Monitoring and Management of Visitor Flows in Recreational and Protected Areas
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Recreation in Urban Forests: Monitoring Specific User Groups and Identifying their Needs with Video and GIS-support

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Abstract: In the urban forest of Stuttgart the forest roads are used by a growing number of people looking for recreation for their leisure activities. To manage and channel the different user groups within an optimized forest road network needs a lot of information: Number and composition of visitors, demands of different user groups concerning standard of roads and trails they use for their activities, conflicts that may rise between different users using the same road at the same time, dedication of roads to special activities (e.g. fitness trail, hiking trail...). Personal interviews with "experts" were made to obtain information about the specific demands of the different user groups, a new method of video monitoring was used to collect longtime information about number and composition of visitors, and analysis of road network was done with the help of GIS. The results show that these tools complement one another quite well and the combination of obtained data may help to channel visitor flows and to minimize conflicts between different user groups

INTRODUCTION

Forest roads, in former times planned and constructed for the needs of wood harvesting and transport, are the key factor for recreational access to and activities in forests. Leisure activities in urban forest include hiking, biking, horse-riding, jogging and inline-skating. The different user groups may have different demands and impacts on the roads they use for their activities and on the surrounding environment. Using the same roads at the same time may lead to increasing conflicts between the different users. Managing the increasing number of visitors in urban forests needs information about the number, composition and temporal distribution of visitors as well as a profound knowledge of their demands. These information may help to channel visitor flows and to minimize conflicts between users by establishing roads that meet the special requirements of the different user groups.

This paper discusses some methodical aspects and results of an investigation dealing with the analysis and optimization of a multiple use forest road network in the urban forest of Stuttgart (v. Janowsky, 2001). This forest is managed as a multifunctional forest. The objectives are to produce wood for industrial use in an efficient and sustainable way, and to provide opportunities for all kind of recreational activities and outdoor use for the more than 500,000 inhabitants of the town and the region. The objective of this study is to derive an optimized forest road network that meets the requirements of forest management as well as the needs of recreation and outdoor use most effectively. Compared to the status quo, this optimized forest road network should also be characterized by lower maintenance costs and reduced impact on the forest ecosystem. For analyzing the status quo as basis of further optimization the following methodical tools were used (see also fig. 1):

- Video monitoring
- Personal interviews
- Geographic Information Systems (GIS)

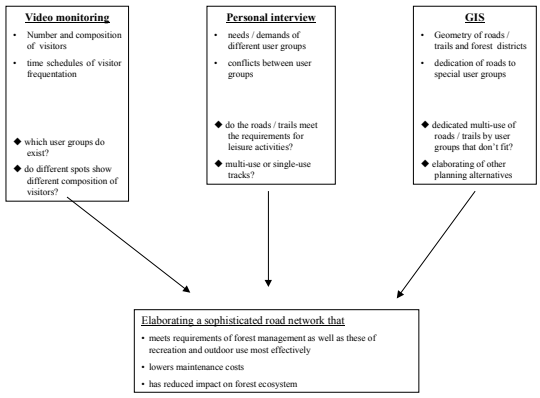

Figure 1: Methodical tools for optimization of multi-use forest network

METHODS

Collecting data about number, composition and time schedules of visitors by video monitoring

Some areas of the urban forest of Stuttgart show a heavy frequentation by the city-dwellers, but up to now actual and exact numbers of long-range studies do not exist. In former counts around Stuttgart visitors were counted only on single days by a couple of people (e.g. school classes) standing at different points - mostly entrances – in the forest. Because of the serious disadvantages of that method – high manpower resulting in data for only a few days that can't be extended for a longer period– a new method was developed and tested: an automatic video-supported long-range study of visitor number and composition.

This method should fulfil the following technical requirements:

- limited need for service
- no waste of videotapes by recording at times when nobody comes by
- enclosed information about date and time of recording
- no personal related information as faces or number plates of cars
- small and inconspicuous camera for outdoor use (i.e. water resistant and shockproof) that can be fastened easily at different points

Based on these preconditions a system of several electronic components was composed: A water resistant case contains the hen's egg sized camera and a radio transmitter. Operation power of the camera is ensured by a car battery. The camera sends a radio signal to the receiver which is attached to a movement registering sensor. A signal of this sensor activates the recording control station and the video recorder starts recording for a defined period of time (5 seconds). A time-date generator inserts time and date of the recording. Collecting of personal information is excluded by the focal length of the camera.

