Location Aware ICT in Addressing Protected Areas' Goals

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Abstract. This paper addresses the use of ICT (in particular of Mobile location-aware information systems) to facilitate information access, exchange and provision in natural areas, especially as concerns two user groups: the visitors and the park managers. Online interviews were carried out among different protected area administrators in order to understand and identify important issues related with the tourism management. Alternatively, the needs and wishes of the visitors were assessed through surveys and participant observation. A system called WebPark has been designed based on these user needs and tested in the Swiss National Park and in the Wadden Sea. The main result was that the WebPark application is able to satisfy user needs and to provide park managers with a tangible benefit.

1. Introduction

Recent years have witnessed a radical change in the exploitation of rural and natural areas for tourism. Tourism now accounts for a significant share of economic activity of those rural communities that enjoy attractive environmental settings, the proximity to parks or to appealing environments and natural surroundings. The effects of this phenomenon are significant and widespread, encompassing social, economic and environmental aspects (Butler 1998).

The intensive use of parks and natural areas, poses sustainability issues and creates new problems to the management of these areas. Large number of visitors, for instance, may have negative impacts and deteriorate environmental quality, the very asset that makes the areas attractive. At the same time, area managers have to serve the needs of large amounts of visitors, with issues ranging from visitors' safety to information provision.

This paper addresses the use of ICT to facilitate information access, exchange and provision in natural areas, especially as concerns two user groups: the visitors and the park managers. The basic assumptions are (1) by introducing or improving information flows it is possible to affect user's behaviour towards a more sustainable

use of natural resources, while (2) providing park managers' with tools to manage visitors distribution and geographic behaviour.
More specifically, the paper addresses:

1. The information needs of the tourists, relevant to enhance their experience, and may include items such as information on flora and fauna, facilities, trail descriptions, etc.;
2. The information needs of the park organisations, as concerns information to visitors (advise, safety, environmental awareness, etc.) and information to managers (intensity of use of the park, the distribution of visitors and the like).

The first part of the paper focuses on understanding the issues in natural parks management that arise from high number of visitors. Online interviews were conducted among an expert panel composed by sixty-seven park administrators (responsible for tourism and communication within the park) of distinct protected areas in Europe. The goal was to collect their assessment of the challenges related to the (over)exploitation of the park resources, and the introduction of targeted information provision a tool for park sustainability.
The results, although not statistically relevant, indicate trends and reveal common issues: park managers are concerned about the distribution of visitors inside the park, such as high local concentrations that pose a significant disturbance to the environment, and acknowledge the relevance of tools to monitor the whereabouts of tourists. Safety issues are considered important by almost all park managers, such as warnings for visitors in the field about the proximity or dangers (e.g. weather alarms, avalanches). Almost all interviewed park managers refer to environmental education as one of the main institutional mandates of the parks, and expect users to be interested in receiving information during their outdoor visit to the park. This implies that park managers link information provision to visitors' behaviour: visitors which are better informed are expected to make more eco-friendly decisions.
The second part of the paper addresses visitors' information needs assessed through user survey (questionnaires) and visitor monitoring (participant observation - shadowing). The survey was carried out in two case study areas: the Swiss National Park and the Wadden Sea. Although these areas have very different characteristics – the first is a strictly protected mountainous area, while the second is a coastal area with an important recreational function – unpredictably, both surveys identified very similar information needs. The research concluded that the tourists are interested in accessing information during their visit and they mainly desire, in order of importance: safety information (e.g. weather alerts), flora and fauna background information and navigation information (such as maps or own position).
The needs of the park visitors during the visit were identified using participant observation (following the users on a field trip and recording all information needs/questions). This step also assessed the degree of location dependency for information needs, (if the questions are dependent on where the visitor is or not). The information needs that are intrinsically geographic (e.g.: "what's the name of that lake?" or "are we still inside the park?") account for more then half of the total number of questions.
The third part of the paper describes the developed wireless location-based information system - WebPark – that was designed to meet the needs of visitors and

park managers that emerged from these assessments. The system, available on mobile handsets capable of wireless internet connection, provides location-aware access to multiple data sources in the field, where it is most important. WebPark is meant as a personal digital guide for visitors and is designed for field use.

