

The applicability of GIS in wilderness planning with an example of the Käsivarsi Wilderness Area

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Abstract

This paper examines the applicability of computer-based geographic information systems (GIS) in wilderness planning in general and in recreation planning in particular. The case of GIS application in the Käsivarsi Wilderness recreation plan is presented.

The Finnish Forest and Park Service (FPS) is preparing a plan for the Käsivarsi Wilderness Area. FPS uses public participation widely in land use planning and recreationists are one important interest group in the Käsivarsi Wilderness Area. Therefore, recreation use volume, used routes, huts, as well as users' characters and opinions were surveyed for one year (June 1996 - May 1997). This yielded a data base of 1369 recreationists. The travelled routes and backcountry overnight locations were entered into a GIS database using Arc/Info-software.

Spatial information is an essential part of land use planning. The example from the Käsivarsi Wilderness Area demonstrates that GIS provide new technological possibilities for the planning process, supporting participatory recreation planning of the area.

Keywords: GIS, wilderness planning, outdoor recreation

1 Introduction

Land use planning is dependent on accurate spatial information. Typically, maps of different themes have been used. More recently computer-based geographic information sys-

tems (GIS) have been developed to provide up-to-date data storage and to aid in planning. Geographic information systems were developed by combining computer assisted cartography and database technology. The first system to be generally acknowl-

edged as a GIS was developed in Canada to analyse land inventory data (Star and Estes 1990). Since the earliest prototypes from the early 1970s the number of applications has been numerous. GIS has been widely applied in network management (pipelines, sewer and cable networks), land use planning, natural resource planning and forestry (Bernhardsen 1992).

The application of GIS in outdoor recreation and wilderness planning is much more recent. Although spatially related information plays an important role in recreation and wilderness planning, GIS is not yet widely applied. Spatially referenced data is used in databases storing information on the area's physical attributes such as land use, camp sites, watercourses or tourist resorts. Examining the attributes of recreationists with GIS is fairly rare and studies about the subject are few. However, the number of GIS applications is expected to increase considerably in the next few years as soon as planners become fully aware of the potential of the systems.

This paper examines the applicability of GIS in wilderness planning in general and in outdoor recreation planning in particular. The case of GIS application in the Käsivarsi Wilderness recreation plan is presented.

2 Use of GIS in land-use planning

Geographic information systems have been used in numerous applications and in some cases the neces-

sity of GIS has also been criticised. The system was originally developed for analysing data where spatial referencing was relatively easy (e.g. physical environment). However, in several applications the spatial representation is inherently more difficult. For example in socio-economic applications, when studying phenomena relating to people (e.g. unemployment, deprivation), the accurate defining of location is usually not possible (Martin 1996). An area in which GIS technology and associated methodologies have the potential to make an important impact is land use planning (Haines-Young et al. 1993). The need to manage urban areas was one of the main reasons for the development of GIS. Planning new infrastructure, waste and factory site selection are sectors where GIS has been widely applied and the results have been good. Usage of GIS to solve rural and agricultural problems has been extensive covering applications from dam site selection and runoff analyses to predicting crop yields on farmlands (Haines-Young et al. 1993).

Recreation and wilderness planning are fields where the combination of maps and thematic information forms an important part of the planning process and therefore the application of GIS offers great prospects. One would think GIS would be the most important tool for planners, but this does not seem to be the case. GIS has until recent years been a relatively unfamiliar tool in wilderness and recreation planning. It seems though that the predicted boom in the number of GIS applications has been starting to enter the

field only in the last couple of years. GIS has been applied in several wildlife management studies when determining habitats of wildlife species and wildlife movement corridors (Knick and Dyer 1997, Waller and Mace 1997). Several GIS applications have spawned especially in the United States to restore, protect and manage natural resources. In areas heavily used in recreation, GIS is used in identifying unique habitats, in resource management, designing of park infrastructure and in impact assessments. GIS provides also an efficient tool to graphic displays thereby facilitating e.g. in public participation processes.

