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Potentials and limitations of coordinated spatial and non-spatial information management in protected areas: requirements of park projects in Switzerland

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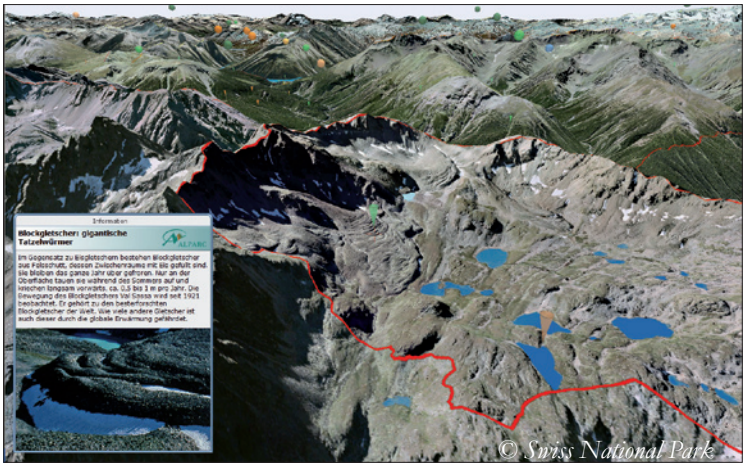
Abstract

Information management and geoinformation systems (GIS) have become indispensable in a large majority of protected areas all over the world. These tools are used for management purposes as well as for research and in recent years have become even more important for visitor information, education and communication. This study is divided into two parts: the first part provides a general overview of GIS and information management in a selected number of national park organizations; the second part lists and evaluates the needs of evolving large protected areas in Switzerland.

The results show a wide use of GIS and information management tools in well established protected areas. The more isolated use of singular GIS tools has increasingly been replaced by an integrated geoinformation management. However, interview partners pointed out that human resources for GIS in most parks are limited. The interviews also highlight uneven access to national geodata. The concept of an integrated geoinformation management is not yet fully developed in the park projects in Switzerland. Short-term needs, such as software and data availability, motivate a large number of responses collected within an exhaustive questionnaire. Nevertheless, the need for coordinated action has been identified and should be followed up. The park organizations in North America show how an effective coordination and cooperation might be organized.

Introduction

In recent decades, several thousand protected areas of varying protection status have been created all over the world. The main issues for these parks are nature conservation, rural development, monitoring and research, as well as public communication and environmental education, with different weightings of each topic. Although the objectives of the protected areas cover a wide range of topics, nowadays information management and technology are considered indispensible for management and monitoring in protected areas. Geographical information systems (GIS) in particular have become important from the 1990s onwards. Early studies in this field predicted that GIS could be used in various fields, such as planning processes, monitoring, conservation evaluation and quantitative analyses for home ranges and habitats of species, migration analyses and spatio-temporal evaluations (Burrough 1986; Jäger 1988; Allgöwer & Bitter 1992; Goodchild 1996). One of the first GIS for protected areas was introduced in Berchtesgaden NP, starting in 1980 with the interpretation of aerial colour infrared images and the setting up of base data and basic IT (Franz 1995).
The Swiss National Park, founded in 1914 and thus one of the oldest protected areas in Europe, introduced a GIS in 1992 with the general aim of providing managers and researchers with a tool for data capture, data analysis and long-term data storage (Haller 2009). Other large protected areas in the Alps followed. The intervening years were marked by a growing number of applications, which showed the immense variety of use of GIS in the field of environmental protection in general and in protected areas in particular (Blaschke 1999).