2. Issues in the management of Natural Areas: the view of park managers

Tourism research in protected areas shows that visitors have specific information needs/questions during their visit and most of them are location dependent (Abderhalden et al 2002). Examples include: "what's the name of this plant?" or "which animals can I see around me?" or practical information, like "can I make a picnic here?" or "how many hours left to walk to the peak?".
Managers of natural areas recognise these needs and are looking into new digital means of information provision. Examples are the publication of CD-ROMs and the increasing availability of Natural Areas websites. These new ways of providing information to the visitors, however, fall short on satisfying the visitor's needs when they are most important: in the field, during the visit.
Eagles (2003) also acknowledges the importance of education while visiting natural parks: "as educational levels rise, demand for appreciative and learning opportunities associated with parks and protected areas increases". The needs and wants of tourists are crucial concepts to be taken into account by the park administrations in order to improve the tourist experience. Parks increasingly rely on market funding with a shift from government grants to visitor fees and service charges (Eagles 2003). This results in higher levels of visitor focus in management: if the focus is shifting towards the visitors, their needs of information in the field cannot be ne-glected.
To understand these (and other needs) and in order to identify the priorities and commonalities, sixty-seven park administrators in Europe were contacted and interviewed in relation to information provision to tourists and general tourism management issues. These collected opinions and beliefs are important to point out trends and directions that are common to most of the park managers in Europe. The outcomes of this investigation are divided into two different topics: environmental education and visitors' spatial distribution along the park area.

2.1 Environmental education

Information availability is instrumental to environmental education and awareness. It increases visitor's knowledge about the environment and fosters attitudes, motivations, and commitments to make informed decisions and take responsible action (UNESCO, 1978). Environmental education is therefore an indirect instrument for park managers to facilitate the protection of the area and its sustainable use. Kreft-Burman (2002) considers information as "one of the most important aspects of raising environmental awareness". The concept of environmental awareness is defined as a combination of three elements: motivation, knowledge and skills (Kreft-Burman

2002). A high level of environmental awareness enables conscious choices to act in an environmentally friendly way, therefore contributing to a more eco-friendly behaviour from the visitors and minimizing the impact of tourism in the protected area.
The interviews reveal that park managers are aware that information can be instrumental in contributing to park sustainability. Most of the contacted area administrators rate the importance of information supply to the area visitors as "fundamental" or "very important" (see Table 1).

Table 1 - Level of importance of information supply to the area visitors

N= 67	Frequency	Percent
Fundamental *Improving the level of information of visitors and their awareness is the main goal of the Park*	15	22,4
Very Important *Improving the level of information of visitors and their awareness is one of the goals of the Park*	47	70,1
Important *It is considered as important by the park, but priorities for using the resources of the park are elsewhere*	5	7,5
Neutral *It does not make a major difference for the Park.*	0	0
Not important *Informing visitors is not a core goal of the Park*	0	0
Total	67	100,0

Most parks have in place information channels to address this goal. Table 2 gives an overview of which instruments the parks have currently implemented and their degree of implementation among the sixty-seven contacted parks. The high adoption of these instruments is also proof of the commitment to the informing visitors in the field by the park administrators.

Table 2 - Existing instruments to make information available to visitors outdoor (i.e. in the field).