3 The case of the Käsivarsi Wilderness Area

3.1 Study area

The Käsivarsi Wilderness Area covers about 221 000 hectares of land and water in north-western Lapland, in the municipality of Enontekiö. It is the most arctic wilderness in Finland with about 20 fell tops reaching over 1000 meters above sea level. Also Finland's highest fell, Halti (1328 m) is in the area. The entire area is north of pine tree line consisting mostly of barren fell-lands (72 % of the surface area) but also of subarctic birch forests (14 %), peatlands (10 %), and waters (4 %). The area is covered with snow and ice for 8 months of the year. The northernmost part of the wilderness is the only region in Finland being part of the Scandinavian Köli moun-

tain chain. Therefore the area is unique in Finland in its geology, vegetation and landscape.

Recreation is the most recent form of land use in the Käsivarsi Wilderness Area. However, recreationists found the Käsivarsi region relatively early compared to other Finnish wilderness areas. The first known recreationists to the area were Finnish women gymnastics in the beginning of 1930s (Kari 1978). The Käsivarsi Wilderness Area continues to be the most popular Finnish wilderness area among recreationists. The area has 18 open huts and 5 reservation huts, a marked backcountry hiking route (Kalottireitti), and a marked snowmobile route.

3.2 Study design

The Finnish Forest and Park Service (FPS) is preparing a plan for the Käsivarsi Wilderness Area. FPS uses public participation widely in land use planning and recreationists are one important interest group in the Käsivarsi Wilderness Area. Therefore, a recreation survey covering an entire year (from June 1996 to May 1997) was implemented in the area.

The sample for the survey was obtained by placing a book with a cover letter in every wilderness hut asking for name, address and some basic information about the visit. At the end of the snowfree season (summer – autumn 1996) the books were replaced with new ones. Information was entered into a data base from which a sample of 1000 visitors over 16 years of age was randomly chosen (Table 1). They received a more detailed questionnaire via mail ask-

Table I. The sample size and response rate.

	Number of names	Sample size	Number of respondents	Response rate, %	Representativeness	Number of visitors
Summer-autumn (snow-free season)	2 213	1 000	845	84.5	63.4	2 800
Winter-spring (snow-covered season)	1 425	644	524	81.4	61.1	1 800
Overall	3 638	1 644	1 369	83.3	62.5	4 600

ing which route they had travelled, their opinions about various wilderness related issues as well as background information. Same arrangement was implemented after the snow-covered season (winter 1996/97 – spring 1997) had ended. This arrangement ensured that every recreationist over 16 years of age who had written his/her name into the book had the same likelihood to be involved in the sample. Overall this arrangement yielded a data base of 1369 respondents.

Both in summer and in winter there were field interviews to find out how representative the name list in the book was. Approximately 75 % of visitors wrote their name and address information into the books. It could thus be calculated that the overall representativeness of the mail survey was 62.5 %. However, snowmobilers doing only a day-trip into the wilderness tended not to stop in any hut, and are thus clearly under-represented in the sample.

3.2.1 Programmes used

The mail survey results were entered into an Excel data base. This did not include the travelled routes and

backcountry overnight locations, which were entered into a GIS database using Arc/Info-software. Arc/Info is a widely used geographic information system package, which was originally designed for analysing vector data. More recently, the usage of raster data has also become possible. The system consists of modules, from which every user can create the combination best suitable for his/her purposes (Tokola et al. 1994). Each module manages its own activity: Grid is a tool for raster analysis, land use planning and hydrological modelling; Tin is for elevation models and groundwater modelling; Network is used in network analyses, route optimisations and planning. Small scale programmes can be written with Arc/Info Macro Language (AML) which can be used to customise the programme-package better suitable for specific needs.

The routes and overnight locations were transformed into digital form in order to import them into Arc/Info. The routes on paper maps were digitised using a relatively common Finnish cartographic programme Topos. It is a vector-based cartographic system, where map el-

ements are described by lines, points and polygons. Information about the elements is stored in a file as co-ordinates, attached to a type-code corresponding to the map element. Conversion of co-ordinate-files to Arc/Info format is done with a conversion programme called TOAI.

3.2.2 Methods

The distribution of the wilderness use was examined with raster analysis whereby the uneven distribution and use concentration on different parts of the area could be examined with an overlay analysis. The routes were stored into Arc/Info by digitising each route with overnight locations in its own file using the cartographic programme Topos. The analysis was performed by changing the pixel values in each data file into zeros and ones so that the pixels forming the route were defined as ones and other cells as zeros. By summing together the rasterised data layers it was easy to find out the number of visitors going through each pixel. Reclassifying these values into suitable categories the final maps were produced.

