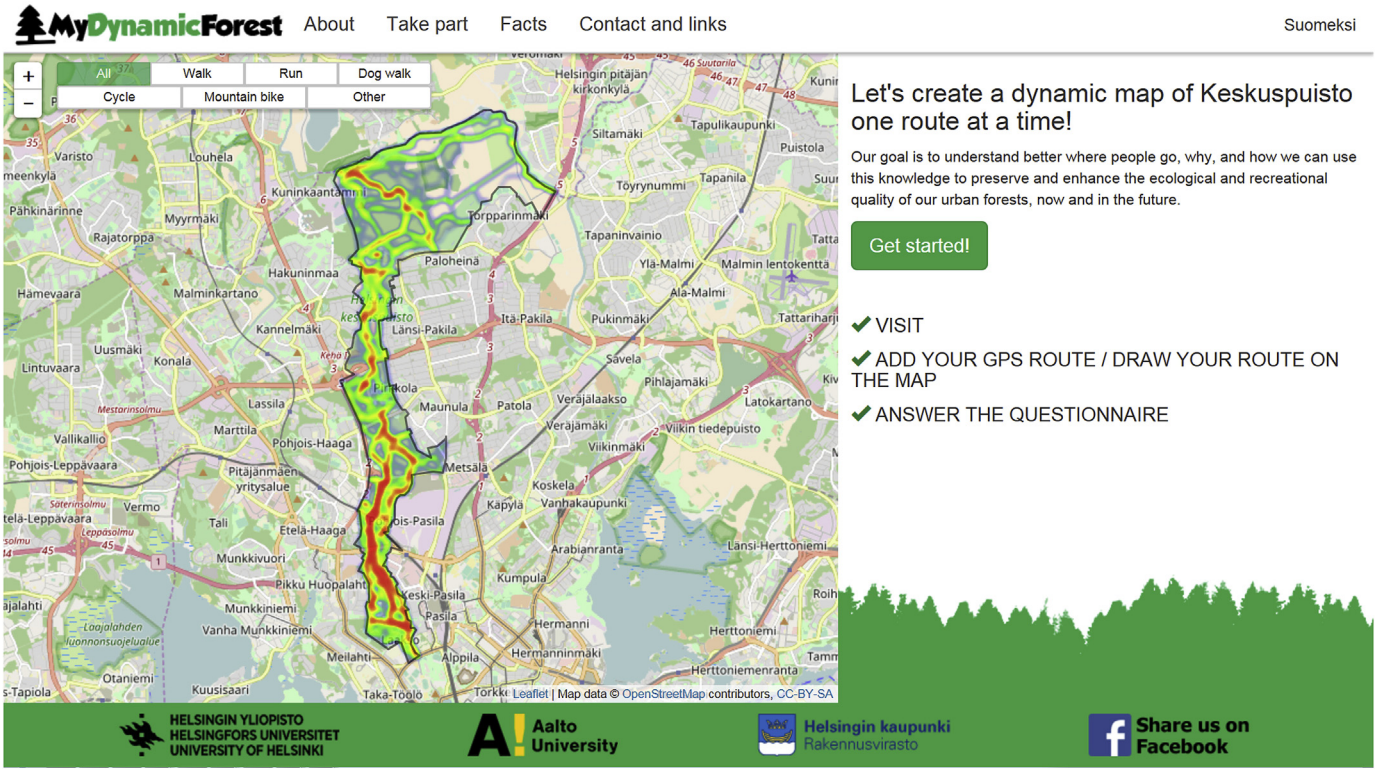

Fig. 1. MyDynamicForest website interface and study area (www.mydynamicforest.fi).