GIS as a tool supporting understanding of visitor flows in recreational areas

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Introduction

In the last two decades the Geographic Information Systems (GIS) framework has become a well-established tool supporting management of natural resources and protected areas (Longley et al. 2001, Gimblett 2002). However, the collection of methods used to store, analyse, model and visualise the visitor flows in natural sites has not yet been exhaustively documented within this application domain. This paper reviews main GIS analytical approaches and discusses their utility for studying visitor flows in recreational areas. The presented overview of methods is illustrated using examples based on empirical data obtained from recent visitor monitoring projects carried out in the Lobau (Viennese part of the Danube Floodplains National Park) by the Institute of Landscape Development, Recreation and Conservation Planning - BOKU University, Vienna.

Overview of GIS-Methods

The choice of adequate GIS analytical tools largely depends on the available input data and the way they are organized (Longley et al. 2001). Visitor flow can be seen as an integral part of an existing spatial object, such as a trail network (Figure 1a). It might also be defined as a separate social phenomenon taking place in a geographic location (Figure 1b), for instance GPS records of tourist movements (Gimblettt & Skov-Petersen 2008). There are also approaches using relational databases to interrelate visitor information and different types of spatial data (Henning 2005, Taczanowska 2009).

For the purposes of this paper, the presented analysis methods have been grouped into the following categories: selection and aggregation approaches, distance-based analyses, density analyses and spatio-temporal analyses. Table 1 summarizes GIS methods and presents possibilities of their application for analysing visitor flows in recreational areas.

Methods falling into the category “selection and aggregation” are very diverse, in particular the use of SQL queries in a relational database allows all sorts of data summaries ranging from calculating volumes of visits at specified locations (Figure 1a), calculating parameters of individual routes, differentiating the intensity of use, and its spatial distribution between various visitor groups. Spatial selection and overlay techniques can support habitat disturbance analysis by identifying areas where public use and sensitive habitats overlap.

Distance-based analyses are typically used for analysing accessibility of recreational areas or accessibility of certain places within the borders of a leisure site. Density analysis can be applied to calculate density of GPS-trackpoints or points where people stop (Taczanowska et al., 2008). In this way the spatial distribution of visitors (Figure 1c) and their resting places (Figure 1d) can be investigated. Spatio-temporal analysis (tracking analysis) enables the representation of the temporal changes of environmental or social data. Within this application, domain tracking analysis can be applied to illustrate movement of visitors in a leisure site.

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Table 1. Overview of GIS-based methods used for analysis of visitor flows

Analysis Method		**Example of an Application Domain**
Selection	Thematic selection	Representing the spatial distribution of specified groups of visitors (eg. hikers vs. bikers / weekend vs. weekday users / tourists vs. locals / morning, midday vs. afternoon visitor flow / etc.)
	Spatial selection	Representing conflict areas, where public use and sensitive habitats intersect
Aggregation	Summarising	Calculating volumes of visits (e.g. per path segment or at specific locations)
		Calculating lengths of individual routes
	Overlay techniques	Representing conflict areas, where public use and sensitive habitats intersect
Distance-based analysis	Network analysis	Definition of catchment area of a leisure site; definition of accessibility zones within recreational areas
		Distances / travel time between origins and destinations (e.g. home address – entrance gate of a recreational area)
		Supply of recreational sites for specified areas (e.g. residential area)
		Calculating the shortest, fastest, most attractive route between origin and destination
	Distance analysis	Distance from a specific object, eg. trail segment, entrance gate, tourist attraction
	Buffer area	Buffer area around specific objects (e.g. along a trail)
Density analysis	Density analysis (Kernel / simple algorithm)	Calculating density of GPS waypoints (tracks or stops), overnight stays, etc.
Spatio-temporal analysis	Tracking	Representation of visitors' movement / spatio-temporal changes of infrastructure