The overnight location maps were produced in the same way as the route maps. The overnight locations were digitised as points and the rasterised layers were summed together in order to define the most frequently used camping sites. This way the number of overnight stays in each pixel was obtained. From this map the most popular campsites were selected and buffers were produced around them in order to find out the overnight stays in each campsite and

in its neighbourhood. With “zonal sum” -function the campsite use within each buffer was calculated.

Arc/Info Macro Language was used to facilitate the data management. With the help of AML the functions were automated so that the programme performed repetitive operations needed for each file with one command.

3.3 Characteristics of the sample

The average age of all adult (16 years or older) visitors was 41 years. 70 % of all the visitors were men. Similar gender imbalance is a common finding among backcountry visitors; it was found e.g. in the UK National Park located in northeastern Lapland (Saarinen 1995). The difficulties of travelling during the snow-free season were reflected in overnight patterns: during the snow-free season 96 % of the visitors stayed overnight in the wilderness area, while for the entire year the figure is 85 %.

Respondents were asked both how they had travelled on this trip (Table 2). One should keep in mind the under-representativeness of snowmobilers, which is evident also from table 2.

Table 2. Mode of travel on this trip.

	On this trip, %
Hiking	53
Skiing	31
At least partly flying	8
At least partly snowmobiling	6
Boating	2
Total	n=1353

3.4 Results

3.4.1 Travelled routes

The number of hikers is heavily concentrated on certain routes, Kalottireitti-route being the most dominating one (Figure 1). The number of hikers per hectare along the marked route varies from 301 up to 900. Other very popular routes are the route to Luossujärvi and the route following a marked snowmobile route to Terbmisjärvi-lake with 301–600 hikers per hectare. Also the route to Ropi Fell and the corridor of river Toriseno are fairly popular hiking routes. The most common route

choice among those recreationists who had been using also some other mode of travel than walking during the snow-free season is the river Lätäseno used mostly by canoeists and rafters (Figure 2). Other route choices in this group seem relatively random.

Also during the snow-covered season (winter and spring) the Kalottireitti-route is clearly the most popular (Figures 3 and 4). The number of visitors in the area is generally lower in winter and the concentration on the marked winter route to Halti Fell is 101–300 per hectare (Figure 3). The wilderness visitors

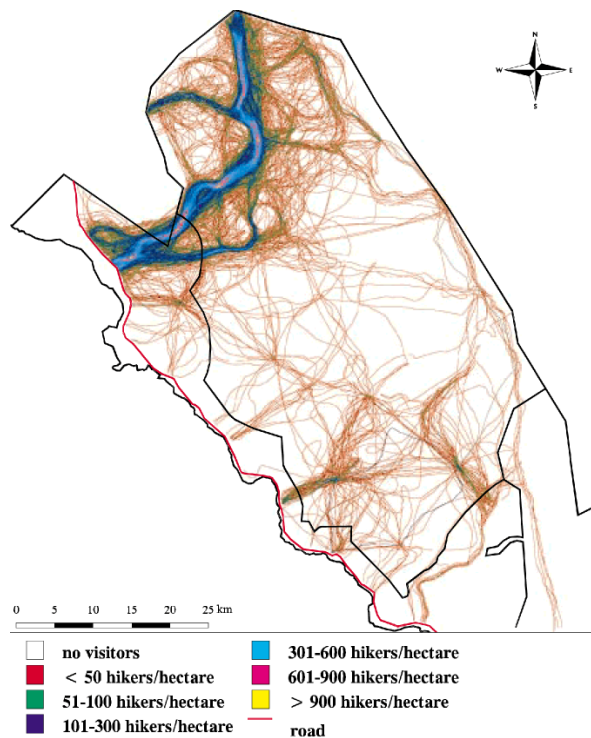


Figure 1. Number and distribution of hikers in the Käsivarsi Wilderness Area during the snowfree season of 1996.

Figure 2. Number and distribution of recreationists travelling also in some other way than walking in the Käsivarsi Wilderness Area during the snow-free season 1996.