By this setting continuing recordings up to one week without need for change of videotape become possible. The necessary service and control measures is limited to check the operation of the system and the regularly change of car battery (once a week) and videotapes (depending on frequentation every 2 to 6 days).

The recording unit is not powered by battery, it has to be connected to the electricity mains. This limits the position of the recording set and so the camera can only be installed at spots within a distance up to 50 meters (range of radio signal) to electric cables.

In this research two such camera systems were posted at four different spots. One camera should provide data for a long-range study and therefor stayed at the same spot for one year, while the other camera was set up at three different spots for shorter times (6 weeks to 3 months).

Personal interviews to identify the needs of specific user groups and conflicts between them

Based on the video recording data and on discussion with the local forest management, following user groups could be identified:

- "traditional" cyclists
- mountain-bike-cyclists
- jogger (using fitness trails as well as normal roads and trails)
- walkers
- hiker
- horse-rider
- forest operations

For forest roads which are constructed and used for the purpose of forest operations as wood harvesting and transport, precise standards for technical design are established. Similar standards for recreation trails are lacking in most cases. To obtain a better knowledge and understanding of the demands of the different user groups and the conflicts that may arise between them using the same roads and trails at the same time for their activities, personal interviews with a panel of experts were made. Because of their specific experience these experts represent the opinion and express the demands of many other people of their user group (Atteslander & Bender, 1993). A total number of 13 experts were chosen, for example leader of jogging groups or riding schools and other representatives and stake holders.

The oral interviews based on a written questionnaire which served as a guideline. The questions are open questions, that means they have no fixed categories for answering but the asked person may articulate her point of view oneself. The order of the questions depends on the course of the interview, often some of the planned questions don't have to be asked expressively, because the answers were already given before.

Regarding the content, the interview guideline is structured in three parts. The first part is dealing with general questions about the position of the interviewed person, about the type and size of the user group he represents and about the frequency and time of activities in the urban forest of Stuttgart. The second part contains the questions about recreation road standard and road density, and the third part deals with possibilities and limitations of overlapping use of different user groups.

Interviews lasted about 90 minutes each and were documented by notes during the interview that were worked out to a detailed protocol afterwards.

Use of GIS for visualisation of roads and trails

The visualisation and analysis of the overlapping use of the roads and trails by the different user groups can be done most effectively by the use of Geographic Information Systems.

Geometry of roads, trails and forest districts was digitized in the Software package ArcView 3.2. For roads and trails information about their length, type

(logging road=1, skidding trail=2, footpath=3) and their dedication to recreational activities were added.

Additionally, the forest roads which are necessary for wood harvesting and transport were marked as dedication to logging.

Each dedication to a special activity was saved in a single column of the database (see table 1). This data structure makes it much easier to locate road segments with high potential for conflicts, because every combination of the different activities can be used for a query.

type	length	hike	bike	ride	fitness	edu-cation	log-ging
1	12 4.7	y	n	y	n	n	Y
2	25 6.1	n	y	y	n	n	n
1	18 9.7	y	y	n	n	n	n
3	45 .8	y	n	n	y	y	n

Table 1: Example for attribute table of feature theme "roads".

RESULTS

Video monitoring

The results presented in this paper do primarily refer to technical / methodical aspects of the video surveillance. For a close look at the results of the statistical analysis of the data see Mutz et al. (2001).

The used method of video monitoring enables management of recreational areas to count visitors over a long period of time with limited input of manpower and costs. Statistical analysis of this data shows cyclical patterns and determinants of visitor behavior that may serve as an input for statistical simulation of visitor flow (Mutz et al, 2001).

Although the main methodical requirements pointed out above are fulfilled, the method still has some disadvantages and weak points that should be mentioned and discussed in the following:

To ensure a continuous operation with low failure times of the system in outdoor use the single components of the system have to be coordinated very well. Failure times may be caused by technical reasons (functional disorder of video camera or connected components) or by delayed change of video tapes or battery. The ratio between days without any failure times and total number of recording days varies at the different spots between 28 % and 80 %. The lowest availability value of 28 % is probably caused by interference to the radio signal at this special location. Frequent monitoring of the video tapes during the first days of recording may show such problems early.