N = 67	Frequency	Percent
Guided tours	59	88,1
Info boards	63	94,0
rangers who can answer questions	55	82,1
Free leaflets	56	83,6
Paid leaflets	37	55,2
Printed guide	37	55,2
Park specific maps	55	82,1

Regarding the investment in information technology for addressing the environmental awareness issue (see Table 3 for an overview), it was observable from the interviews that websites and CD-ROMs are the only commonly used IT tools to inform the visitors. But these tools are not appropriate to inform the visitors in the field. For example, only when hiking in the park visitors need to know if they can picnic or

light a camp fire in a certain area. Website and CD-Rom typically contain rules and information of this type, but they are not accessible outdoors.

Table 3 - Existing information technology tools available for the visitors.

N = 67	Already Available		Planned to have within1 year		Planned to have in the long term		Not planned	
	F	%	F	%	F	%	F	%
Website of the park/areas	60	89,6	4	6,0	2	3,0	1	1,5
CD-ROMs, containing information on the park/areas	23	34,3	9	13,4	13	19,4	20	29,9
Digital kiosk/touch screens in the information centres	25	37,3	9	13,4	15	22,4	17	25,4
Digital kiosk/touch screens in the Park (outdoor)	2	3,0	4	6,0	7	10,4	51	76,1
Mobile devices (Handheld computers) available to users	4	6,0	1	1,5	12	17,9	47	70,1
GPS devices for use by visitors	0	0,0	4	6,0	10	14,9	51	76,1
Mobile devices connected to GPS	0	0,0	3	4,5	10	14,9	52	77,6

It was also observable that access to outdoor information technology (like outdoor digital kiosks and handheld computers for the visitors) are seldom implemented and not even planned by the majority of the park administrators.
The previous results show that the majority of the ICT investment goes to the tools that are not available outdoor (while visiting the park), however the majority of park managers agree to the importance of informing visitors outdoor and specifically about their surroundings (Table 4). Park managers understand and agree that information provision can influence the behaviour of the visitors into a more eco-friendly level, acknowledging therefore information as a tool to aid in the sustainability quest of their protected areas.

Table 4 - Opinion of the sixty-seven contacted parks regarding the relationship between information and eco-behaviour and the importance of informing visitors about their surroundings.

N = 67	Strongly agree		Agree		Neutral		Disagree		Strongly disagree	
	F	%	F	%	F	%	F	%	F	%
Information provision to visitors changes their behaviour	14	20,9	44	65,7	8	11,9	0	0	0	0
The visitors that are better informed about the park make more eco-friendly decisions	12	17,9	49	73,1	4	6,0	0	0	0	0
Users are interested in receiving information during their outdoor visit to the park	18	26,9	40	59,7	6	9,0	1	4,5	0	0
It's important to warn visitors in the field about sensitive areas proximity or dangers (e.g. weather alarms, avalanches) depending on their location	7	31,8	11	50,0	3	13,6	1	4,5	0	0
It would be good to inform visitors about the surroundings of where they are walking	7	31,8	15	68,2	0	0	0	0	0	0

When asked about the main institutional goals of their area (see Table 5), approximately half of the contacted park managers consider leisure as a main goal, though the large majority of the parks consider environmental education as a main mandate. It can be concluded that there should be no effort from the park administration in developing infrastructure to facilitate tourism/leisure (and therefore increase the number of visitors), but the effort should be steered to the improvement of the existing tourism experience by providing access to information and consequently increasing the levels of environmental awareness.

Table 5 - Main institutional mandates of the contacted protected areas.

N = 67	Frequency	Percent
Biodiversity protection	64	95,5
Research/Science	44	65,7
Leisure	38	56,7
(Environmental) education	53	79,1
Information supply to visitors	38	56,7
Cultural Attributes protection	30	44,8
Other	7	10,4

2.2 Visitors' spatial distribution along the park area

Most of the contacted park managers think the distribution of the visitors within the park is an important concern for the park management (see Table 6). Any approach to tackle this issue, starts by knowing the location of the visitors in the park.

Table 6 - Visitors management issues rated by the Park Managers (PM).