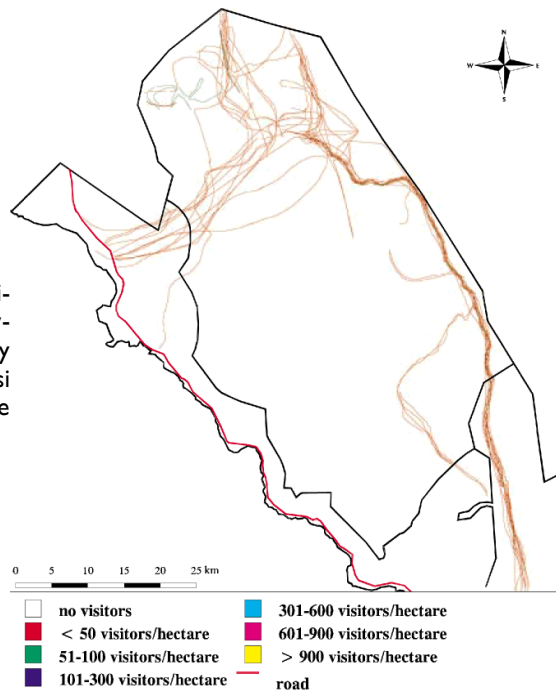
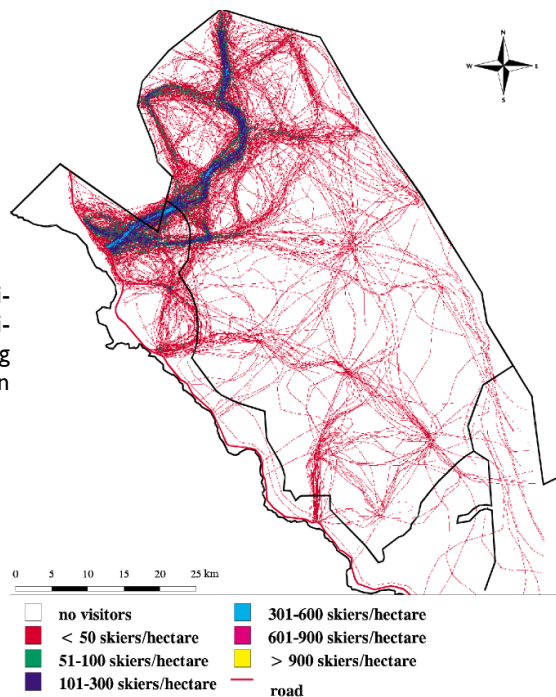


Figure 3. Number and distribution of skiers in the Käsivarsi Wilderness Area during the snow-covered season 1996-97.



who do not ski in winter are mainly snowmobilers (Figure 4). Residents of the municipality of Enontekiö are allowed to snowmobile freely in the wilderness area, while others are requested to stay on marked routes. The route to Halti, requiring a guide, is the most frequently used one also among snowmobilers.

The number of overnight stays is somewhat greater during the snow-free season than in winter due to the smaller number of winter season visitors to the area (Figures 5 and 6). In

summer the most popular overnight location was the hut of Meekojärvi with over 700 overnight stays. The next most popular places were Pitsusjärvi, Saarijärvi and Terbmisjärvi with 301–700 stays. Three of these most popular huts are situated along the Kalottireitti-route, and also Terbmisjärvi is fairly close to the main route. During the winter season the two most popular overnight locations are Pitsusjärvi and Saarijärvi, each with over 300 overnight stays.