While the data capture on video tapes can be done automatically and therefore is very easy, the analysis of the tapes requires a lot of time. Automatic movement / picture analysis seems to be possible but has not been applied until now. Visual analysis takes – depending on the frequency of use of the roads – between 18 and 210 minutes per recording day (daily recording times from 6 a.m. to 10 p.m.). A simplification of visual analysis was tried by determining the number of movements that trigger recording by the parameters recording time per day and time of a single record (5 seconds). The number of events can be calculated this way, but unfortunately, this leads to a significant loss of information: the object that triggered recording can't be identified. It could have been a single person as well as a group of people of two or more persons or a logging truck. Recording can also be triggered by the change of light and shadow (e.g. caused by wind moving twigs) because the movement registering sensors react on differences in brightness. This loss of qualitative information makes it impossible to differentiate the user groups and to make statements about the exact number of visitors. So that kind of simplification of data analysis had to be dropped.

Because of the geomorphology of the forests of Stuttgart, a statistical valid sampling of all visitors of a given area over time requires a systematic counting at many spots.

Caused by

- the recording unit's dependeny on electricity mains, which makes only a limited number of locations available for video surveillance
- the high costs of the recording system (5,000-7,000 DM) and
- the time consuming visual analysis of video tapes

only a few camera sets can be used at the same time. This makes the setting of a systematic sample survey for a complete registration of visitors in a defined area quite difficult or impossible.

So this kind of video monitoring is up to now suitable for correct determination of the frequentation of single roads, but it can not be used to obtain a correct spatial distribution of all visitors. Further development in technical means that ensure more independence of electricity and in analysis methods – e.g. using picture analysis software based on identification of patterns - may allow to obtain results about spatial distribution by a flexible spatial-temporal change of recording locations.

Personal interviews

The interviews were suitable to obtain precise information about standards for recreation trails and about possible conflicts between the different user groups.

	Horse-rider	Hiker	Walker	Jogger	Keep-fit trail
Road length	10-20 km	no statement	1-5 km	12-25 km	3.5-6 km
Width	> 3 m	< 2 m	> 3 m	>1.50 m, better > 3 m	> 1.50 m
Surface	reinforced for go at walk or trot, not reinforced for gallop	not reinforced	reinforced, asphalt if possible	reinforced, no asphalt	reinforced
Condition	good no soft, loamy soil	walkable	very good	good	good
Grade	in general up to 6 %, sections up to 10 %	rough terrain, no maximum gradient	flat, max. 5 %	slightly rough terrain, max. 15 % (60-80 m)	1.5 km flat, slightly rough terrain, max. 20 % (50-100 m)
Route	circular route, not along roads, motorways or tramlines	with regard to scenery, along meadows and vantage points, no roads / cars	towards vantage points or restaurants, sufficient resting benches (every 100 m), starting from parking lots		no steps, starting from parking lots, circular route, signs

	"Normal" cyclists	Mountain-bike cyclists (competitions)	Mountain-bike cyclists (leisure time)	Forest company
Road length	no statement	4.5-6 km		45 – 50 m/ha
Width	> 3 m	< 2 m	predominantly > 3 m	3.50 m
Surface	reinforced, asphalt or fine crushed gravel	max. 15 % asphalt 95 % without asphalt, natural or artificial obstacles	mostly reinforced with some not reinforced sections	reinforced, subgrade and pavement
Condition	good	no long, very muddy sections	good / passable	good
Grade	max. 6 %	no maximum gradient, difference in altitude: 130 – 140 m on the whole distance	rough terrain with different levels blue: up to 6 % red: 6-15 % black: >15%	2-8 (10) %
Route	with regard to scenery, along meadows or vantage points	circular route, Single trails have to be cut free	avoiding sensitive areas and popular hiking trails	max. opening-op effect, regarding terrain, curve radius: 50 m plain country 20 m mountainous country 12 m serpentines

Table 1: demands of different user groups

The standards for different kinds of recreation trails concerning width, surface, condition, grade and route are listed in table 2. A normal logging road is suitable for most of the leisure activities. Some logging trails and footpaths should as well be dedicated to special user groups to ensure attractiveness also for these user groups that prefer that kind of roads for their activities.