N = 67	An issue to solve with top priority for the PM		A regular concern for the PM		An occasional concern for the PM		Does not concern the PM	
	F	%	F	%	F	%	F	%
There are too many visitors	6	9,0	21	31,3	27	40,3	11	16,4
There are too few visitors	7	10,4	12	17,9	11	16,4	32	47,8
The visitors are concentrated only in very few areas (badly spread over the park)	9	13,4	28	41,8	18	26,9	10	14,9
The visitors put themselves at risk	4	6,0	8	11,9	28	41,8	22	32,8
There aren't any means to contact visitors in case of danger or an emergency	6	9,0	5	7,5	26	38,8	23	34,3

The necessity to contact visitors in case of danger or emergencies was classified as an issue that concerns the parks administration. This issue is reinforced by the fact that most of the contacted parks think that visitors put themselves at risk while visiting the area. In accordance to the relevance given to the issue of visitor distribution along the park, most area administrators agree to the need of a tool to monitor the location of

the visitors (see Table 7). Such a tool would allow the managers to better allocate resources and analyse the presence and impact of tourists inside the park (where do they go and when are they there).

Table 7 - Opinion of the sixty-seven contacted parks regarding the need for a solution to know the location of the visitors inside the park.

N = 67	Strongly agree		Agree		Neutral		Disagree		Strongly disagree		Don't know/ No answer	
	F	%	F	%	F	%	F	%	F	%	F	%
The park managers need a tool to monitor the whereabouts of the visitors	11	16,4	27	40,3	16	23,9	10	14,9	1	1,5	1	1,5

3. Information Needs of Visitors

This section specifies the evaluation and analysis of the information needs of visitors to recreational and protected areas. The goal of this research was to understand the current visitor information flows, structure and possible deficiencies during the field visit. With this understanding it was possible to determine the system requirements for the Mobile Information System (e.g. if an information gap is found, one can develop system functionality to fulfil that gap). The research focused on the two case study areas, the Wadden Sea, a protected coastal area in the north of the Netherlands, and the Swiss National Park. This exercise was divided into three steps:

1. assessment of the needs of visitors while visiting the park - assessed through participant observation;
2. assessment of existing information services - evaluated through an extensive exploration of the actual information services available to the visitors.
3. analyses of the visitors' information behaviour - assessed through a qualitative investigation in the form of a survey.

Figure 1 represents the information audit process that involved the steps above and led to the definition of the system requirements. The process started with the assessment of the visitors' information needs in the field. Subsequently, the current information availability was analysed. By comparing the "needs" with the existing "information services", it was possible to identify the information gaps. The next step was to identify the preferences of the visitors in terms of information access. These preferences, in combination with the information gaps, influenced the definition of the system requirements.

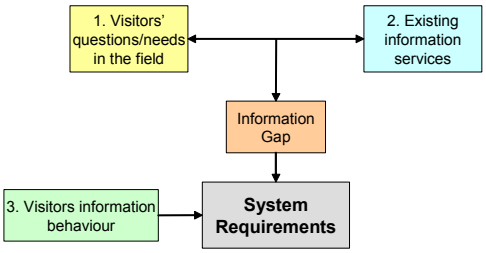

Fig. 1. Work flow and interaction between the different information audit components.

3.1 The needs of visitors during the visit

The method of participant observation was applied to assess the needs of visitors (in this paper we illustrate the results for the Swiss National Park). Participant Observation is a popular and widely used research method in Anthropology and Ethnography studies, but is also applied in other scientific fields as consumer behaviour and marketing (McDaniel and Gates 2002) or software engineering (Lethbridge et al 1998). Participant observation is defined as the involvement of the analyst in the activities of the people in the context he is studying. The researcher is able to get a more accurate insight of the values, dynamics, internal relationships, structures, thoughts and conflicts from the observed actions of the individuals/communities, rather than from their normative statements. The observer should (as much as possible) participate in the activities and generally "immerse" himself as deeply as possible in order to understand and document them (Malinowski 1922).