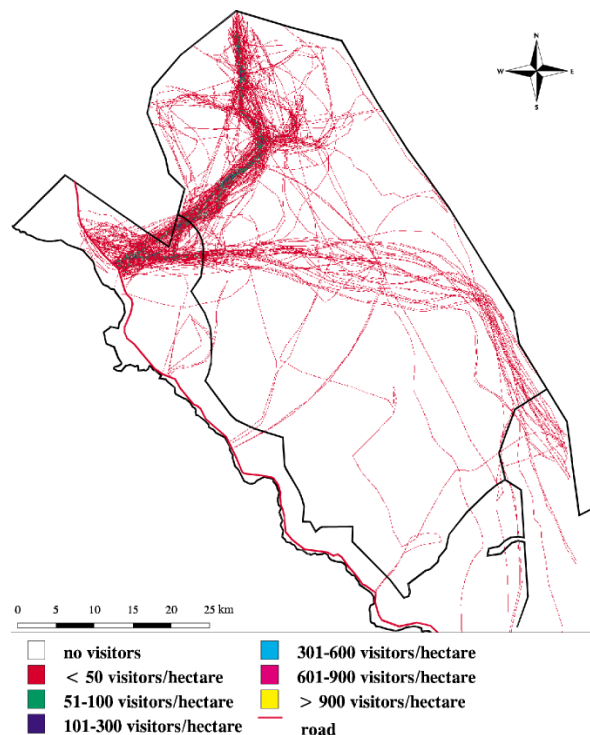


Figure 4. Number and distribution of recreationists travelling in some other way than skiing in the Käsivarsi Wilderness Area during the snow-covered season 1996–97.

Figure 5. Distribution of overnight stays during the snow-free season 1996.

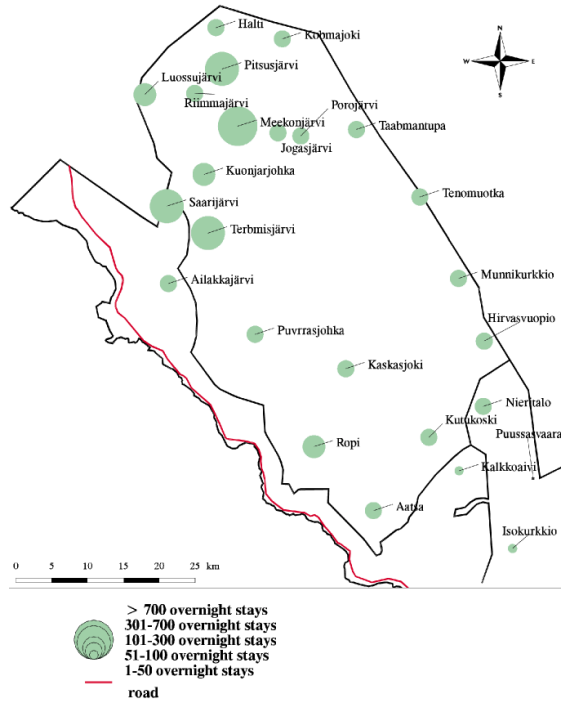
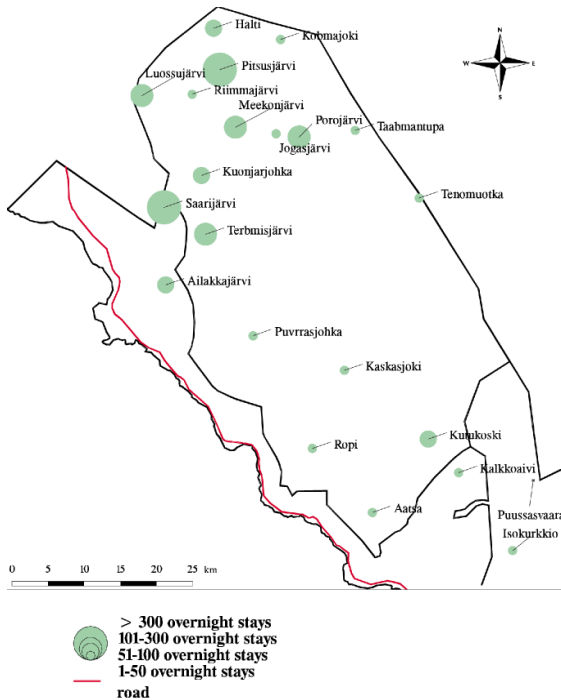


Figure 6. Distribution of overnight stays in the Käsivarsi Wilderness Area during the snow-covered season 1996–97.



3.4.2 Selected management issues

About half of the visitors in the Käsivarsi Wilderness Area had been at least sometimes bothered by crowding, behaviour of other visitors, terrain being trampled or by some other factor (Table 3). The most common explanation for summer time visitors having been bothered

by some other factor was helicopter and aeroplane transportation. Motorised modes of travel, i.e. snowmobiling, motorboating, helicopter and aeroplane were the least acceptable modes of travel according to most visitors (Table 4). However, most of these motorised activities are acceptable at least in parts of the wilderness area.