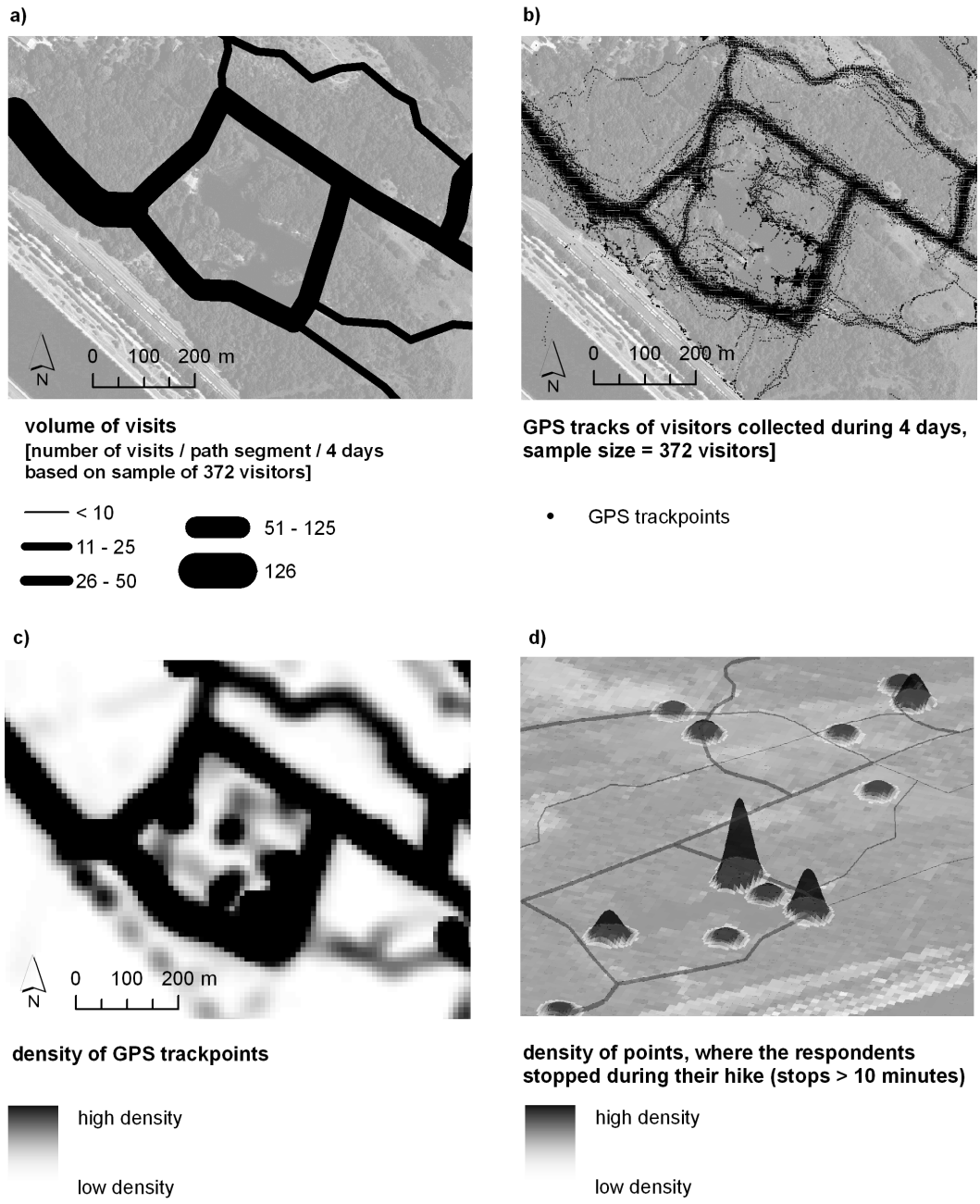

Figure 1. Selected examples of data structures and analysis used to investigate the spatial distribution of hikers around a lake (Dechantlacke) in the Danube Floodplains National Park in Austria: a) visitor flow data represented as an attribute of the trail network [volume of visits per path segment]; b) visitor flow data as a collection of GPS trackpoints; c) example of a density analysis of GPS-trackpoints; d) density of points, where visitors stopped during their hike around the lake. The three-dimensional representation of density values allows to identify even the minor differences between analysed locations.

Discussion & Conclusions

Next to commercial and open source GIS software solutions, there are several specialist applications enabling advanced modelling of visitor flows in recreational areas (Gimblett & Skov-Petersen 2008), such as RBSim, AlpSim, MASOOR and Kvintus. GIS-based analysis can be considered a valuable tool in the explorative phase of visitor flow investigation, having a supportive role for visitor flow models.

We believe that defining relevant analysis objectives and the selection of adequate GIS tools may give a new insight into understanding the spatial context of recreational use and can support management decisions in natural leisure sites.

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