In the case of assessing the needs of visitors while visiting the park, the participant observation was implemented through "shadowing". A researcher followed/ accompanied the visitors while they visit the park in an attempt to detect and record the visitors' problems and questions. The recorded questions were categorized into topics (e.g. fauna & flora, landscape & navigation, park regulations, history) and classified according to their spatial sensitivity (information that is intrinsically geographically or not). The questions with a spatial reference were predominant, 64% of a total of 203 recorded questions (in several observation sessions). Questions without spatial reference accounted for just 36% of the total questions, but were often triggered by a spatial position (e.g. "Have the marmots started hibernation?" which has a temporal reference but no spatial, was triggered by being in an area of Marmot lairs). Most of the 130 questions with a spatial reference concern the topic navigation/landscape (41), flora (30), fauna (26), and geology/geomorphology (19). Most of the questions without spatial reference (from a total of 73), concern the topic fauna (24) or flora (20). Only a few questions apply to historical themes and research or the park in general (Abderhalden and Krug 2003).

3.2 Existing information services

The goal of this step was to evaluate existing information services in recreation/protected areas in terms of what information is currently available and its spatial relevance. This study was carried out for the case of the Swiss National Park (adapted from Dias et al 2002). It included an extensive information analysis of tourist guides, web site and CD-ROM. The analysis was performed using a "reverse" approach. Although the information (the answers) were analysed, the intention was to identify questions that could be answered by the current available materials (these questions should be comparable with the questions identified in the actual needs assessment phase). The identified questions were generic, trying to correspond to blocks of information that tourists could typically use. A question like, "What does the Red deer eat?", although it is answered in the materials, it's very specific and if used would lead to a too meticulous list of all the information available, inadequate for future comparisons. That specific question was integrated into a generic block: "Habitats and behaviour of the animals in the park". The information was classified into pre-established categories: "Nature"; "Park info"; "Recreational activities" and "visitor logistics". Categories and sub categories were established depending on the information found.

The spatial sensitivity of the information was classified according to the following classes (the parameters for the spatial reference correspond to different levels of accuracy in position determination technology (Beinat and Dias 2003)):

- Spatially independent;
- Low (accuracy > 1 km), can be obtain by means of Cell ID.
- Medium (30 m < accuracy < 1 km), can be obtain by means of Network-enhanced Cell ID or E-OTD;
- High (accuracy < 30 meters), can be obtain by means of GPS technology.

The spatial sensitivity classification was designed to be consistent with the accuracy required to complement a specific block of information. E.g. weather and climate in the park was classified with a low spatial sensitivity (accuracy > 1 km), because (typically) the weather and climate do not vary within short distances.

The Temporal Sensitivity of the information was classified according to the following classes (see Table 7 for examples):

- Static (time insensitive);
- Low (update rate <1 time/year);
- Medium (update rate < 4 times/year)
- High (update rate < 1 time/month);
- Real Time (updated every day).

Table 7 - Temporal Sensitivity parameters and corresponding examples.

Temporal Sensitivity	Examples
Static	*When and why was the park founded?*
Low (updated <1 time/year)	*What are the main ongoing research projects*?
High (updated < 1 time/month)	*Essential equipment: what to take and wear*? Depends on the climate and weather.
Real Time (updated every day)	*Which trails can be followed*? Information that should be updated continuously in order to direct people to certain areas and minimize the impacts from their activities.

Seventy-four "blocks" of information/questions were identified. Figure 2 shows the distribution of the questions between categories and subcategories and provides an overview of each information category extent. If a majority of questions are allocated to a certain category, the more extensive it is the information available regarding that specific category.