Detail of a 3D scene and the description of a point of interest

With the increasing interconnection and integration of geoinformation (GI) into common IT structures, new features and responsibilities were defined for GIS workers, summarized by the term Spatial Data Infrastructure (SDI) (Groot & McLaughlin 2000). But this evolution of GIS was followed by a new challenge: the small groups of GIS specialists in large protected area organizations are no longer able to aggregate all types of expertise needed. A modern SDI in a protected area demands the maintenance of hard- and software as well as database design and implementation, expertise in standards of geodata and metadata, skills in IT services, surveying, ecological analysis and modelling and cartography. Therefore the challenge is to find new approaches to combine all these skills on geoinformation and IT for protected areas without loosing the specific knowledge needed to combine questions from all fields of managing a protected

Table 1 – Results of the interviews of GI specialists in existing parks in North America and in the Alps

Country	USA	Canada	Austria
Park	**US National Park Service**	**Parks Canada Agency**	**Hohe Tauern NP (Tyrolian Part)**
Development of GIS	GIS in use for over 20 years	GIS in use for over 20 years	GIS in use since 1993
Strategy of park organization	NPs are part of public administration and embedded in the national managing organization NPS	NPs are part of public administration and embedded in the national managing organization PCA	Park management is part of federal administration of Tyrol
Organization of GIS through national managing organizations	NPS develops the strategies and programmes of geoinformation management	Nationwide coordination via geomatics coordinator of PCA	So far no nationwide coordination via managing organizations
Organization of GIS in the parks	In the individual parks, independently organized and funded, mostly part of the resource management division	In the individual parks, independently organized and funded, mostly part of the ecosystem research and protection division	GIS and IT are linked to federal administration of Tyrol
GIS applied in...	all fields, but mainly Natural Resource Management	nature protection, management, security, education	planning, management, visitor information, research
Infrastructure	Enterprise GIS license since 2003	Joint GIS license in whole PCA, in the parks desktop GIS since 2004	Desktop GIS in the park, databases and server at the federal administration
Geodata access	Free of charge from USGS	Free of charge from governmental agencies, provincial data not always free of charge	Federal and governmental data free of charge
Resources	Number of users increasing, limited resources of GIS and IT specialists	Limited resources of GIS and IT specialists, intended increase to two GIS specialists per park	Per part of the park 50% full-time equivalent (FTE), just enough for critical tasks
Cooperation in GIS	Coordination through the GIS Program Office, cooperation through regional technical support centres	Annual meetings of GIS and IT specialists, Regional Service Centers since 1998, since 2007 coordination via Geomatics Coordinator	Joint projects, support of GIS and IT by the federal administration Tyrol, cooperation with the other two parts of NP Hohe Tauern in other federal states
Services	Interactive Map Center and NPS Data Store, both under revision	Web mapping application planned	Geodata server and internet map server
Standards	Park borders, facility management, trails, ongoing work on more standards e.g. web services	Ongoing work on standards, common data models and web services	Common data models planned for the whole park and with project partners
Metadata	In the NPS Data Store, extended FGDC standard	Metadata catalogue in progress	Metadata catalogue together with federal state of Tyrol

area. Until 2009, there was only one national park in Switzerland. The situation for creating new protected areas was rather difficult compared with other European countries due to the legal situation regarding protected areas. In 2007, the revision of the Law on the Protection of Nature and Cultural Heritage (Schweizerischer Bundesrat 2007) set the legal base for the creation of parks of national importance, including the categories national park, regional nature park and nature discovery park (Walder 2006). By January 2009, 20 park project proposals had been submitted to the Swiss Federal Office for the Environment (FOEN). Alongside the initiation and installation phases of new parks and its administrations, the FOEN was interested in coordinating information management in general and geoinformation in particular on protected areas in Switzerland.

The study presented here was conducted to analyse the current situation and the requirements of data information management in protected areas (Haller et al. 2008). By addressing the following questions we wanted to create the basis for future coordination of information management in protected areas in Switzerland.

- What kinds of systems, networks, coordination and cooperation exist for assessing the geoinformation management in existing protected areas?
- What kind of information is relevant for assessing feasibility, project planning and implementation of park projects and for running the parks?
- What are the requirements of the most important actors in park projects regarding coordination of information management?