Table 3. Has any of the following factors disturbed you while visiting the Käsivarsi Wilderness Area? (n=1149...1352).

	Not at all	Somewhat	A lot
	%		
Number of visitors	51	42	7
Behavior of other visitors	59	34	7
Some other factor	59	29	12
Terrain being trampled	65	32	3

Table 4. How suitable do you find the following functions in the Käsivarsi Wilderness Area? (n=1307...1348).

	Fully suitable	Suitable in parts of the area	Not suitable at all
	%		
Snowmobiling outside the route	3	12	85
Motorboating	3	26	71
Guided snowmobile tours	13	43	44
Snowmobiling on the route	13	45	41
Aeroplane transportation	12	47	42
Helicopter transportation	14	48	39
Dog-sledges near huts	28	46	26
Hikers with dogs	57	31	13
Reindeer drives	54	38	8
Guided hiking tours	49	45	6
Dog-sledging	45	49	5
Guided ski-tours	52	44	4

3.4.3 GIS knowledge in management of the Käsivarsi Wilderness Area

The purpose of the Finnish wilderness areas is to preserve their pristine character, to protect the Sami culture and traditional subsistence uses, and to facilitate greater multiple-use of the natural environment (Wilderness Act 1991). Preserving the pristine character of the area is essential also from a recreation experience point of view. According to the survey the three most important reasons for visiting the Käsivarsi Wilderness Area were scenery, area's wilderness and pristine character.

The geographic analysis on the distribution of wilderness recreation use in Käsivarsi shows a trend, also known in wilderness recreation literature, that the distribution of visitors is never even but tends to follow certain routes (Lucas 1990). The most popular route in the Käsivarsi Wilderness Area is the marked back-country hiking route Kalottireitti. Regardless of the season the Kalottireitti-route is the most popular. Similarly, the overnight locations are unevenly distributed. The most popular overnight locations are found along the Kalottireitti-route, where the density of visitors is the greatest. The concentrated use patterns were reflected also in the responses to the survey question about crowding.

Wilderness planning aims at integrating the goals of different users into an acceptable management plan that meets the requirements of the Wilderness Act. According to the survey, the most significant recreation conflict exists between those visitors travelling by traditional

modes of travel and those travelling by motorised methods (flying, snowmobiling).

The result that most visitors accept all modes of travel at least in some parts of the Käsivarsi Wilderness Area gives possibilities for zoning. Wilderness character is a relative and subjective concept, and therefore zoning can create regions with different wilderness character.

Once the zones from a recreation point of view have been created, they will be compared to focus areas of other important wilderness uses. These include local subsistence use (reindeer herding, hunting, fishing and picking cloudberries) and commercial nature tourism. Thus, GIS continues to be an important tool throughout the planning process. Knowledge of the current recreation use patterns in the Käsivarsi Wilderness Area in an easily interpretable map format will facilitate in making well informed decisions. This kind of spatially related information is useful for everybody involved in the planning process from local people to managers.

4 Conclusions

Geographic information systems can dramatically expand information storage and manipulation capabilities. They help to supply current information on the state of the planning area and provide tools for efficient analysing.

The advantage of digitising information compared to other geographically oriented methods is the simplicity of storing. The routes can be

stored with the same accuracy as they are expressed on paper maps. Storing is easy because no consideration is necessary on the category of the route or the equivalency of routes close to one another. Also exceptional choices of hiking routes can be stored without difficulties or making the storing system more complex. The main source of error in the Käsivarsi GIS analysis comes from the scale of the map (1:400 000). It is not easy to digitise information fully accurately from this scale, and on the other hand, not all the respondents had drawn the routes that accurately.

The type of geographic data gathered about recreational use in the Käsivarsi Wilderness Area provides also possibilities for more detailed analyses. For example, the relationship between the route chosen and personal attributes (age, gender, etc.) could be studied. Similarly, the relationship between the route chosen and the physical attributes of the area, or between the route chosen and recreational activities participated could be studied. Moreover, with buffers around main watercourses the correlation between the vicinity of water and choice of overnight location could be studied.

In conclusion, the example from the Käsivarsi Wilderness Area demonstrates that computer-based geographic information systems (GIS) provide new technological possibilities for the planning process, supporting participatory recreation planning of the area.

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