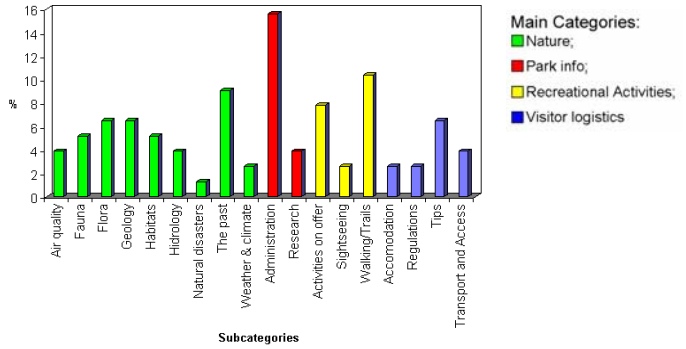

Fig. 2. Percentage of questions per subcategory and category (colours).

Note that the actual needs of visitors in the field were also classified by means of a similar process, which allows comparison between the information demand and supply. The results of the available information (Figure 2) were as follows:

- 45% of the questions are classified into "Nature";
- "Recreational activities" were covered by 21% of the questions;
- the category "Park info" contains 18% of the questions, and;
- Visitor logistics accounts for 16% of the questions.

The distribution of the questions in relation with the different Temporal Sensitivity and Spatial Sensitivity parameters is illustrated in Figure 3. It is easy to see that the largest set of questions is time and space independent.

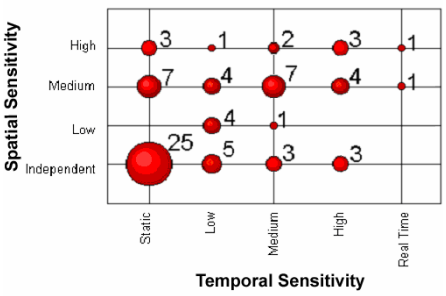

Fig. 3. Temporal and spatial Sensitivity of the information on offer (Dias et al 2002)

The comparison of the information demand (based on questions asked during the shadowed field park visit) and the information supply (based on questions that can be answered by available materials: CD-Rom, Leaflets, website, maps and brochures) in terms of the topics/categories covered, does not present major gaps. For the actual needs of the Visitors, the majority of the questions were related with "nature" (fauna + flora + Geology) and it is also "nature" the topic from the existing information services that contains the most information available.

In contrast, the temporal and spatial characteristics of the information available (Figure 3) are discordant with the temporal and spatial characteristics of the information demand: there is a clear mismatch. Most of the questions from the visitors comprise a high spatial component, while most of the questions identified in the materials did not have, or have a very limited, spatial component.

In order to satisfy the visitors in terms of information needs in the field, the system must, therefore, have available an extensive and diverse collection of "Nature" information. It should extend the existing information on offer by assigning geographic relevance to the current information blocks. Furthermore, the information that is intrinsically not geographic (e.g. information about the behaviour of animals) should be associated with geographical locations where the need for such information will arise (e.g. the animal habitats or places from where visitors can see the animals).

3.3. Visitors' information behaviour

The information needs of visitors in recreational and protected areas were assessed with the help of a survey distributed to park visitors. This exercise has the following goals:

1. identify the characteristics of the target group (those who expressed an interest in accessing mobile information within national parks);
2. identify which services visitors are most likely to use;
3. understand the actual information behaviour (i.e. identification of the mechanisms used by visitors to obtain information about the area).

One question in the survey explained the concept of the Mobile Information service and asked if the respondents (a total of 179) were willing to use this service. Almost

one quarter (24%) of the respondents stated that they would use the service. These respondents can be defined as the target group. The cross analysis between the "target group" and the "others" (people that would not use, or use it with certain restrictions) reveals interesting differences. The target group is more willing to use their mobile phones in holidays, has more previous experience with mobile internet services and PDA use and showed more willingness to use a map in the area. This indicates, as expected, that it's a person more familiar with new technologies and interested in geographic concepts (maps). In terms of delivery mechanisms, the user group stated a clear preference to read the information in the screen as opposed to an audio solution. The most important services identified were "Maps and other information for orientation purposes based on the actual position" and "Safety information such as severe weather warnings, shelter harbours". Table 8 summarises the responses for six possible information services.