Methods

The study was conducted in two parts:

In the first part, we analysed existing systems and networks of geoinformation and information management in the national park organizations in North America (Parks Canada Agency and the U.S. National Park Service) and in four national parks in the Alps (Berchtesgaden NP, Germany; Hohe Tauern

	Austria	France	Germany
	Gesäuse NP	**Parc National des Ecrins**	**Berchtesgaden NP**
	GIS in use since 2000	GIS in use since 1992	GIS in use since 1980
	Park management is organized as private limited company	NPs are part of public administration and subordinated to DNP	Park management is part of public administration of the Free State of Bavaria
	So far no nationwide coordination via managing organizations	As yet no nationwide coordination via managing organizations, but planned	As yet no nationwide coordination via managing organizations
	Organized and funded by the park management, part of the nature protection division	Organized by the park management, funded by research and projects	Organized by the park management, part of the functional area research and IT
	management, analysis, cartography, research	more in management than in research	research, monitoring, management
	Desktop GIS in the park	Desktop GIS in the park	Desktop GIS and geodata server in the park, also geodata server at the federal administration
	Federal and governmental data free of charge	Data from Institut Géographique National are free of charge	Data of the Free State of Bavaria are free of charge
	20–30% FTE, resources limited	100% FTE plus 50% FTE internship, limited resources	150% FTE GIS specialists, 400% FTE users limited, resources
	Joint projects, personal contacts, contacts with universities	Two meetings every year, beginning coordination through Parcs Nationaux de France	Joint projects, workshops, cooperation with the computing centre of the Free State of Bavaria and Salzburg University
	None, but geodata server and metadata portal desired	Applications at different levels for park staff, web map server planned	Geodata server exists, internet map server planned
	Common data models with project partners	Common data models with project partners	Common data models with project partners and harmonization with the Free State of Bavaria
	Planned metadata catalogue	Metadata catalogue planned	Metadata catalogue exists

NP, Austria; Gesäuse NP, Austria; Parc National des Ecrins, France). We chose these organizations for their long traditions in GIS use and their activities in joint projects. In addition, we decided to analyse national park organizations with different organization structures to get a wide variety of insights into the possibilities of information management strategies. The GI specialists of the selected national park organizations were interviewed using informal guided interviews. The guideline included the most important aspects of SDI-type strategy, infrastructure, geodata, resources, cooperation, services and the standards used for data and metadata. As the parks differ in structure and organization, the guidelines were adapted for each park organization. Guidelines were sent to the interview partners in preparation for telephone interviews. In addition to their statements and reports on information management practices and existing coordination and cooperation, the interview partners also assessed their current situation. In a second part of the study, an analysis of needs was conducted among all park projects in Switzerland by sending out a standardized questionnaire asking for their requirements regarding information management. In total, we sent out 34 questionnaires. Six questionnaires came back with a comment that the park project had been postponed or had failed. Nine park projects did not reply. The overall effective rate of response was thus 68%. The nineteen completed questionnaires do not allow a wide variety of statistical analyses. Several respondents remarked that the questionnaire was rather complex and that they had answered some of the questions only partially. This lead to a rise in missing values and the number of cases varies for each question. At the time of the survey, most of these park projects had not passed the evaluation process of the FOEN for becoming parks of national importance, therefore most of these park projects did not yet have a fully staffed park management including GIS experts. So it was in most cases park managers and not GIS experts who filled in the questionnaires and they often could not reflect on their specific future needs regarding information management and GIS. Despite these difficulties, the answers to the questionnaire gave a first insight into the requirements, pressing problems and wishes regarding geoinformation and IT management in protected areas in Switzerland.

The status of geoinformation in parks in North America and in four selected national parks in the Alps

In Canada and in the United States, the national park system is part of the public administration and parks are embedded in the national managing organizations US National Park Service (NPS) and Parks Canada Agency (PCA). GIS in the NPS is coordinated nationwide by the National Information Systems Center, which develops the strategies and programs of geoinformation management (Table 1). In Canada, the official nationwide coordination of GIS in the parks began in 2007 by the Geomatics Coordinator of the PCA, but GI specialists have met regularly for fifteen years.