In principle a parallel use of different user groups seems to be possible at least on logging roads wider than 3m. On more narrow roads and trails the conflicts may increase. Especially mountain-bikers show a high potential for conflicts. This is mostly caused by their relatively high speed and their nearly noiseless moving resulting in sudden appearance in front of other people. Theoretically the user group of the horse-riders shows a similar potential for conflicts. Because of the legal requirements in Baden-Württemberg that limit riding on specially dedicated trails, other users can avoid this trails and so much less conflicts do arise. Quite conflict-free user groups appear to be the joggers and the walkers and hikers as long as they don't have unleaded dogs with them. Figure 2 shows the potential for conflicts between the different user groups as it is seen by the interviewed people.

seen from \ with		Hiker		Walker		Cyclists	MTB	Horse-rider	Jogger	Edu-catio	Forest company
		with dog	without dog	with dog	without dog						
Hiker	with dog		-	-	-	+	++	+	-	-	+
	without dog	-		-	-	+	++	+	-	-	+
Walker	with dog	-	-		-	++	+++	++	-	-	++
	without dog	-	-	-		++	+++	++	-	-	++
Cyclists		+++	-	+++	-		-	+	-	-	+
MTB		+++	-	+++	-	-		+	-	-	-
Horse-rider		++	-	++	-	++	+++		-	-	+++
Jogger		+++	-	+++	-	-	++	+++		-	+
Education		+	-	+	-	+	++	+++	-		++
Forest company		-	-	-	-	-	+	+	-	-	

+++	heavy conflicts
++	middle conflicts
+	slight conflicts
-	no conflicts

Figure 2:conflicts between user groups

The personal interviews do not only result in general statements about demands and conflicts but may also address specific local problems. Furthermore, the integration of local protagonists leads to a better acceptance of management measures.

Analysis of the road network with Geographic Information Systems (GIS)

Based on the results of the interviews it is possible to locate road segments that have a high probability for conflicts. In this context not only the overlapping use of different leisure activities but also the type of the road / trail have to be taken into account. Logging roads that are usually wider than 3 m can be dedicated to different leisure activities without causing heavy conflicts, while on small footpaths multi-use dedication should be handled very carefully.

A simple query in the GIS-database may show for example all footpaths that are dedicated for riding and as fitness trail. If this multi-use is assessed as not acceptable, one of the special dedications has to be shifted to nearby roads, taking into account the demands cited by the experts in the interviews. This shifting can be done easily in the GIS by changing the attributes in the attribute table. The more information about the road sections (concerning parameters as grade, surface, etc.) are stored in the database, the better the demands of the different user groups can be met.

CONCLUSIONS AND OUTLOOK

The use of Geographic Information Systems, video monitoring and personal interviews for monitoring different user groups may be very promising because these tools can be used in combination and are complementary to each other.

The Geographic Information System contains not only the information about the location of the forest roads. Additional attribute information as a dedication to certain activities, grade of the road, width, surface, etc. enable the management to compare the actual status of the road network with the demands of the different user groups, which were articulated by the experts in the personal interviews. The more information about the roads are available, the better the requirements of the users can be met.

Improved information could be gained of the GIS by adding information about terrain, i.e. by a digital terrain model.

It was shown that dedication of roads and trails to special activities which fulfil the requirements of the specific user groups in combination with the technical design and condition of the single roads seems to be a suitable way to channel visitor flows and to minimize conflicts between different user groups.

As the interviews showed, many people avoid forest roads that don't meet their demands, so a "bad" condition of a road may be understood as an intentional instrument to keep certain types of visitors apart from this special road. A parallel dedication of roads as alternatives for the specific user groups is necessary to obtain this effect. As results from other investigations (Wöhrstein, 1998)

and experiences with new dedicated mountain-bike routes show, a dedication of suitable roads to a special activity leads to decreasing conflicts.

A further development of the methodology of video surveillance in the direction pointed above resulting in the possibility to obtain statistically valid data of spatial distribution of visitors in time may link the results of this surveillance with the GIS. The spatial distribution of the visitors could then be visualized and analyzed in the GIS.

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