Table 8 - Importance of information services (results from the Wadden Sea case).

N = 77	Important	Nice to Have	Less important	Not necessary
i) Maps and other information for orientation purposes based on your actual position	38.0%	33.8%	14.1%	14.1%
ii) Information on tidal flats, mud-walking possibilities	33.8%	41.6%	10.4%	14.3%
iii) Information about vegetation and animals	16.7%	43.6%	24.4%	15.4%
iv) Local information about current research projects	7.0%	23.9%	39.4%	29.6%
v) Thematic maps, for example geological, tidal maps	16.7%	41.7%	18.1%	23.6%
vi) Safety information such as severe weather warnings, shelter harbours	62.5%	26.4%	2.8%	8.3%

For the Swiss National Park, Abderhalden et al (2002) investigated also the most popular information used by visitors when preparing the visit to the protected area. Table 9 lists and ranks (in order of popularity) the information sources.

Table 9 – Information sources used to prepare a visit to the SNP (Abderhalden et al 2002).

N = 1520	Frequency	%
Internet	977	64.3
Maps	925	60.9
Leaflets	737	48.5
Books	657	43.2
Friends / Relatives	381	25.1
CD-Rom	370	24.3
No opinion	26	1.7
Other	24	1.6

The results show that *Internet* is the most popular way to get information about the park. The second most used source *are paper based maps*. This leads to an interesting conclusion: people seek digital dynamic information (Internet) in combination with geographical enabled data (maps). The third source in terms of preferences was *Leaflets* (which are intrinsically mobile: they are intended to fit on a pocket and to be taken into the field trip).
These findings are the basis of the design of the WebPark mobile information system. The system is developed in a way that it can integrate these two familiar information sources (Internet + maps) and it has to be portable.

4. WebPark: Location-based information Service in natural areas

Mobile information systems enable people to access information about natural and cultural resources regarding places they visit. Mobile technology encompasses a vast array of technical solutions, but in the context of this paper it refers to systems that allow the user to access the internet, or specific data services, with personal handsets through a wireless data connection.
The user needs assessment was recognized as a fundamental step to create a meaningful service. Brown and Duguid (2000) draw attention to the danger of innovations that fail to improve the mechanism they intend to replace, "[new technologies] often aim to remove a surface constraint (objects, organizations, practices, institutions) without appreciating their submerged resourcefulness. When this happens, the old resourcefulness often wins, to the frustration of technologies and futurologists". It is not the intention of WebPark to compete with paper maps or guides. These are undoubtedly efficient and valuable information sources. WebPark aims at giving complementing services and information. Services and information that are not possible to have available via the current mechanisms. For example, it's impossible for a 10 cm screen (with limited colours display) to compete with the quality of artistic hand-made paper maps. But the digital map can offer other features, like the real-time position of the user via GPS, and can be tailored to represent (for each visitor) the spatial distribution of the natural features that are of most interest for that particular visitor. Such possibilities are not available with the traditional static paper-based media. A digital system is also appropriate to present information that changes rapidly and needs constant update, e.g. the location of where the last ungulate was seen or the closed routes due to rock fall or birds breeding season.
WebPark develops a series of services for users of recreational and/or protected areas based on wireless technology. It enables users to request information from several databases using their mobile phone or PDA and filters the information based on location, time and user profile relevance. Information services include: flora and fauna description linked to the habitat the tourist is visiting, routes, hotels and restaurants close to the visitor, current position on a map, and more. Two specific trial products have been developed to test these concepts for two study areas: The Wadden Sea (the Netherlands) and the Swiss National Park (see Figure 5).


Fig. 4. Functional test of WebPark.