In France, national parks are also part of the public administration and report directly to the Direction de la Nature et les Payages (DNP). National parks in Germany are part of the public administration of the federal states and report to the respective state's ministry

Table 2 – Importance of spatial data (N=18)

	Total Highly relevant: 2 points Important: 1 point Not relevant: 0 points	Number of mentions		
		Not relevant	Important	Highly relevant
Topical maps	**31**	0	5	13
Spatial and land-use plans	**31**	0	5	13
Topographical maps	**30**	0	6	12
General plans	**28**	1	6	11
Aerial images/orthophotos	**26**	0	10	8
Terrain model	**17**	5	9	4
Satellite images	**11**	8	9	1

responsible for nature protection. In Austria, nature protection is the responsibility of the federal states, but here the parks can be organized in different ways. In contrast to North America, the park organizations in these three countries have as yet taken on no nationwide coordinating tasks in geoinformation management, but there are plans to do so in France.

As the parks are linked to the public administration, they can use geodata of governmental and federal agencies free of charge. In the US, the national parks can use base data from the USGS, which are available publicly and free of charge.

In most of the interviewed parks, the GIS of the particular park is organized and funded independently. Although geoinformation management is mostly situated in the park divisions dealing with resource management or research and protection, geoinformation is used in all tasks and by all user groups in parks, albeit with differing emphases. GIS is mainly used in research, monitoring and management support. In North America above all, use of GIS in the areas of security, visitor information and communication has become important. All interview partners pointed out that human resources for GIS in most of parks are limited and an increase would be desirable.

In North America, the expertise is bundled in nine Regional Technical Support Centres (US) and three Regional Services Centres (Canada), where GIS programs are implemented and where GI specialists in the parks get support with advanced analysis and data management tasks. These centres also coordinate and implement tasks across multiple parks. In Europe there is no such concentration of expertise.

Both in Canada and in the US, cooperation and coordination within GIS between the parks are considered to be quite good, albeit with room for improvement and development. In the US, cooperation between the parks mostly takes place between the parks and the Regional Technical Support Centres and within the framework of projects conducted by the NPS GIS Program Office. Coordination takes the form of standardization and harmonization of data, with the goal of unifying NPS-wide data sets, which are to be made available over distributed standardized services.

Cooperation within information management between the interviewed parks in Europe ranges from personal contacts through workshops and joint projects (e.g. in research and tourism) to initiatives at European levels, as already shown for parks in Middle and Eastern Europe by Wagenknecht & Walz (2007). The will to cooperate is very strong and cooperation is considered essential.

Analysis of information management requirements of park projects in Switzerland

The park managers were asked to assess the importance of spatial data for their work (Table 2). The establishment of a park of national importance involves several stages, starting with a feasibility study, going through a project planning and implementation phase before going into full operation. At the time of the survey, most park projects were still in the project phase and therefore the park managers were not yet able to reflect on what might be of importance for their parks in the future or provide much information on the current situation of information management. The answers clearly show that processed data, especially topographical and thematic maps, are considered highly relevant for park management. Aerial images and orthophotos are seen as important, whereas terrain models and satellite images are of less relevance.

Aspects of information and related data besides spatial data are important for park management.

Table 3 – Park management tasks and information and data requirements

Data types:	Tasks of parks: Management	Research	Communication and public relations
Basic spatial information			
Socio-economics			
Ecology			
Processes & dynamics			
Flora & fauna			
Spatial planning & landscape planning			
Infrastructure			
Park administration			
Education and visitor information			
Visitors			
Communication/PR			
Sources			

Legend:

Relevance/number of mentions	High	Medium	Low	No mentions

Table 4 – Advantages of coordinating information and data management

	Total A: 3 points B: 2 points C: 1 points D. 0.5 points Rest: 0 points	Number of mentions				
		A	B	C	D	E, F, 0
Benefiting from (technical) skills of others	**30**	8	2	2		5
More efficient & professional park administration	**20.5**	3	3	5	1	5
PR effect	**15**	2	4	1		10
Savings	**13.5**	1	2	5	3	6
Stronger bargaining position	**13.5**	1	4	2	1	9
Better cooperation	**12.5**	2	2	1	3	9

Three fields of activities could be distinguished, where specific information and data are requested by park managers:

- management: general management issues, planning of measures, project development, knowledge management
- research: monitoring, controlling, analyses
- communication and public relations: marketing, education and sensitization

Table 3 shows what kind of information and data is being used and what is likely to be used in future for different park management tasks.

Management tasks require mainly basic information for spatial planning as well as infrastructure. Visualization is important for displaying planning criteria. Data on spatial planning issues, infrastructure as well as data used in education packages and visitor information are important for communication and public relations. For research tasks, park managers mainly request data on socio-economic aspects and on nature (ecology, flora and fauna). These are mainly used to analyse changes in the region and monitor development.

Managers of parks that are not fully established yet find it difficult to assess which of the requested information and data should be recorded, processed and provided internally or externally. In general, two groups of information could be identified from the responses:

- basic information, socio-economics, ecology, processes and dynamics, flora and fauna, spatial planning and landscape planning: this is general, basic information and often thought to be expensive and to require lots of statistical analyses. Such information and data could be managed externally as not every park has the resources to manage this internally. However, if included into a coordinated information system, flexibility has to be rather high since the parks might have different interests in assessing and processing the data.
- infrastructure, park administration, visitors, communication and public relations are mainly data used for administrative tasks and could be managed internally.

We also asked park managers what kind of problems they experience in obtaining data from various sources. The responses made it clear that finding the right information and data as well as the cost of doing so are major problems for them. Only four parks have special licence agreements for data with federal offices such as the Federal Office of Statistics or the Federal Office for the Environment. Most parks have not dealt with the question of licence agreements yet due to the incipient status of their park projects.

These results show that park managers could be interested in some kind of coordination regarding information and data management, but it says nothing about the dimensions of such coordination. When asked explicitly about coordination of information and data management, the answer is very clear: most parks regard coordination as important and see it as an effective way of saving financial, personal, time and infrastructure resources (Table 4).

Benefiting from (technical) skills of others was mentioned as one of the most important advantages of coordinating information and data management. Most of the respondents are not experts in geoinformation management and could not clearly assess and name the pros and cons of coordination. The results of this assessment should therefore be considered as preliminary references in the discussion on future cooperation and coordination of geoinformation management.

Discussion and conclusion

The interviews in park organizations showed that geoinformation has become an accepted and well established component of park management, with over 20 years of use in some parks. Geoinformation is used in all tasks and by all user groups in parks, albeit with differing weighting. The national parks in North America, with their managing organizations National Park Service and Parks Canada Agency, are at the forefront of coordination and cooperation in geoinformation management. Expertise is bundled in regional centres of competence.

The survey in Switzerland shows that hardly any common standards or jointly used infrastructures were established yet but there was a strong will to cooperate. At the time of the survey, most participating park managers were in the middle of preparing the management plans to fulfil the requirements of the FOEN for further evaluation of the park projects. It was therefore rather difficult for them to go into concrete detail about possibilities for future coordination of information and data management. Interviewees pointed out that human resources for GIS in most parks are limited. The interviews also highlight differ-

ing access to national geodata. The answers revealed that park managers are struggling to provide data and the financial requirements for the infrastructure. They support coordination and cooperation on information management. At the time of the survey, most park managers could not clearly assess their future strategies for coordinating information management because of the early project status and they often lack familiarity with the topic of geoinformation management. However, when we look at the solutions found in other parks of Europe and North America, there are several possibilities that could also be sketched into a future coordination project in Switzerland, such as a centre of competence for GIS in parks or a joint licence for GIS data and software for all parks.

From the survey in the park projects in Switzerland and from the analysis of existing systems and networks on geodata and information management in protected areas in Switzerland and abroad, we can conclude that there is a major need for and great benefit in coordinating and cooperating in information management. Most parks in Switzerland are still in the phase of building up the park structure. All of them are confronted with questions regarding geoinformation management and information technology. We conclude that a group of experts is needed to draft possibilities for coordination and then discuss these with the park managers. As an initial step, we propose the creation of a network for these two topics, which enables joint data models and joint data acquisition or licences as well as research co-ordination. An even better solution would be to bundle a part of the resources in a common centre of competence.

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