The system is web-based and runs on a PDA via wireless Internet (GPRS or UMTS). It can also operate offline, with stored data when Internet connection is unavailable. The position is obtained from GPS.
It is important to underline three issues/constrains that the service architecture allows to cope with. First, since the user is mobile, the communication with the services must be wireless. Second, users can carry only small palm-sized devices, with strong limitations in terms of display and computing power. Third, the typical use is in Natural Areas, which may be characterised by partial wireless network coverage. To cope with the latter, WebPark does not rely on a permanent Internet connection, not even on constant bandwidth.

5. Results and conclusions

The contacted park managers indicated a clear need for them to know the distribution of the tourists in the park in order to manage the tourism impacts more accurately. Managers lack the ability to know in real time the number and distribution of visitors and if the exploitation is not sustainable (e.g. if there are concentrations of visitors in certain areas that may pose a significant disturbance to the environment). This paper tries to develop upon previous work in the field of monitoring and management of visitor flows in recreational and protected areas by presenting a new framework to collect visitor data and to influence visitor distribution. This framework is enabled by mobile information systems with advantages shared by both visitors and managers: the visitors feel motivated to carry this device in order to fulfil their information needs and park managers can profit from the system by having up-to-date and easy accessible data about visitors spatial distribution in the park. Mobile Information system have the possibility to retrieve, store and display in real time the location data of the visitors (or specific individuals, e.g. the park rangers). This data can be used to perform on-the-fly or offline analysis of aggregated visitor spatial behaviour, in order to identify vulnerable areas to the presence of overwhelming number of visitors. Then, park managers can influence the distribution of visitors via information

provision (e.g. the managers can, in real time, recommend tourists to take specific routes, in detriment of others, in order alleviate human pressure on the ecosystem). Knowing the location of the staff can also prove useful in the allocation of resources. This research is not the first to address the issue of visitor distribution and geographic behaviour inside protected areas (Shapochkin et al 2004, Barringer et al 2002), but previous research on impacts is based on tourist flow data collected through end of the visit diaries and retrospective questionnaires.

Knowing the location of the visitors acquires additional significance in the case of safety. It was indicated by the park managers that the visitors put themselves at risk and that in cases of danger or emergency, there aren't any means to contact the visitors. The mobile information system can aid the park management by providing bidirectional information flows: (a) The administration receives information about the location of the visitor and can use this information to (b) send medical assistance, weather alerts or other danger warnings specifically tailored for the individual visitor based on his location.

Information was acknowledged by the park managers as influencing the visitor behaviour. More eco-friendly behaviour is expected from more informed tourists. Mobile information systems can be a valuable tool in addressing this issue. When visitors are in the field they are more motivated to know about the area natural richness.

In developing a meaningful mobile information system, local expertise (the park managers, rangers or local people) plays an important role, especially in content development. This process, which involves the local communities, can generate new sources of income in the underprivileged rural areas (e.g. park rangers or local experts can collect information that can be sold in real time to tourists).

Mobile information systems can enhance convenience, learning and interaction in the heart of the park. Convenience because they allow the access to information any-time, anywhere. Learning because it can answer questions and give information about natural features where visitors are most motivated to know, during the field visit when they are in contact with these natural features. And also Interaction, Tourists can become valuable "Active Visitors" that collect constructive data. With the right information and the right tools, visitors become more environmental aware at the same time they interact with each other and the park management by leaving back valuable intellectual contribution in the form of spatio-temporal comments and multimedia. Digital recording (audio, video and photo) has become practical and integrated in common day-to-day devices as mobile phones and digital cameras allowing the creation of vast web repositories for preserving and sharing feelings and perceptions of the nature by all elements of society. "Aware tourism": information aware, location aware, environmental aware!

The WebPark experience demonstrates the added value of location-aware information provision to users and managers of natural and recreation areas. User feedback has been very positive in spite of the known limitations of the current equipment and technology. The main result was that the WebPark application is able to satisfy user needs and to provide park managers with a tangible benefit.

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